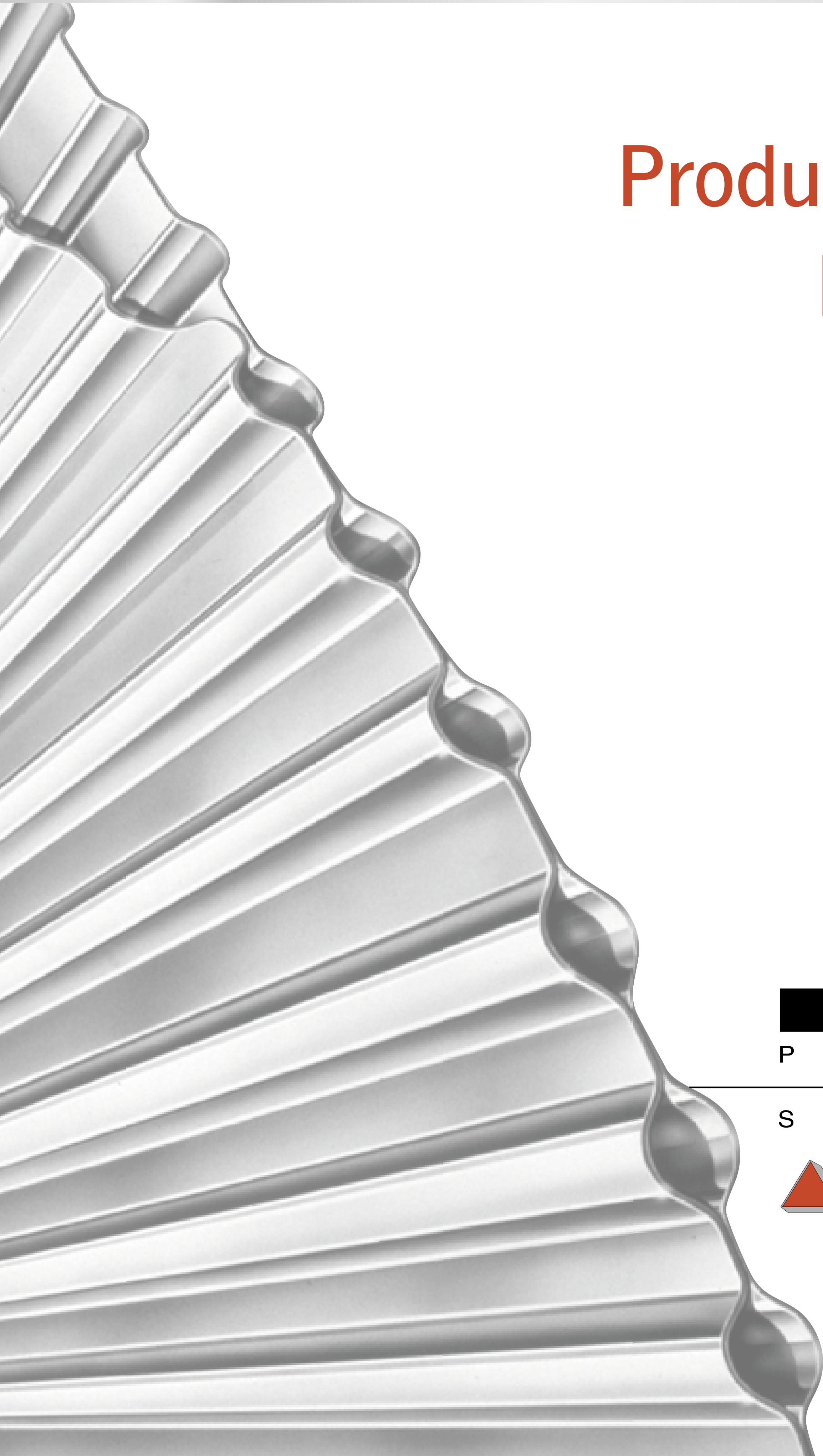


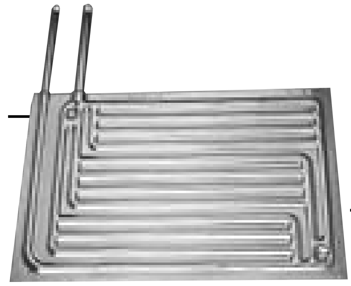
Product Data Manual

PLATECOIL®

PRIME SURFACE

TRANTER®

The heat transfer people



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Platecoil®
for HEAT TRANSFER

PLATECOIL is a very efficient and versatile prime surface type heat exchanger. Its unique design remains the key to both its high heat transfer efficiency and versatility for heating and cooling applications.

By providing the right answers to a broad range of heat transfer needs PLATECOIL heat transfer equipment has been saving thousands of engineering, fabrication, and installation man-hours in numerous industrial applications for over 50 years. Its continuing popularity is a direct result of its proven capability to satisfy an almost unlimited variety of requirements for size, shape, pressure containment, capacity, materials and surface finishes.

Every PLATECOIL product is backed by an experienced staff of sales representatives, engineers and modern production facilities. These resources are readily available to analyze and solve your specific heat transfer need, no matter how complex or complicated that may be.

In the event your heat transfer requirements are relatively uncomplicated, the information presented in this manual will allow you to specify the PLATECOIL that fits your specific application. Every effort has been made to present a selection of data that will be reliable and helpful, both from the standpoint of selecting the proper heat transfer surface and in determining heat transfer rates, fluid flow rates, etc.

Please remember that industrial heat transfer processes are not generally subject to rigidly controlled conditions. As a result, factors affecting heat transfer rates, material life and other items can vary from day-to-day. Therefore, the pertinency of the engineering data in this manual as applied to a specific application must be judged in relationship to the variables involved. Also, the information in this manual is subject to change without notice. The manufacturer reserves the right to change specifications at any time.

Whatever your heat transfer need may be, contact the PLATECOIL representative in your area. Put his experience and heat transfer know-how to work for you . He'll see to it that the PLATECOIL product you require is designed and built to exactly meet your specific application requirements and you will receive the best possible return on your PLATECOIL investment.

For further information, contact:
PLATECOIL • Tranter, Inc. • P.O. Box 2289 • 1900 Old Burk Highway (76306) • Wichita Falls, Texas 76307
Telephone: (940) 723-7125 • FAX (940) 723-5131 • Visit our website at: http://www.tranter.com

TRANTER®
The heat transfer people

Platecoil Heat Exchangers

What is PLATECOIL...

PLATECOIL designates a group of heat transfer products fabricated from two metal sheets, one or both of which are embossed. When welded together, the embossings form a series of well-defined passages through which the heat transfer media flows. Two embossed sheets welded together form a Double Embossed PLATECOIL. One embossed sheet welded to a flat companion plate is know as a Single Embossed PLATECOIL.

MULTI-ZONE PLATECOIL

The passages formed by the embossings are designed to provide PLATECOIL users with a choice of two basic flow patterns, depending on the application. PLATECOIL's *Multi-Zone* flow configuration is ideal for use when steam is the heating medium. The Serpentine flow configuration finds wide application with liquid heat transfer media such as water, oil and liquid refrigerants.

With its zoned header design, *Multi-Zone* PLATECOIL provides far more heat transfer efficiency than pipecoil or units with straight headers in applications requiring the use of steam. The *Multi-Zone* headers and flow arrangement provide controlled distribution of the steam as it flows through the PLATECOIL. The rate of condensate removal from the passages or passes is significantly increased as compared to units with straight headers. Efficiency reducing condensate blocking is minimized. As a result, *Multi-Zone* PLATECOIL provides faster heat-up and better heat transfer rates.

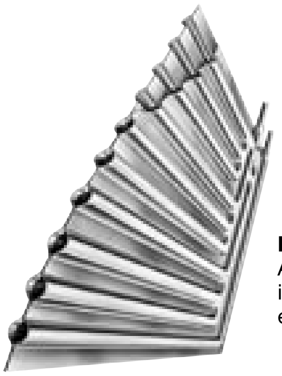


Fig. 2-1
A double embossed PLATECOIL unit is formed by welding together two embossed metal sheets.

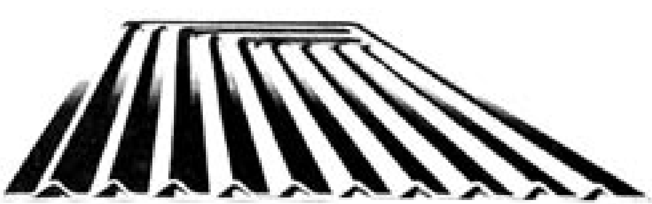


Fig. 2-2
In single embossed PLATECOIL, one sheet is not embossed, thus providing a flat surface and a reduction in PLATECOIL thickness of about one half.

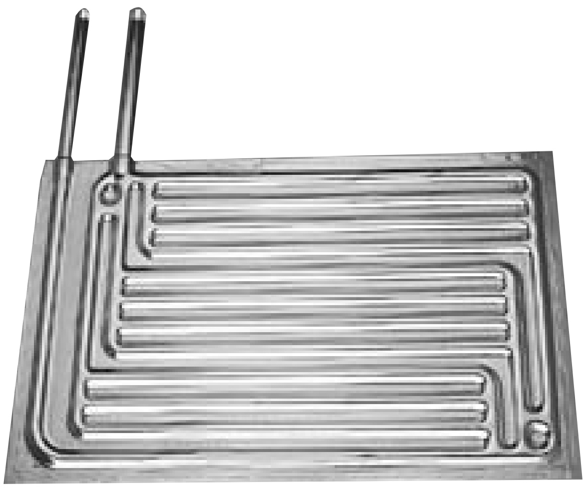


Fig. 2-3
Multi-Zone PLATECOIL—available in a wide range of widths, lengths and materials. An acknowledged standard wherever heat transfer is required in industry.

SERPENTINE PLATECOIL

PLATECOIL with a *Serpentine* flow configuration provides outstanding performance with liquid heating or cooling media, because its configuration allows high internal flow velocities to be achieved. As a result, high heat transfer rates can be obtained. *Serpentine* PLATECOIL is frequently specified for use with cold water, high temperature hot water, hot oil and refrigerants. When used with refrigerants, the *Serpentine* flow design offers the additional advantage of eliminating the possibility of “short-circuiting”.

STANDARD STYLES, SIZES & FABRICATIONS

Both *Multi-Zone* and *Serpentine* double-embossed PLATECOIL are available in over 300 standard sizes. Several styles are also offered in a choice of either carbon steel or Type 316L stainless steel. A large inventory of standard PLATECOIL is maintained. Orders can often be shipped within a matter of a few days. Details on dimensions, configuration and types are presented on pages 5 through 23.

A variety of standard PLATECOIL fabrications, such as drum warmers, vessels, suction heaters, and screw conveyor troughs are also available. These pre-engineered units are designed to satisfy a wide range of heating and cooling requirements in industrial process applications. Refer to pages 34 through 42 for detailed information.

SPECIAL DESIGNS & FEATURES

PLATECOIL can be bent, rolled, or otherwise formed into virtually any configuration. It has inherent flexibility. In addition to carbon steel and stainless steel, PLATECOIL can be fabricated from such materials as Monel, nickel and a variety of other corrosion resistant materials. Flow configurations, other than *Multi-Zone* and *Serpentine*, can be specified to meet special design and performance requirements. Several types of surface finishes can be provided to minimize fouling and reduce maintenance. Large pass, heavy gauge PLATECOIL is another option available to satisfy requirements for high internal flow rates, low pressure drops and rugged use. Details on special PLATECOIL designs and features are provided on pages 14 through 28.

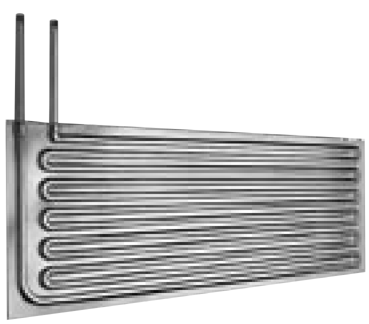


Fig. 3-1
Serpentine PLATECOIL — allows high internal flow velocities to be achieved.

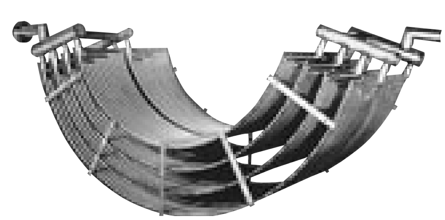


Fig. 3-2
PLATECOIL can be rolled to a specific diameter in either single or double embossed.

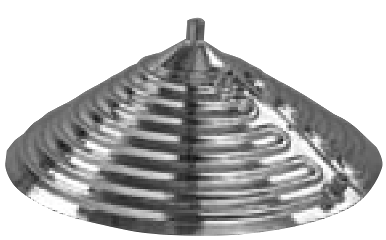


Fig. 3-3
PLATECOIL can be supplied in circles or other shapes with various flow patterns.

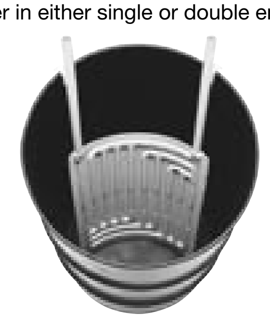


Fig. 3-4
A curved PLATECOIL for immersion in a drum warmer.

QUALITY CONSTRUCTION

Strict quality control standards govern the fabrication of all PLATECOIL products to assure structural integrity and durability. Since welding plays such an important role in PLATECOIL's fabrication process, only experienced personnel and modern welding equipment are utilized.

Lighter gauge carbon and stainless steel PLATECOIL embossings and components, for instance, are normally joined together using resistance welds. Other welding processes are also used as dictated by the type and gauge of material. PLATECOIL can also be ASME Code stamped as indicated on page 17. Details on the PLATECOIL welding criteria and fabrication processes are found on page 33.

FACTORY TESTED & INSPECTED

The final step in the PLATECOIL fabrication process is testing and inspection. All PLATECOIL receive an air-under-water leak test before being authorized for shipment. Other testing processes ranging from hydrostatic pressure test to mass spectrometer testing are also available to satisfy special requirements. Refer to page 16 for details.

PLATECOIL IS THE ANSWER

With its practically unlimited selection of materials, sizes, shapes, pass patterns, capacities and other features, PLATECOIL can meet an endless variety of heat transfer requirements. Whatever your need, plain or fancy, simple or complex, chances are PLATECOIL can meet it. PLATECOIL's versatility is the reason it remains one of the best known names in industrial heat transfer and maintains its position as the most efficient prime surface heat exchanger available.

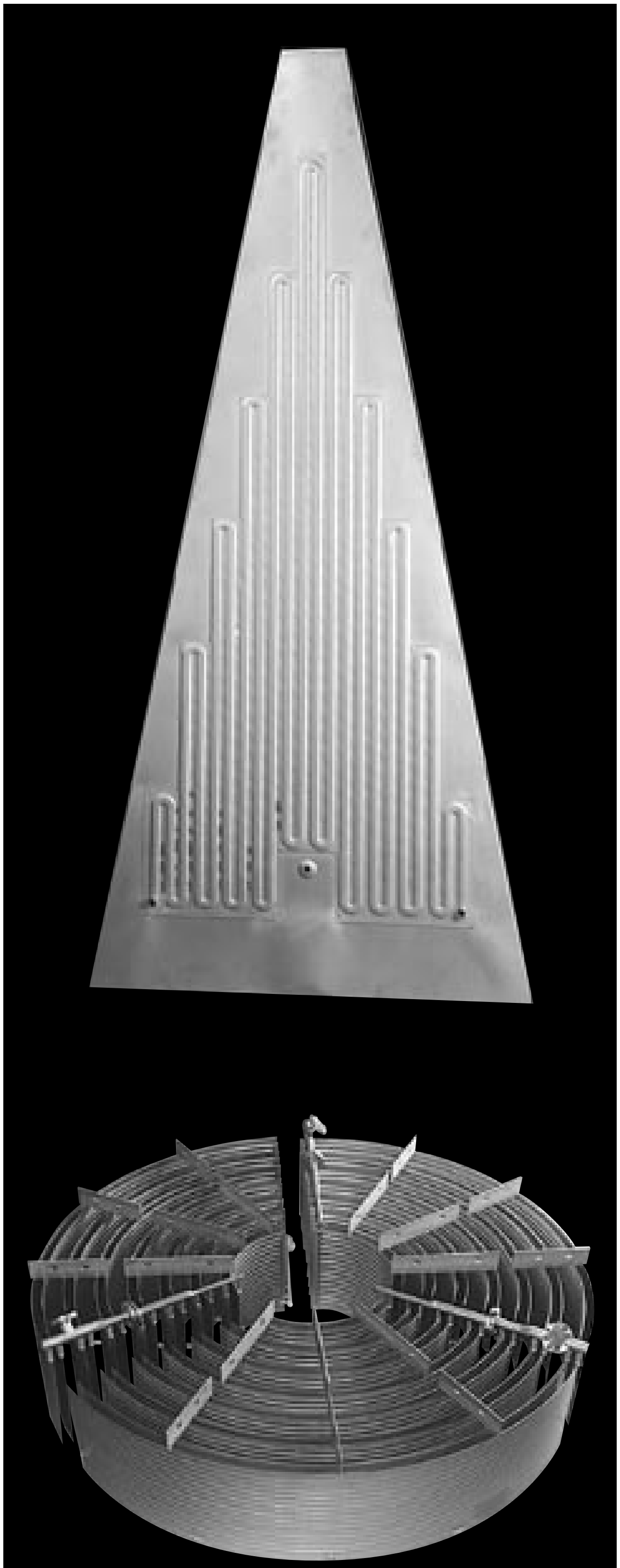


Fig. 4-1 Special PLATECOIL Designs

Standard Platecoil

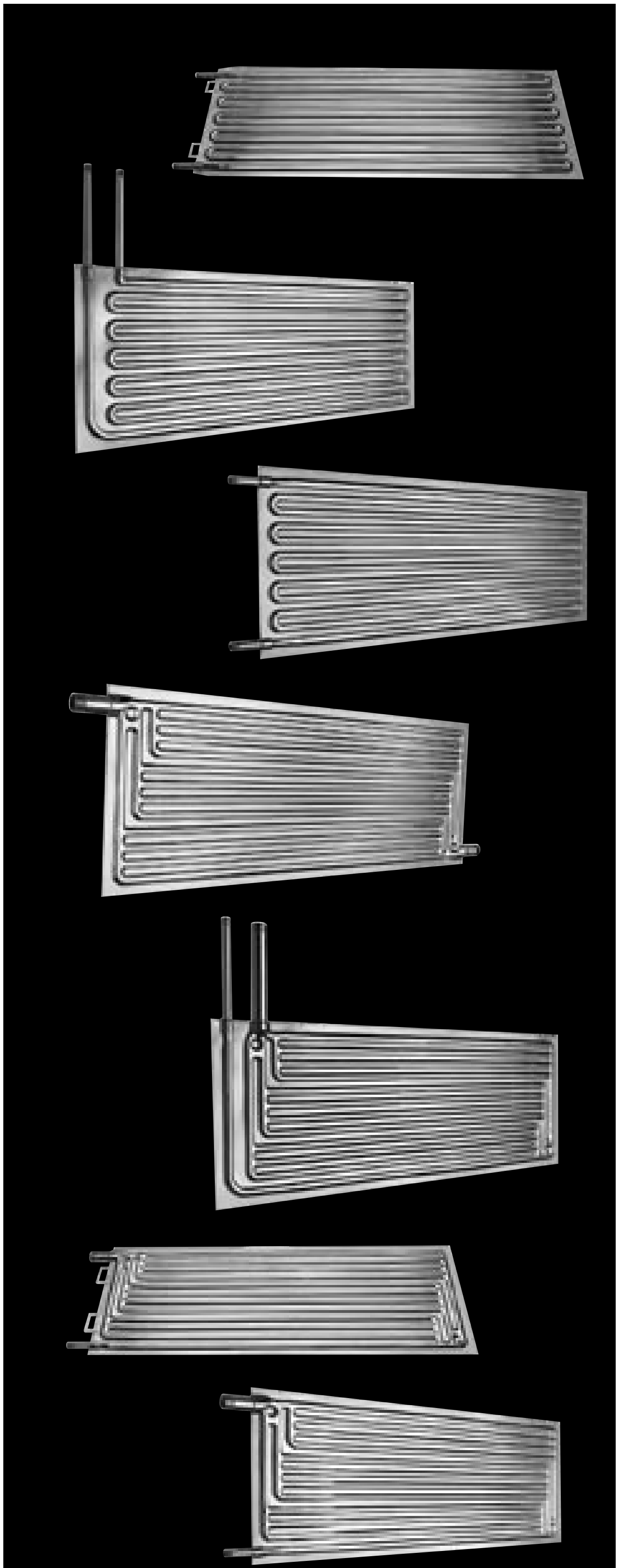


Fig. 5-1 Standard PLATECOIL

PROVEN PERFORMERS

The following pages contain data on several basic Standard styles. They have been selected as standard units, because over the years they have proven their ability to provide fast and highly effective answers to a wide range of heat transfer requirements. Many of these units, in a variety of sizes, are maintained in stock at the PLATECOIL factory. Shipment can often be made in a matter of days. Contact your PLATE-COIL Sales Representative for details on units available from stock.

STYLES

Standard Style PLATECOIL are available with either *Multi-Zone* or *Serpentine* flow configurations. *Multi-Zone* PLATECOIL includes the Style 90, Style 80 and Style 70. *Serpentine* PLATECOIL comes in two basic styles, the Style 60 and the Style 50. All styles can be furnished as double or single embossed units.

Standard styles can also be supplied in hydraulically expanded (ECONOCOIL®) construction (pages 99-101).

SIZES

Standard PLATECOIL are available in over 300 sizes; widths range from 12” to 43”. Length dimensions range from 23” to 143”. See the chart on page 12 for a listing of available sizes.

MATERIALS

Standard Style PLATECOIL materials include carbon steel and Type 316L stainless steel. Carbon steel PLATECOIL are available in 12 and 14 gauge material. Type 316L stainless steel PLATECOIL units are available in 14 and 16 gauge material.

Carbon steel PLATECOIL can be used in fresh water, mild alkalies, inorganic oils and caustics. It is also used in refrigeration service. Type SA-414 carbon steel contains 0.15% max. carbon and 0.25 to 0.50% manganese.

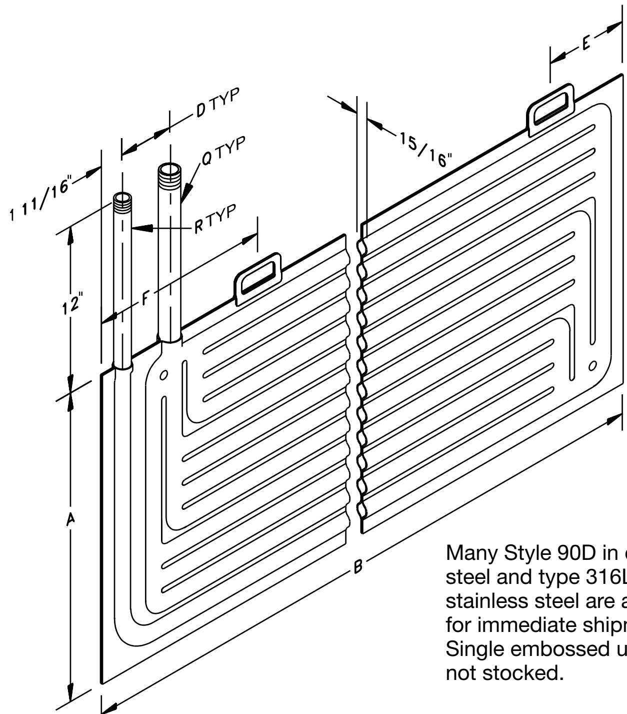
Type 316L stainless steel PLATECOIL are often used with phosphoric and nitric acids, plus a variety of other solutions. It is regularly found.in applications that cannot tolerate discoloration or contamination, such as in the processing of food and drugs.

The chemical breakdown of type 316L stainless steel is as follows. Composition: 10 to 14% nickel, 16 to 18% chromium, 2 to 3% molybdenum: and a maximum of 1% silicon, 2% manganese, 0.03% carbon. Other 300 series stainless steels are available.

PLATECOIL can be furnished in other materials as described on page 28.

PLATECOIL STYLE 90

This is a general purpose style PLATECOIL used with steam or other condensing media in thousands of open tank heating applications. It readily installs on the side of tanks with specially designed hangers, page 15. With pipe unions installed above the liquid level, PLATECOIL may be easily removed without emptying the tank. See page 80 for Quick Selection Chart.



Many Style 90D in carbon steel and type 316L stainless steel are available for immediate shipment. Single embossed units are not stocked.

Platecoil Style 90

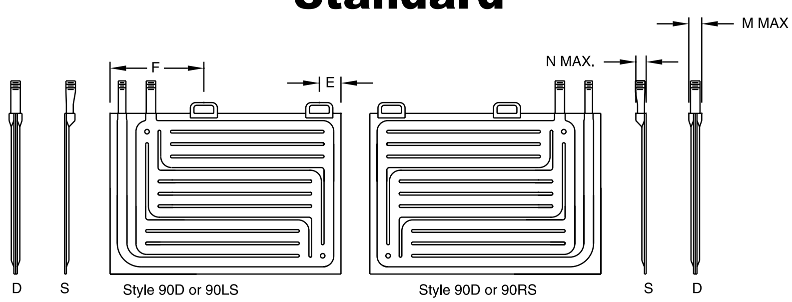
Dim. A (in.)		No. of Passes	Dimension (in.)						
Nominal	Actual		D	G	M	N	O	P	V
12	11 15/16	6	4	2 1/8	1 1/2	1 1/4	3 15/16	2 3/4	1 7/16
18	18 13/16	10	4	1 15/16	2 1/16	1 7/8	3 7/16	2 3/4	1 7/16
22	22 1/4	12	4	1 15/16	2 1/16	1 7/8	3 7/16	2 3/4	1 7/16
26	25 11/16	14	6	2 1/8	2 9/16	2 1/8	3 7/16	2 3/4	1 7/16
29	29 1/8	16	6	2 1/8	2 9/16	2 1/8	3 7/16	2 3/4	1 7/16
36	36	20	6	2 1/8	2 9/16	2 1/8	3 7/16	2 3/4	1 7/16
43	42 7/8	24	6	2 1/8	2 9/16	2 1/8	3 7/16	2 3/4	1 7/16

See page 12 for surface areas and weights. See page 14 for standard pass cross section.

Fitting Size Table for Double Embossed

Dim. A with Length B	Pipes—MPT		Coupling—FPT	
	Q (in.)	R (in.)	U (in.)	T (in.)
12”–All Lengths	1	3/4	1	3/4
18” & 22” –Thru 47”	1	3/4	1	3/4
18” & 22” –Over 47”	1 1/2	3/4	1 1/4	3/4
26”, 29”, 36”, 43”–All Lengths	2	1	1 1/2	1

Standard



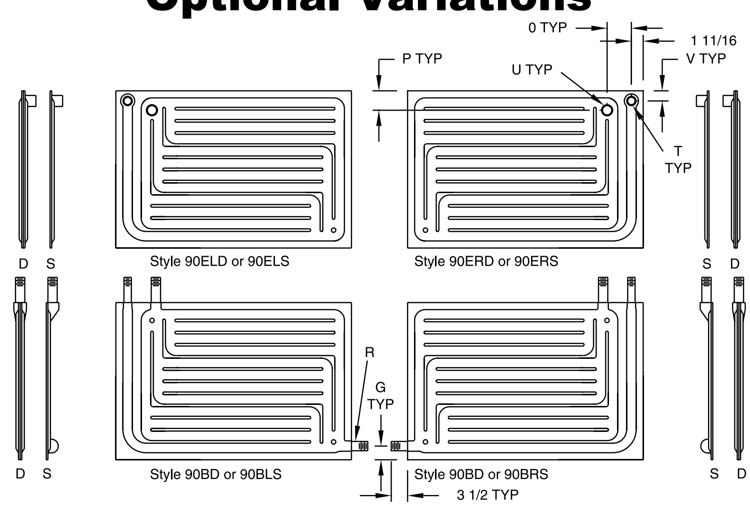
Handles supplied on single embossed only on request.

B,E & F Dimensions (in.)

Furnished as standard in the following lengths:								
B	E	F	B	E	F	B	E	F
23	3	11	59	3	13	107	3	13
29	3	11	71	3	13	119	3	13
35	3	13	83	3	13	131	3	13
47	3	13	95	3	13	143	3	13

B dimension is 1/2” shorter on PLATECOIL over 22” wide.

Optional Variations*



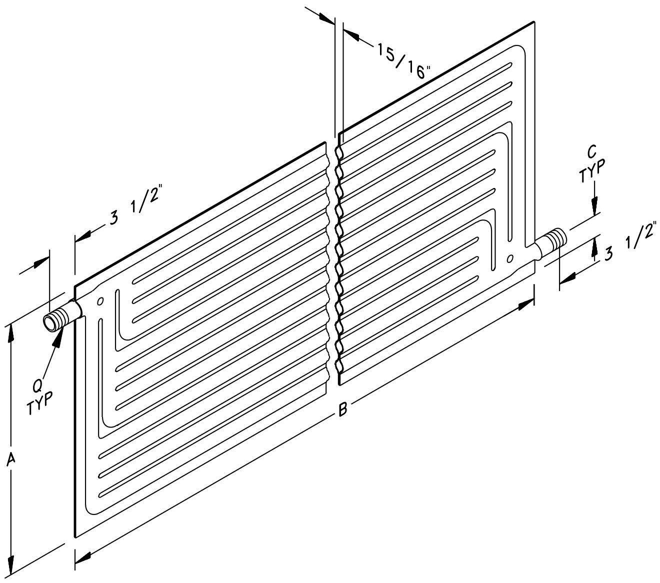
* Contact the factory for other available variations.

Fitting Size Table for Single Embossed

Dim. A with Length B	Pipes—MPT		Coupling—FPT	
	Q (in.)	R (in.)	U (in.)	T (in.)
12”–All Lengths	3/4	1/2	1	3/4
18” & 22” –Thru 47”	3/4	1/2	1	3/4
18” & 22” –Over 47”	1	1/2	1 1/4	3/4
26”, 29”, 36”, 43”–All Lengths	1 1/4	3/4	1 1/2	1

PLATECOIL STYLE 80

This versatile PLATECOIL is used with steam or liquids. It is particularly desirable for use with liquids involving high flow rates with resulting low pressure drops. Excellent for use on end in agitated tanks when steam is the heating medium (see pages 48 and 49). Handles are available at no cost and are located the same as on Style 70.



Platecoil Style 80

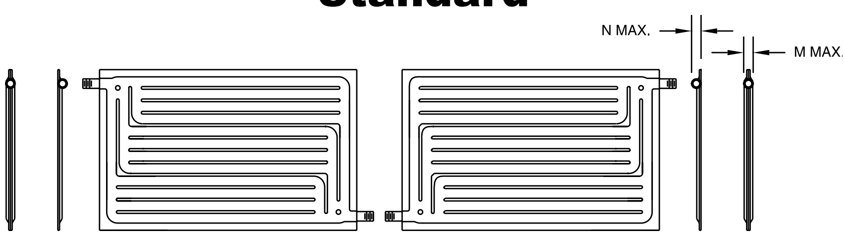
Dim. A (in.)		No. of Passes	Dimension (in.)				
Nominal	Actual		C	H	X	M	N
12	11 15/16	6	2 1/8	2 1/2	2 3/4	1 1/2	1 1/4
18	18 13/16	10	1 15/16	2 1/2	2 3/4	2 1/16	1 7/8
22	22 1/4	12	1 15/16	2 1/2	2 3/4	2 1/16	1 7/8
26	25 11/16	14	2 3/4	2 1/2	2 3/4	2 9/16	2 1/8
29	29 1/8	16	2 3/4	2 1/2	2 3/4	2 9/16	2 1/8
36	36	20	2 3/4	2 1/2	2 3/4	2 9/16	2 1/8
43	42 7/8	24	2 3/4	2 1/2	2 3/4	2 9/16	2 1/8

See page 12 for surface areas and weights. See page 14 for standard pass cross section.

Fitting Size Table for Double Embossed

Dim. A with Length B	Pipes—MPT	Coupling—FPT	
	Q (in.)	U (in.)	T (in.)
12"–All Lengths	1	1	3/4
18" & 22" –Thru 47"	1	1	3/4
18" & 22" –Over 47"	1 1/2	1 1/4	3/4
26", 29", 36", 43"–All Lengths	2	1 1/2	3/4

Standard



Style 80D or 80LS

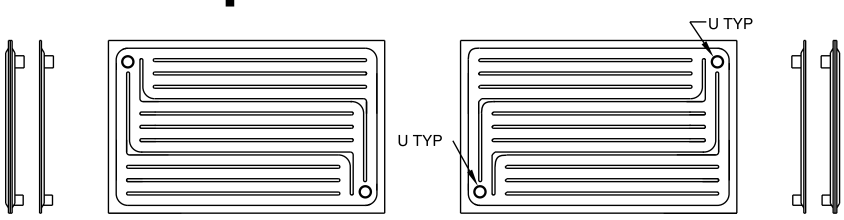
Style 80D or 80RS

B Dimensions (in.)

Furnished as standard in the following lengths:		
23	59	107
29	71	119
35	83	131
47	95	143

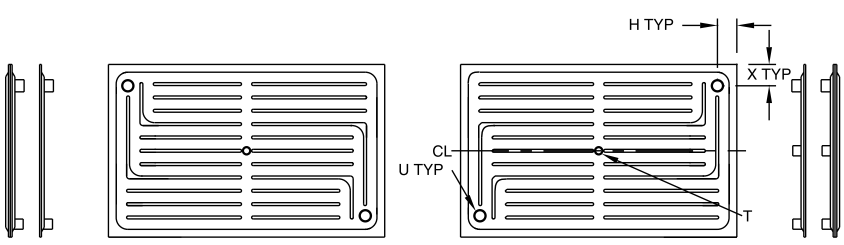
B dimension is 1/2" shorter on PLATECOIL over 22" wide.

Optional Variations*



Style 80ELD or 80ELS

Style 80ERD or 80ERS



Style 80MLD or 80MLS

Style 80MRD or 80MRS

* Contact the factory for other available variations.

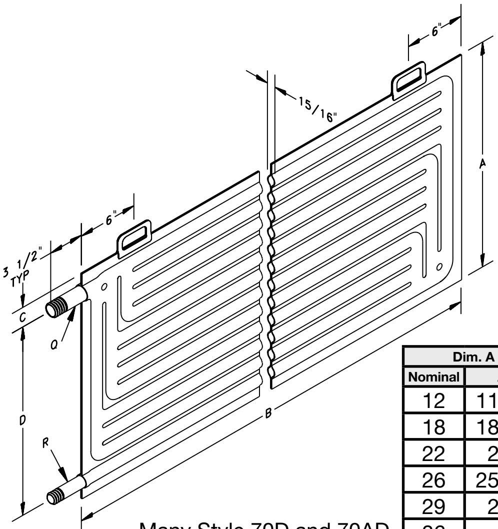
Fitting Size Table for Single Embossed

Dim. A with Length B	Pipes—MPT	Coupling—FPT	
	Q (in.)	U (in.)	T (in.)
12"–All Lengths	3/4	1	3/4
18" & 22" –Thru 47"	3/4	1	3/4
18" & 22" –Over 47"	1	1 1/4	3/4
26", 29", 36", 43"–All Lengths	1 1/4	1 1/2	3/4

PLATECOIL STYLE 70

Style 70 PLATECOIL are efficient for use with steam or other condensing media. Connections through the wall of a tank can be made conveniently or they can be installed vertically with handles on the end. For handles on end specify "Style 70A." 12" (A dim.) Style 70A are furnished with one end mounted handle, those over 12" have two handles.

For banking a number of Style 70 PLATECOIL to a common header, see page 50. See page 80 for Quick Selection Chart.



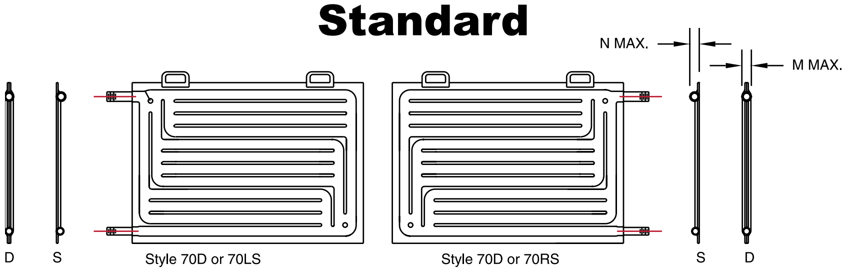
Many Style 70D and 70AD in carbon steel and type 316L stainless steel are available for immediate shipment.

Platecoil Style 70

Dim. A (in.)		No. of Passes	Dimension (in.)								
Nominal	Actual		C	D	X	H	I	K	L	M	N
12	11 15/16	6	2 1/8	8 1/8	2 3/4	2 1/2	7 1/2	6		1 1/2	1 1/4
18	18 13/16	10	1 15/16	15 3/16	2 3/4	2 1/2	14 3/8	6 1/8	6 3/16	2 1/16	1 7/8
22	22 1/4	12	1 15/16	18 5/8	2 3/4	2 1/2	17 13/16	6 1/8	10	2 1/16	1 7/8
26	25 11/16	14	2 3/4	21 1/4	2 3/4	2 1/2	21 1/4	7 3/4	10 3/16	2	2 1/8
29	29 1/8	16	2 3/4	24 11/16	2 3/4	2 1/2	24 11/16	7 3/4	13 5/8	2 9/16	2 1/8
36	36	20	2 3/4	31 9/16	2 3/4	2 1/2	31 9/16	7 3/4	20 1/2	2 9/16	2 1/8
43	42 7/8	24	2 3/4	38 7/16	2 3/4	2 1/2	38 7/16	7 3/4	27 3/8	2 9/16	2 1/8

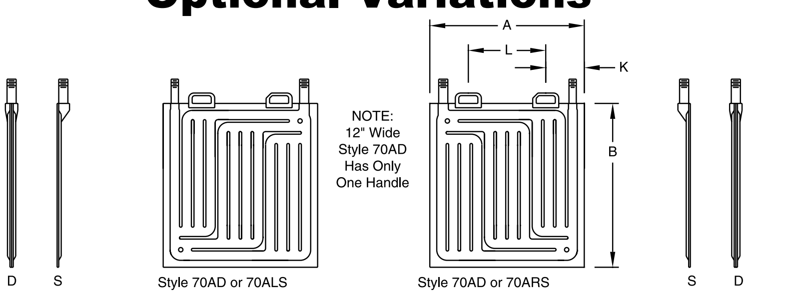
See page 12 for surface areas and weights. See page 14 for standard pass cross section.

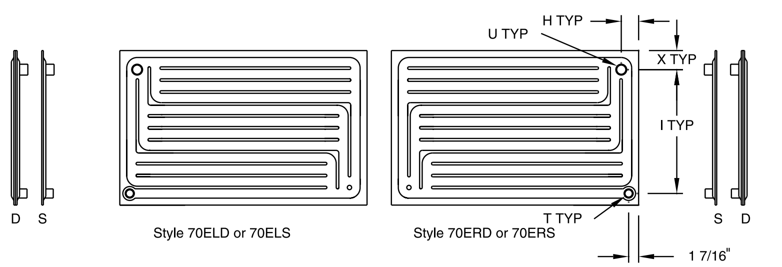
Standard



Handles supplied on single embossed only on request.

Optional Variations*





* Contact the factory for other available variations.

Fitting Size Table for Double Embossed

Dim. A with Length B	Pipes—MPT		Coupling—FPT	
	Q (in.)	R (in.)	U (in.)	T (in.)
12"–All Lengths	1	3/4	1	3/4
18" & 22" –Thru 47"	1	3/4	1	3/4
18" & 22" –Over 47"	1 1/2	3/4	1 1/4	3/4
26", 29", 36", 43"– All Lengths	2	1	1 1/2	1

B Dimensions (in.)

Furnished as standard in the following lengths:		
23	59	107
29	71	119
35	83	131
47	95	143

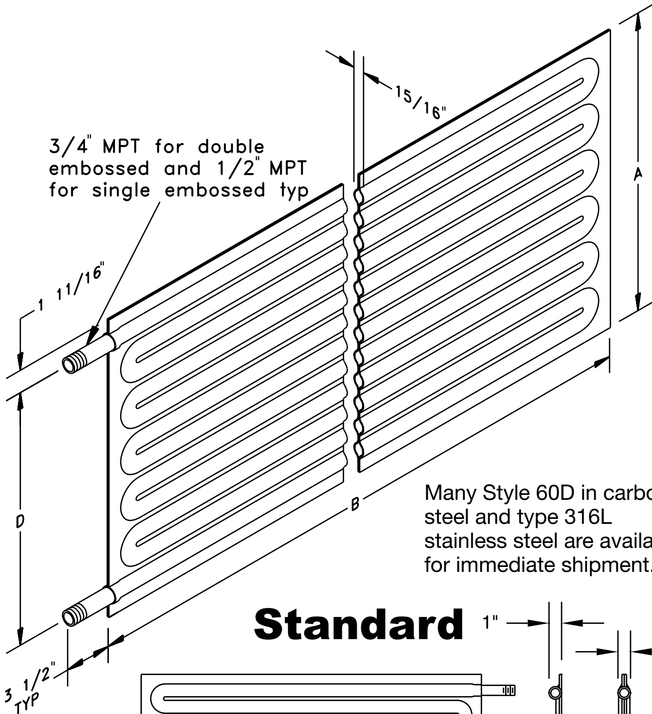
B dimension is 1/2" shorter on PLATECOIL over 22" wide.

Fitting Size Table for Single Embossed

Dim. A with Length B	Pipes—MPT		Coupling—FPT	
	Q (in.)	R (in.)	U (in.)	T (in.)
12"–All Lengths	3/4	1/2	1	3/4
18" & 22" –Thru 47"	3/4	1/2	1	3/4
18" & 22" –Over 47"	1	1/2	1 1/4	3/4
26", 29", 36", 43"–All Lengths	1 1/4	3/4	1 1/2	1

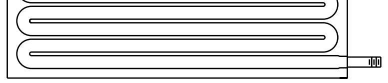
PLATECOIL STYLE 60

This *Serpentine* pass design is desirable for use with liquid heat transfer media. Generally used with cold water, high temperature hot water, hot oil, refrigerants, etc. The higher internal velocities obtained with liquids in the *Serpentine* design generally improve overall heat transfer rates. Handles are available at no extra charge and are located the same as on Style 70. For handles on side, specify "Style 60 With Handles." For handles on end, specify "Style 60A." 12" (A dim) Style 60A are furnished with one end mounted handle, those over 12" have two handles.



Many Style 60D in carbon steel and type 316L stainless steel are available for immediate shipment.

Standard

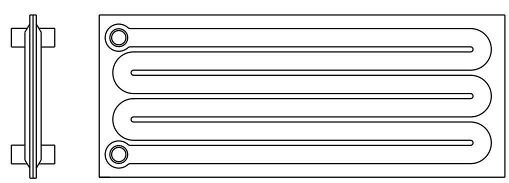


Style 60D or 60S S D

Table 1—for Styles 60, 60A, 60G, 60K

Dim. A (in.)		No. of Passes	Dimension
Nominal	Actual		D (in.)
12	11 15/16	6	8 9/16
18	18 13/16	10	15 7/16
22	22 1/4	12	18 7/8
26	25 11/16	14	22 5/16
29	29 1/8	16	25 3/4
36	36	20	32 5/8
43	42 7/8	24	39 1/2

See page 12 for surface areas and weights. See page 14 for standard pass cross section.



D Style 60N

Style 60N is a two circuit self-contained heat exchanger.

Optional Variations*

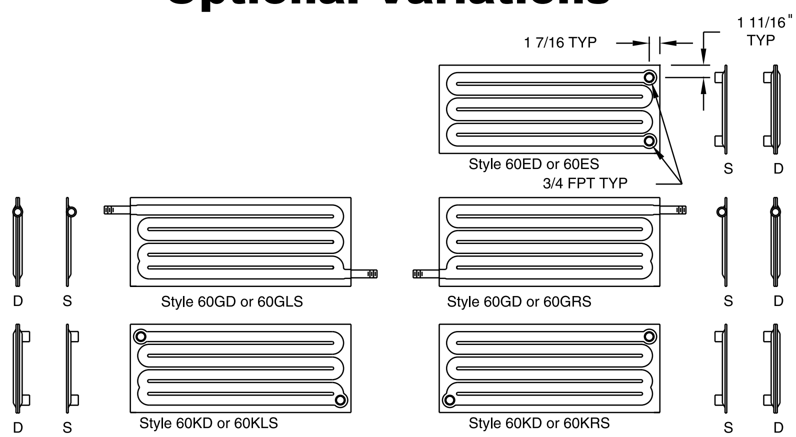


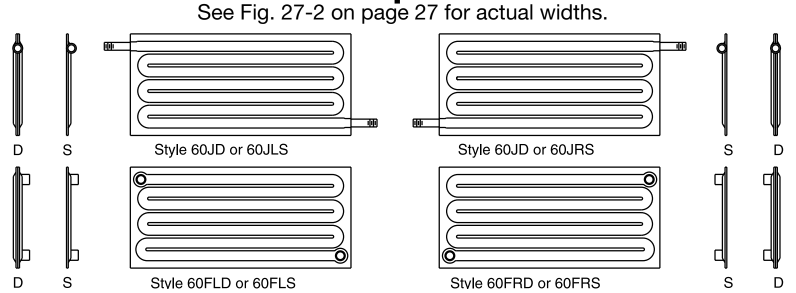
Table 2—All Styles B Dimensions (in.)

Furnished as standard in the following lengths:		
23	59	107
29	71	119
35	83	131
47	95	143

B dimension is 1/2" shorter on PLATECOIL over 22" wide.

Odd No. of Pass Optional Variations*

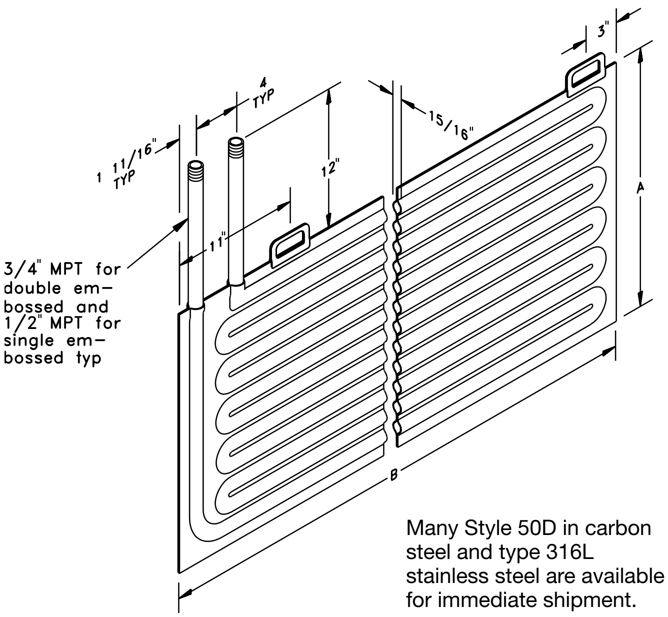
See Fig. 27-2 on page 27 for actual widths.



* Contact the factory for other available variations.

PLATECOIL STYLE 50

Style 50 *Serpentine* pass PLATECOIL is designed primarily for heating or cooling applications in open tanks when liquid heat transfer media are used. By merely breaking two connections the PLATECOIL can be removed without emptying the tank.



Many Style 50D in carbon steel and type 316L stainless steel are available for immediate shipment.

B Dimensions (in.)

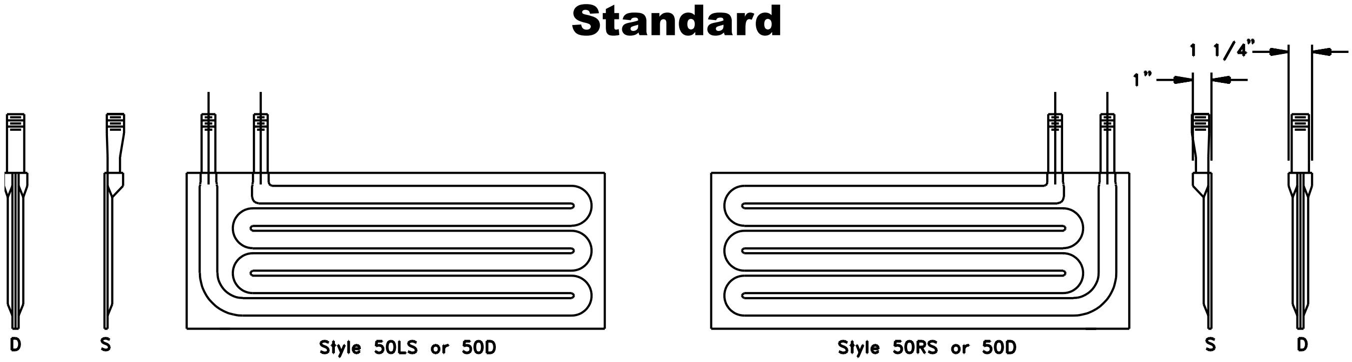
Furnished as standard in the following lengths:		
23	59	107
29	71	119
35	83	131
47	95	143

B dimension is 1/2” shorter on PLATECOIL over 22” wide.

Dim. A (in.)		No. of Passes
Nominal	Actual	
12	11 15/16	6
18	18 13/16	10
22	22 1/4	12
26	25 11/16	14
29	29 1/8	16
36	36	20
43	42 7/8	24

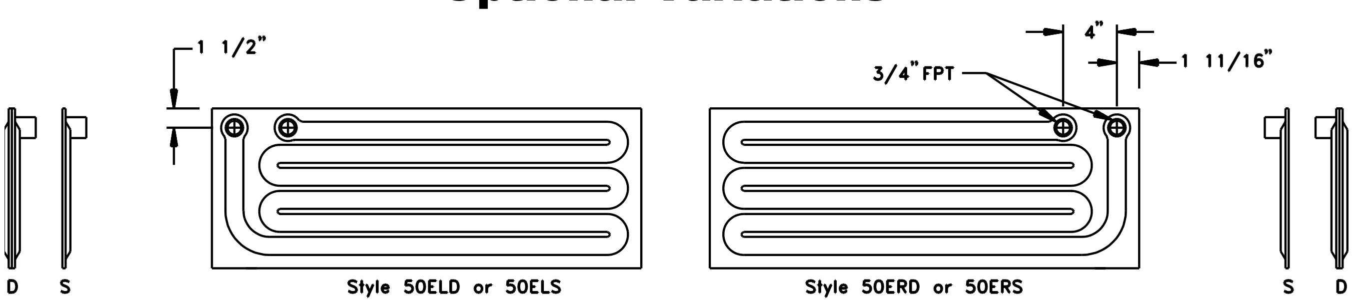
See page 12 for surface areas and weights. See page 14 for standard pass cross section.

Standard



Handles supplied on single embossed only on request.

Optional Variations*

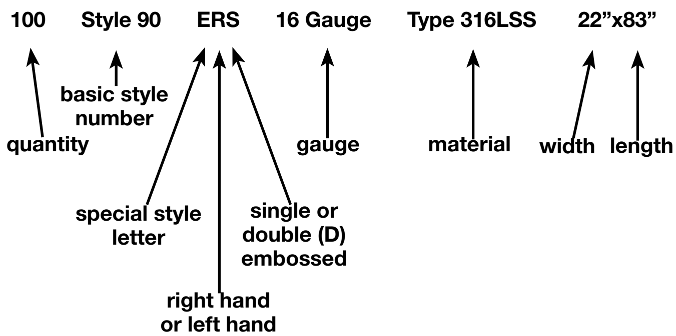


* Contact the factory for other available variations.

Standard Platecoil Ordering • Selection

ORDERING GUIDELINE

Faster and better service in filling orders for Standard Style PLATECOIL can be given if orders contain a complete description of the PLATECOIL required. The following illustrates the description for a typical order.



The letter codes which are used with the two digit Style numbers indicate the following:

Letter Code	Description
D	Double embossed
S	Single embossed
L	Left hand embossing for single embossed unit
R	Right hand embossing for single embossed unit
A, B, E, G, K, M, etc.	Inlet/Outlet locations and configurations

Here are some other points to remember:

a. Call out gauge. For single embossed, this applies to both the embossing and the companion plate.
b. For special inlet/outlet pipe lengths, call out as “Total pipe length.”
c. If PLATECOIL are to be rolled or curved, state whether the length or width dimension is to be curved.
d. Often a simple free-hand sketch accompanying the order, can clarify special details that would be difficult to describe otherwise.
e. Specify desired finish on stainless steel PLATECOIL, i.e. as welded, passivated, or electropolished.

MATERIAL SELECTION

For assistance in determining what material is best suited for your particular application, refer to the Material Selection Charts found on pages 29-32. Obviously, any material that has previously proven satisfactory in a particular application at your plant, would be a safe choice when the PLATECOIL is to be used for the exact same service.

SIZE SELECTION

The amount of surface area required to provide necessary heating or cooling can be calculated by referring to the Heat Transfer and Fluid Flow Calculations Section beginning on page 66.

GAUGE SELECTION

Maximum recommended operating pressures for PLATECOIL in various gauges are shown on page 16. In addition to this, there are certain other factors that should be considered when selecting the gauge of PLATECOIL for a particular application.

1. 14 ga. stainless PLATECOIL are preferable for industrial spray washers and similar equipment having high continuous operating heat load requirements. This heavier gauge has proven very satisfactory for the cyclic operating conditions encountered in these machines.
2. Many metal processing and chemical solutions are corrosive and cause some attack. This is particularly true of a heating unit due to the higher temperatures encountered. Examples are aluminum bright dip and sulphuric acid steel pickling solutions. For such applications the use of 14 or 12 ga. PLATECOIL will extend equipment life.
3. If the PLATECOIL will be in contact with an abrasive slurry a heavier gauge material is preferable.
4. Heavier gauge companions for single embossed PLATECOIL improve flatness and general rigidity. See the flatness standards on page 18.
5. The flat side surfaces of single embossed PLATECOIL can be free of seam weld marks if the companion plate is 3/16” or heavier. These thicknesses are MIG welded and this is done from the embossed side only.

SELECTION & OPERATING DATA

Standard PLATECOIL (3/4” Pass)

Surface Areas & Weight

Double Embossed Surface Areas

Fig. 12-1

ALL STYLES IN SQUARE FEET

Nominal Width Inches	Length in Inches											
	23	29	35	47	59	71	83	95	107	119	131	143
12	4.3	5.4	6.5	8.8	11.1	13.3	15.6	17.8	20.1	22.3	24.6	26.8
18	6.8	8.5	10.3	13.9	17.4	21.0	24.5	28.1	31.6	35.2	38.7	42.3
22	8.0	10.1	12.2	16.4	20.6	24.8	29.0	33.2	37.4	41.6	45.8	50.0
26	9.2	11.7	14.1	18.9	23.8	28.6	33.5	38.3	43.2	48.0	52.9	57.7
29	10.5	13.2	16.0	21.5	27.0	32.5	38.0	43.5	49.0	54.5	60.0	65.5
36	12.9	16.3	19.7	26.5	33.3	40.1	46.9	53.7	60.5	67.3	74.1	80.9
43	15.4	19.5	23.5	31.6	39.7	47.8	55.9	64.0	72.1	80.2	88.3	96.4

Areas of Flat Side Only for Single Embossed

Fig. 12-2

ALL STYLES IN SQUARE FEET

Nominal Width Inches	Length in Inches											
	23	29	35	47	59	71	83	95	107	119	131	143
12	1.9	2.4	2.9	3.9	4.9	5.9	6.9	7.9	8.9	9.9	10.9	11.9
18	3.0	3.8	4.6	6.1	7.7	9.3	10.8	12.4	14.0	15.5	17.1	18.7
22	3.6	4.5	5.4	7.3	9.1	11.0	12.8	14.7	16.5	18.4	20.2	22.1
26	4.1	5.2	6.2	8.4	10.5	12.7	14.8	16.9	19.1	21.2	23.4	25.5
29	4.7	5.9	7.1	9.5	11.9	14.4	16.8	19.2	21.6	24.1	26.5	29.0
36	5.7	7.2	8.7	11.7	14.7	17.7	20.7	23.7	26.7	29.7	32.7	35.7
43	6.8	8.6	10.4	14.0	17.6	21.1	24.7	28.3	31.9	35.4	39.0	42.6

Approx. Net Weights in Pounds: All Styles 14 ga. and 12 ga. Carbon Steel

Fig. 12-3

Nom. Width Inches	Length in Inches																							
	23		29		35		47		59		71		83		95		107		119		131		143	
	14 ga.	12 ga.	14 ga.	12 ga.	14 ga.	12 ga.	14 ga.	12 ga.	14 ga.	12 ga.	14 ga.	12 ga.	14 ga.	12 ga.	14 ga.	12 ga.	14 ga.	12 ga.	14 ga.	12 ga.	14 ga.	12 ga.	14 ga.	12 ga.
12	13	18	16	23	19	27	26	37	33	46	40	55	46	65	53	74	60	83	66	93	73	102	80	111
18	20	28	25	36	31	43	41	57	52	72	62	87	72	101	83	116	94	131	104	145	114	160	125	175
22	24	34	30	42	36	51	49	68	61	85	74	103	86	120	98	138	110	154	123	172	135	189	148	207
26	27	38	35	49	42	58	56	79	70	98	85	119	99	139	113	158	128	179	142	199	157	219	171	239
29	31	44	40	55	48	67	64	89	80	111	96	135	112	157	128	180	145	202	161	226	177	248	194	272
36	38	53	48	68	58	82	78	110	98	138	118	166	138	194	159	222	179	250	199	278	219	306	239	334
43	46	64	58	81	70	97	94	131	118	165	141	198	165	231	189	265	213	299	237	331	261	365	285	399

Approx. Net Weights in Pounds: All Styles, 16 ga. and 14 ga. Stainless Steel

Fig. 12-4

Nom. Width Inches	Length in Inches																							
	23		29		35		47		59		71		83		95		107		119		131		143	
	16 ga.	14 ga.	16 ga.	14 ga.	16 ga.	14 ga.	16 ga.	14 ga.	16 ga.	14 ga.	16 ga.	14 ga.	16 ga.	14 ga.	16 ga.	14 ga.	16 ga.	14 ga.	16 ga.	14 ga.	16 ga.	14 ga.	16 ga.	14 ga
12	11	13	14	17	16	20	22	27	28	34	33	42	39	48	44	55	50	63	56	70	61	77	67	84
18	17	21	21	27	26	32	34	43	43	54	52	65	61	76	70	87	79	98	87	109	96	120	105	131
22	20	25	25	32	30	38	41	51	51	64	62	77	72	90	83	103	93	116	103	129	114	142	124	155
26	23	29	29	37	35	44	47	59	59	74	71	89	83	104	95	119	107	134	119	149	132	164	143	179
29	26	33	33	42	40	50	53	67	67	84	81	101	94	118	108	135	121	152	135	169	149	186	163	204
36	32	40	41	51	49	61	66	82	83	103	100	124	116	145	133	166	150	188	167	209	184	230	201	251
43	38	48	48	60	59	73	79	98	99	124	119	148	139	173	159	199	179	224	199	249	219	274	239	291

For stainless PLATECOIL approximate shipping weight: Add 50% to above for one PLATECOIL per crate, 30% for two or more per crate. Carbon steel PLATECOIL are not crated.

SURFACE AREA AND WEIGHT CALCULATION

Calculation of Surface Area & Weight

The heat transfer surface area and total weight of any standard size, standard pass, single or double embossed PLATECOIL can be obtained readily from the tables on page 12. However, many applications may indicate the use of sizes other than those listed in the tables.

For standard pass PLATECOIL in sizes not included in the tables, the following equations permit quick calculation of surface area and weight.

Total Surface Area (sq. ft.)

$$\text{Area} = \frac{(A)\ (B)\ (2.26)}{144} = \text{sq. ft.}$$

where A = width in inches; B = length in inches

NOTE: For single embossed PLATECOIL, use 2.13 as a multiplier instead of 2.26. This gives the area considering both sides of the PLATECOIL, as used in immersion applications where space limitations or other factors may require the use of single embossed construction. For external clamp-on installations or single embossed tank wall sections, only the flat side area should be considered; the heat transfer surface area becomes simply:

$$\frac{(A)\ (B)}{144} = \text{sq. ft.}$$

Approximate Weight of PLATECOIL (lb.)

$$\frac{(A)\ (B)\ (2)\ (W)}{144} = \text{lbs.}$$

W = Weight per sq. ft. of material used (refer to table below)

For single embossed PLATECOIL with companion plate thicker than the embossing, or extending beyond the embossing, or both, the equation is:

$$\frac{(A_1)\ (B_1)(W_1)}{144} + \frac{(A_2)\ (B_2)\ (W_2)}{144} = \text{lbs.}$$

where:

A_1, B_1, W_1 equate to embossing dimensions and weight per sq. ft.

A_2, B_2, W_2 equate to companion plate dimensions and weight per sq. ft.

Weights of Various Metals (in pounds per sq. ft.)

Fig. 13-1

	U.S. STANDARD GAUGE REVISED, OR MANUFACTURERS' STANDARD GAUGE FOR SHEET METAL								PLATE	
	18 (0.0478")	16 (0.0598")	14 (0.0747")	12 (0.1046")	11 (0.1196")	10 (0.1345")	8 (0.1644")	7 (0.1793")	3/16 (0.1875")	1/4 (0.2500")
CARBON STEEL	2.000	2.500	3.125	4.375	5.000	5.625	6.875	7.500	7.650	10.195

	U.S. STANDARD GAUGE							PLATE	
	18 (0.0500")	16 (0.0625")	14 (0.0781")	12 (0.1094")	11 (0.1250")	10 (0.1406")	8 (0.1719")	3/16 (0.1875")	1/4 (0.2500")
STAINLESS STEEL 18-8	2.100	2.625	3.281	4.594	5.250	5.906	7.219	7.985	10.646
MONEL	2.297	2.848	3.583	5.007	5.742	6.431	7.855	8.590	11.484
NICKEL	2.311	2.865	3.604	5.037	5.776	6.470	7.902	8.642	11.553
ALLOY 20Cb-3	2.304	2.88	3.60	5.04	5.76	6.48	7.92	8.64	11.52
ALLOY B-2	2.40	3.03	3.75	5.24	6.01	6.78	8.27	9.04	12.02
ALLOY C-276	2.33	2.93	3.63	5.07	5.81	6.56	8.00	8.74	11.63
ALLOY G	2.12	2.68	3.31	4.63	5.31	5.99	7.31	7.99	10.62
INCONEL	2.210	2.740	3.450	4.820	5.530	6.150	7.510	8.210	10.970

	STANDARD THICKNESS								
	0.0236"**	0.032"	0.040"	0.045"	0.050"	0.056"	0.063"	0.080"	0.090"
TITANIUM*	0.554	0.751	0.938	1.056	1.173	1.314	1.478	1.877	2.112
ALUMINUM•• 5052-0	0.349	0.447	0.559	0.629	0.698		0.880	1.117	1.257

NOTE: FOR CLARIFICATION ALWAYS SPECIFY 7 GAUGE OR HEAVIER BY THEIR DECIMAL EQUIVALENT THICKNESS GIVEN IN INCHES.

* Available as ECONOCOIL Only.

** Standard Thickness for ECONOCOIL.

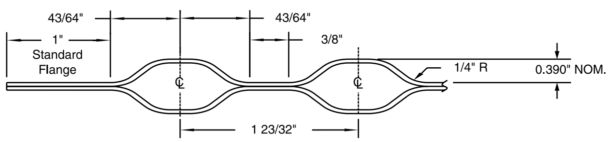
•• Not Available as PLATECOIL. Included for reference only.

PASS SIZE & HEADER DIMENSIONS

The embossings used for Standard Style PLATECOIL form what is termed a 3/4” size passage, or pass. This pass size is approximately equivalent in area to 3/4” steel pipe for double embossed units and 1/2” steel pipe for single embossed units. Refer to Fig. 14-1 and 14-2 for detailed dimensional information on pass configurations. Note Figure 14-3 concerning area data on headers. Large pass size Special PLATECOIL are also available. See page 21 for details.

Fig. 14-1

DOUBLE EMBOSSED

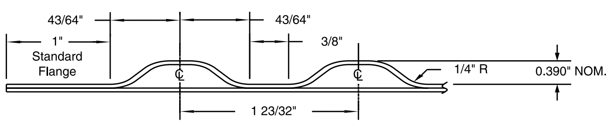


Internal Cross Sectional Area = 0.582 sq. in. nom.

Actual area varies with gauge and material.

Fig. 14-2

SINGLE EMBOSSED



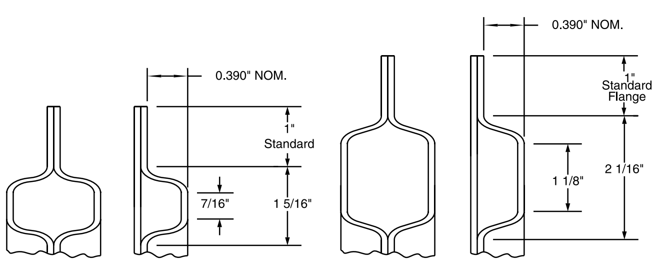
Internal Cross Sectional Area = 0.291 sq. in. nom.

Actual area varies with gauge and material.

Fig. 14-3

HEADER DETAILS

#320 Header | #667 Header



Double Embossed Cross Sectional Area of Header .640 sq. in.	Single Embossed Cross Sectional Area of Header .320 sq. in.	Double Embossed Cross Sectional Area of Header 1.334 sq. in.	Single Embossed Cross Sectional Area of Header .667 sq. in.

All areas vary with gauge and material.

Fig. 14-4

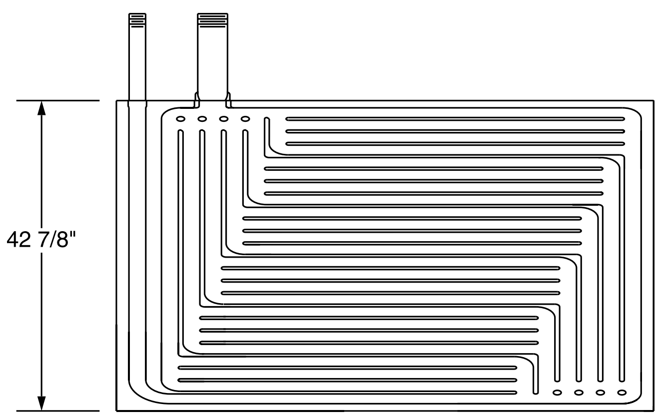
NUMBER OF ZONES AND PASSES PER ZONE FOR STANDARD (3/4” PASS) *MULTI-ZONE* PLATECOIL

Nominal Width Inches	Number of Zones	Number of Passes Per Zone Counting From Top to Bottom of PLATECOIL*	Total Number of Passes
12	2	3, 3	6
18	3	4, 3, 3	10
22	3	4, 4, 4	12
26	4	2, 4, 4, 4	14
29	4	4, 4, 4, 4	16
36	5	4, 4, 4, 4, 4	20
43	6	4, 4, 4, 4, 4, 4	24

* Last Zone includes condensate pass for Styles 90 and 70.

Fig. 14-5

MULTI-ZONE DATA



43” Wide PLATECOIL
Depicting Zone and Pass Layout

HANDLES

One or two handles (Fig 15-1) are furnished as standard on PLATECOIL Styles 90, 70 and 50. Unless specified, they are not furnished on Styles 80 or 60, or on Single Embossed PLATECOIL.

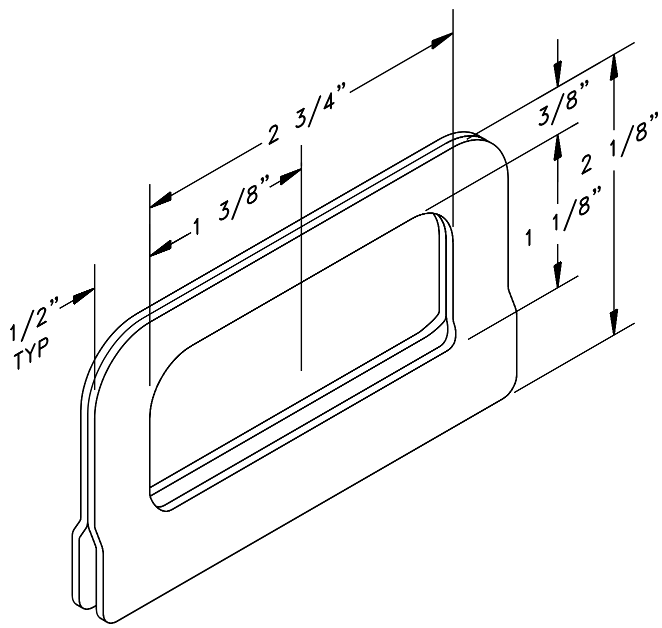


Fig. 15-1

STANDARD HANDLE*

See pages 7 through 11 for locations on PLATECOIL.
* Normally furnished, however ROD TYPE may be specified at no extra cost. ROD TYPE are furnished whenever a perimeter seal weld is required. Dimensions are basically the same as standard handles.

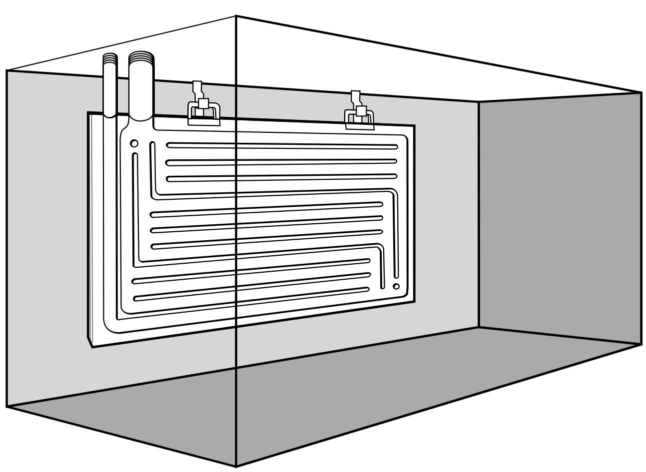


Fig. 15-2
Typical installation in a tank showing the use of QUICK CHANGE PLATECOIL hangers with a Style 90.

HANGERS

PLATECOIL "Quick Change" hangers are designed as a convenient, economical means of supporting PLATECOIL at the proper distance from the tank wall. They are constructed of the same material as the PLATECOIL with which they are used.

Two standard hanger models are available. No. 5504 is for use with PLATECOIL of 22-inch width, or less. They are fabricated from 14 ga. carbon steel and 16 ga. stainless steel and other alloys.

No. 8804 is for use with PLATECOIL widths of 26 inches thru 43 inches. They are fabricated from 14 ga. carbon steel and 16 ga.stainless steel and other alloys.

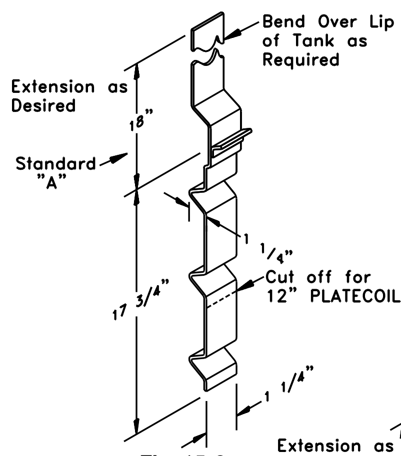


Fig. 15-3
Hanger No. 5504-18

The bottom edge of the PLATECOIL should be at least 3" off the bottom of the tank for natural circulation to occur.

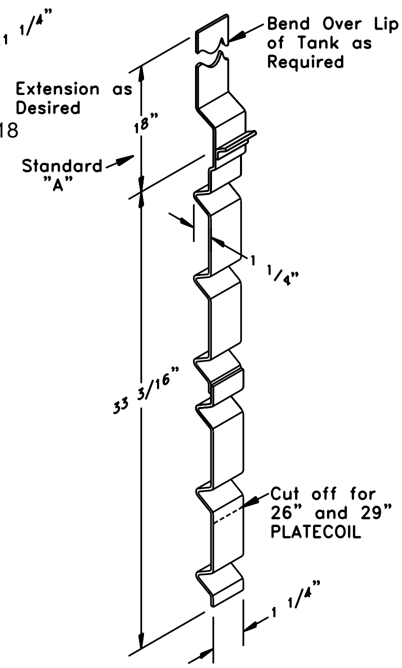


Fig. 15-4
Hanger No. 8804-18

NOTE: The "-18" indicates the standard extension length. If longer extension is required, indicate by changing, i.e., -30 would indicate 12 inches longer than standard. Specify material when ordering.

INTERNAL OPERATING PRESSURES FOR STANDARD (3/4” PASS) PLATECOIL

Fig. 16-1

Gauge		CARBON STEEL	304,304L, 316, 316L, MONEL
Double Embossed		PSI	PSI
16		180	250
14		300	330
12		400	400
Single Embossed		PSI	PSI
Embossing Companion			
16	16	130	160
16	14	145	190
16	12	180	205
16	11	205	240
14	14	190	240
14	12	215	270
14	11 & over	265	290
12	12 & over	265	300

Applicable to Style 70, 80 & 90 *MULTI-ZONE* and 320 header and Style 50 & 60 *SERPENTINE* pass.

ASME code pressure ratings are available from the factory upon request.

1. Standard test pressure is 250 psig air under water. For pressures above 250 psig hydrostatic tests are performed.
2. Ratings for carbon steel apply for -20°F to 500°F and are based on a 4 to 1 or greater safety factor without corrosion allowance.
3. Ratings for stainless steel and Monel apply up to saturated steam temperature for pressures shown with 5 to 1 or greater safety factor without corrosion allowance.
4. All pressures shown apply for resistance welding and for MIG welding when gauges permit.
5. For #667 header PLATECOIL use 50% of the operating pressures shown.
6. FABRICATION TECHNIQUES MAY PERMIT HIGHER OPERATING PRESSURES IN CERTAIN CASES.

EXTERNAL PRESSURE RATINGS FOR STANDARD (3/4” PASS) PLATECOIL

For use in pressure vessels and other miscellaneous applications, external pressure ratings become important considerations. The values shown in the chart are maximums at room temperature. No safety factor is included. If elevated temperatures are involved, contact the factory.

External Pressure Ratings

Fig. 16-2

STYLE	CARBON STEEL		STAINLESS STEEL	
	Gauge	External PSI	Gauge	External PSI
Double Embossed	14/14	600	16/16	400
	12/12	1400	14/14	600
Single Embossed	14/12	800	16/14	400
	12/12	1000	14/14	400
	—	—	14/12	800

LEAK & PRESSURE TEST OPTIONS

All PLATECOIL receive an Air-Under-Water Leak Test. The PLATECOIL are immersed in a water filled tank containing a leak detection agent. Air pressure is applied internally and the water is watched for bubbles. This test has proven superior to a hydrostatic test, since leaks can be more easily detected. This test is effective in checking for leak rates as low as 1 X 10^{-4} atmospheric cc/sec.

HYDROSTATIC TEST

The PLATECOIL is filled with water and a pump builds up pressure internally. The exterior surfaces are checked for leaks. This test is used for test pressures above 250 psig and at lower pressures when specified by the customer. In addition, it is always required for ASME code stamped PLATECOIL.

HELIUM LEAK TEST

The test is performed in a special booth and the PLATECOIL is charged with helium at 100 to 150 psig. A special probe is passed over external surface to check for leaks. This test is effective in checking for leak rates as low as I x 10^{-5} atmospheric cc/sec.

MASS SPECTROMETER TEST

This is the most sensitive leak test procedure used and is required for PLATECOIL for cryogenic service. The PLATECOIL is sprayed with helium or placed in a helium filled enclosure and a vacuum pulled on the PLATECOIL passes. Any helium that can leak into the passes is picked up by the machine and shows up as a leak rate on the indicator. Leak rates as low as 1 x 10^{-9} atmospheric cc/sec. can be detected.

ANALYSIS OF SENSITIVITY OF TESTS

A Helium test at 10^{-5} atmospheric cc/sec. is 10 times as sensitive as the 10^{-4} air under water test. The mass spectrometer test at 10^{-9} atmospheric cc/sec. is one hundred thousand times as sensitive as the 10^{-4} air-under-water test.

NOTE: Dye penetrant tests can be made to check welds for surface porosity, slag or cracks.

ASME CODE STAMPED PLATECOIL

PLATECOIL and PLATECOIL products can be code stamped with the ASME “U” Stamp or “UM” stamp.

The “U” stamp signifies that the product has been manufactured in compliance with the ASME Boiler and Pressure Vessel Code Section VIII, Div. 1 and that it has been inspected by an authorized inspector.

The “UM” stamp also signifies that the product has been manufactured in compliance with the ASME Boiler and Pressure Vessel Code but was exempted from code inspection.

On PLATECOIL and PLATECOIL products code stamped with the “U” stamp (not “UM” stamp) a National Board Number will be supplied if required by State and Local Boiler Codes, and registered with the National Board of Boiler and Pressure Vessel Inspectors (NB). National Board registration can also be provided in those cases where registration is not required by local or State codes but has been requested by the customer.

Code stamping of any type should be requested at the time of order if it is required. Please check State and Local Boiler Codes before specifying a code stamp.

Resistance welded and MIG welded PLATECOIL are code stamped in accordance with the ASME Code Section VIII, Division 1, appendix 17.

Other PLATECOIL fabrications can be code stamped if assembled by conventional processes covered by Section VIII, Division 1 of the ASME Boiler and Pressure Vessel Code.

SHIPMENT

Generally, any Code Stamped PLATECOIL product will be processed in a special manner and may require one to two weeks longer than normal fabrication times.

APPLICATIONS

PLATECOIL can be code stamped per the limitations below when used for the containment of substances other than those defined as lethal substances by Section VIII, Div. 1, Par. UW-2(a).

CODE STAMP MARKING DATA

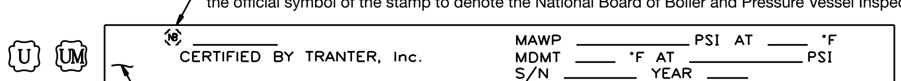
All PLATECOIL furnished with the code stamp will be marked by metal stamps on the flange between the fittings (whenever possible - otherwise the most appropriate flange or location). Markings will be as noted below with pressure, temperature, and serial number blanks filled in.

U-1A certificates are furnished with the “U” stamp and U-3 certificates with the “UM” stamp. U-2 certificates are supplied with components that will be incorporated into completed products by other manufacturers. Copies of the form will be supplied to the customer at time of shipment.

ASME NAMEPLATE

Fig. 17-1

The NB Symbol shown below is applied only if the unit is required to be registered with the National Board. It is the official symbol of the stamp to denote the National Board of Boiler and Pressure Vessel Inspectors Standard.



“U” or ”UM” symbol shown to the left is applied as required. They are the official symbols of the stamp to denote The American Society of Mechanical Engineers Standard.

ASME MATERIALS FOR PLATECOIL

Fig. 17-2

WELDING METHOD	GAUGES	MATERIALS
Resistance Welded: Per ASME Sec. VIII Div. 1 Appendix 17	.045” minimum 1/4” nominal-maximum or any combination not exceeding this min. or max.	CARBON STEEL: SA-414 (0.15% C Max.) STAINLESS STEELS: SA-240 Types 302, 304, 304L, 316, 316L NONFERROUS METALS: Monel 400, Nickel 200, Inconel 600, Incoloys 800 & 825, Alloys B-2, X, 625, C-20Cb-3, C-22, C-276, G, 904L, AL-6XN
MIG Welded: Per ASME Sec. VIII Div. 1 Appendix 17	Embossing .045” min. .130” max Companion .130” min no max.	CARBON STEELS: SA-414 (0.15% C Max.), SA-515/516 grade 70, SA-516 (0.25% C Max.) STAINLESS STEELS: SA-240 Types 302, 304, 304L, 316, 316L, 309S, 310S, 317, 317L, 321, 347, 348, XM15 NONFERROUS METALS: Inconel 600, Incoloy 800, Incoloy 825, Alloys B-2, X, 625, C-20Cb-3, C-22, C-276, G, 904L, AL-6XN

FLATNESS STANDARDS FOR STANDARD (3/4” PASS) SINGLE EMBOSSED PLATECOIL

The table below shows normal flatness standards for resistance welded single embossed PLATECOIL with standard 1” wide perimeter flanges. These measurements are made by laying the PLATECOIL on a flat surface with the flat side down. The fractions shown represent the maximum distance that any part of the flat side of the PLATECOIL, in a free state, will be from the flat surface.

These figures are maximum deviations from the flat surface and are not ± tolerances.

By holding all 4 corners and the sides down these tolerances will be reduced to approximately 1/2 of the amounts shown. A similar result can be obtained by affixing the PLATECOIL to a flat framework at installation.

Contact factory if closer flatness tolerances are needed. Heavier gauge companions, special processing and/or stiffener bars are methods used.

Flatness Standards (3/4” Pass) 16/16 STAINLESS STEEL and 14/14 CARBON STEEL

Fig. 18-1

Length	Width						
	12”	18”	22”	26”	29”	36”	43”
23	3/16	1/4	1/4	1/4	1/4	5/16	5/16
29	1/4	1/4	1/4	5/16	5/16	3/8	7/16
35	1/4	1/4	5/16	5/16	3/8	7/16	7/16
47	5/16	5/16	3/8	7/16	7/16	1/2	9/16
59	5/16	3/8	7/16	1/2	1/2	9/16	5/8
71	3/8	7/16	1/2	9/16	9/16	11/16	3/4
83	7/16	1/2	9/16	5/8	11/16	3/4	7/8
95	1/2	9/16	5/8	11/16	3/4	7/8	1
107	9/16	5/8	11/16	3/4	13/16	1	1-1/16
119	9/16	11/16	3/4	7/8	7/8	1	1-1/8
131	5/8	3/4	13/16	1	1	1-1/8	1-1/4
143	11/16	13/16	7/8	1	1-1/16	1-1/8	1-5/16

Volumetric Displacement and Internal Volume of Platecoil

Fig. 18-2

	cu. in./sq. ft. nom.	gal./sq. ft. nom
Internal Volume		
Double embossed	46	.20
Single embossed	23	.10
Displacement		
Double embossed	64	.28
Single embossed	41	.18

These values are for one sq. ft. of PLATECOIL based on length x width (do not use total of both side areas) and apply to standard pass PLATECOIL of 14 or 16 gauge construction.

PRESSURE DROP DATA FOR STANDARD (3/4” PASS) PLATECOIL

Details on pressure drop involving all Styles of PLATECOIL, single and double embossed, standard units can be obtained from the charts appearing on page 84 and 85 of the PLATECOIL Heat Transfer Design Data Section.

ACCESSORIES & OPTIONAL FEATURES

A variety of accessories such as mounting lugs, special fittings, and tie-rod assemblies can be ordered for use with PLATECOIL. These are described on pages 24 and 27.

PLATECOIL can also be made available with special surface finishes and coatings. Stainless Steel units, for instance, can be provided with an electropolished finish. PLATECOIL can also be rolled or curved, specially welded and tested. All these options are described on page 25.

In addition, PLATECOIL is available on a special order basis in a variety of gauges and materials other than carbon steel and stainless steel. A complete list of optional materials is shown on page 28.

Other Platecoil Styles

STYLE 40 SERIES - PARALLEL

For conditions requiring higher flow rates or lower pressure drops than *Serpentine* type PLATECOIL, series parallel style 40 PLATECOIL are supplied. The flexibility offered by this style permits optimization of velocity versus pressure drop for best heat transfer. The sketches below illustrate typical products. Other widths and pass configurations are available.

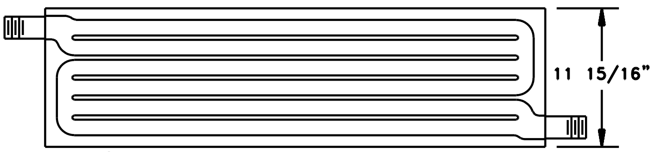


Fig. 19-1 Style 40-12-2-2-2

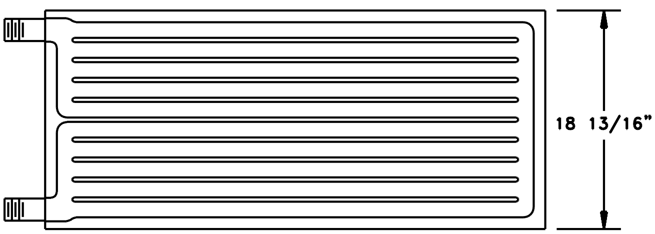


Fig. 19-2 Style 40-18-5-5

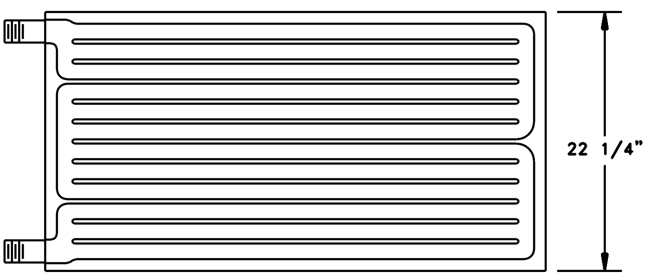


Fig. 19-3 Style 40-22-3-3-3-3

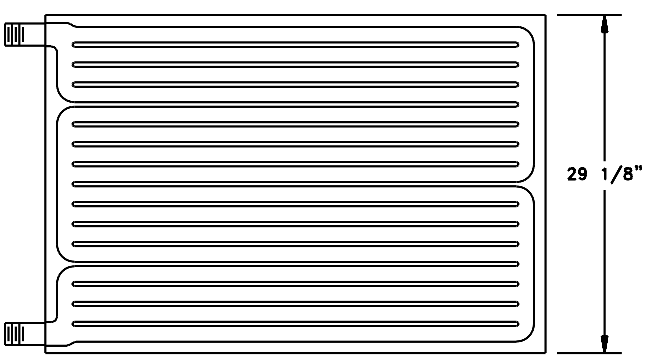


Fig. 19-4 Style 40-29-4-4-4-4

Style 40 designates 3/4” pass size PLATECOIL with a series-parallel pass arrangement. The second number designates the width of the PLATECOIL. Each following number indicates the number of passes in each zone from top to bottom.

HEAVY DUTY EMBOSSINGS AND SPECIAL COMPANION PLATES

In addition to Large Pass PLATECOIL embossings which can be furnished from material as heavy as 10 gauge, embossings for 3/4” pass PLATECOIL can also be fabricated in heavier gauges than those shown on page 12. Ten gauge material is usually the maximum. Contact the factory or your PLATECOIL Sales Representative for details.

Through the use of MIG welding, the flat “companion” plates for single embossed PLATECOIL can be supplied in any thickness desired. Also “companion” plates can be furnished with width and/or length dimensions greater than the embossings. This allows for the design of formed flanges and other special requirements. Heavier gauge companion plates for single embossed PLATECOIL improve flatness and general rigidity. See the Flatness Standards Chart on page 18.

PLATECOIL IN NON-STANDARD SIZES

Because of its unique versatility, PLATECOIL can be furnished in a variety of sizes other than those shown in the tables on page 12. There are, however, certain practical size limitations imposed by both fabrication capabilities and shipping restrictions which must be considered. These are as follows:

Maximum Width - For a single embossing with 24 passes, the maximum width is 43” for most styles. In some styles, 26 passes can be provided with a maximum width of 46” or wider with butt weld.

Minimum Width - The minimum width for a single pass configuration is 2”.

Maximum Length - For a single embossing, the maximum length is approximately 24 feet. Longer lengths can be supplied by joining one or more pieces with butt welds. Shipping limitations are the only constraint.

Minimum Length - Minimum length is normally 23”, unless cutting and joining pieces by butt welding is acceptable, or if quantities justify special tooling.

Standard PLATECOIL can usually be furnished with length or width dimensions smaller than standard. See page 27.

LARGE PASS PLATECOIL

Style 30 PLATECOIL have large passes equal to 1-1/2” dia. sched. 40 pipe cross section. Pattern 200 PLATECOIL have a slightly smaller cross section and higher pressure ratings than style 30. Details are shown on page 21. These styles are available in both Header and *Serpentine* construction.

Large Pass PLATECOIL provide the advantage of higher internal flow rates and/or heavy duty construction. They are available in carbon steel, Type 316LSS, and a variety of other materials as described on page 26. Large Pass PLATECOIL embossings can be pressed from material thicknesses ranging from 12 through 10 gauge.

1. Water cooled walls, hoods, heat screens, and other protective and/or heat reclaiming surfaces.

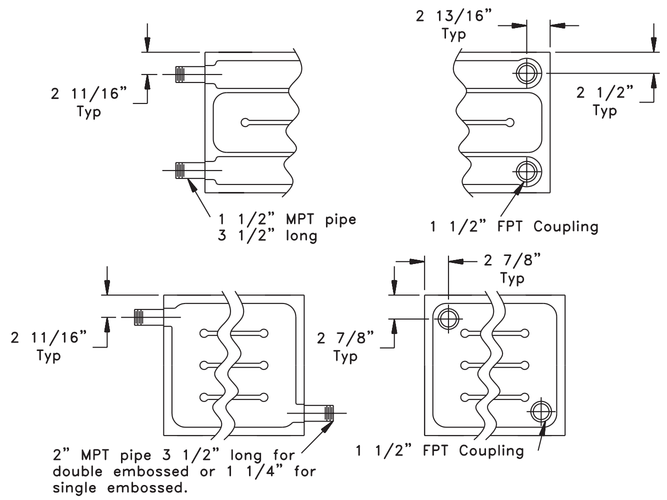
2. Storage tank heaters where metal thickness must include a corrosion and/or erosion allowance.

3. Fluidized bed applications involving abrasive materials.

4. Heat exchangers using muddy, silty river water, etc.

5. Hot oil heating systems where low pressure drop is important.

Fig. 20-1
Typical Styles and Fittings



Note: Dimensions shown are typical for Style 30 Platecoil. Pattern 200 dimensions will differ slightly.

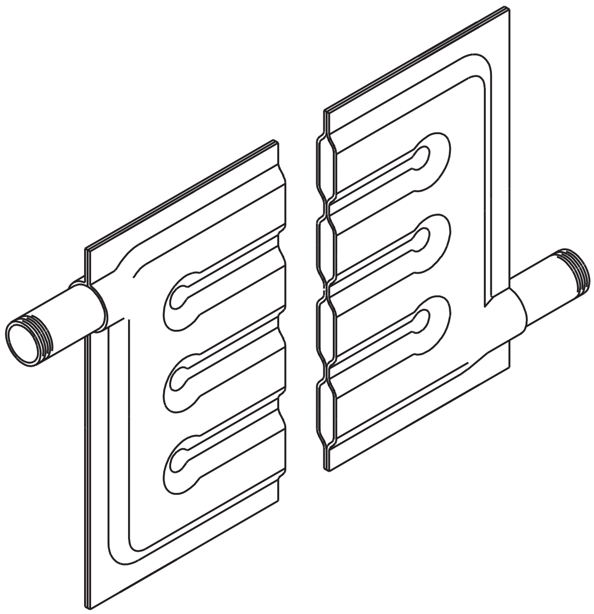


Fig. 20-2
Header Style

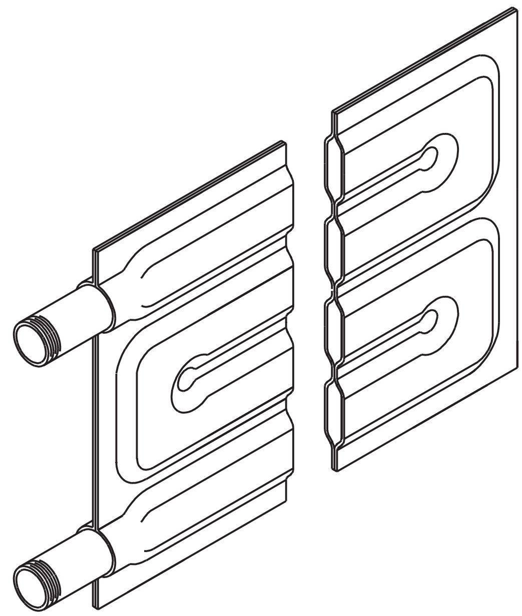


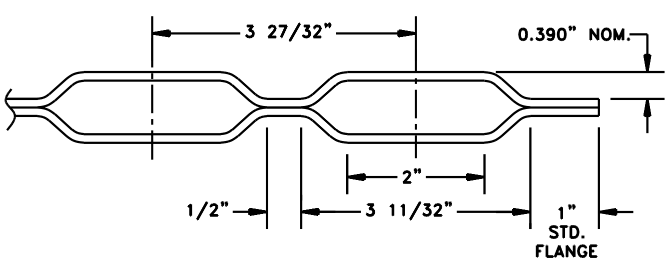
Fig. 20-3
Serpentine Style

LARGE PASS PLATECOIL (cont'd)

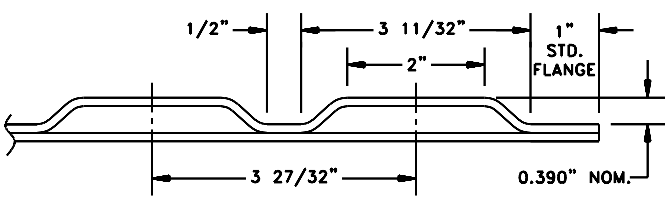
CROSS SECTIONAL DETAILS

Applies to Headers and Passes

Fig. 21-1
Style 30

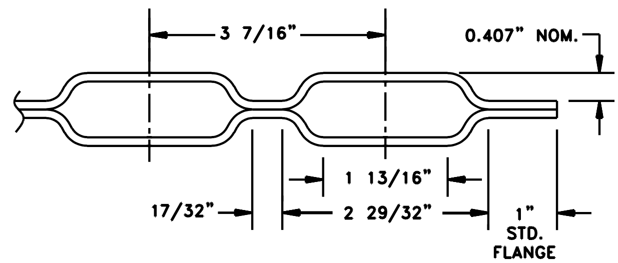


Internal Cross Sectional Area: Double Embossed 2.1 sq. in. nom.

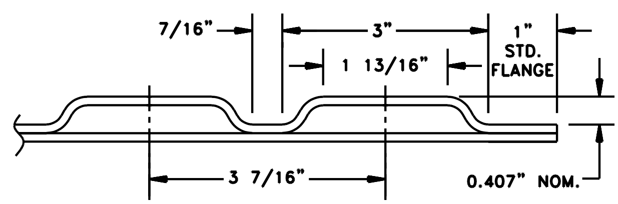


Single Embossed: 1.05 sq. in.

Fig. 21-2
Pattern 200



Internal Cross Sectional Area: Double Embossed 1.86 sq. in. nom.



Single Embossed: 0.93 sq. in.

LARGE PASS PLATECOIL

Width vs. Number of Passes

Fig. 21-3

No. of Passes	Style 30 width	Pattern 200 width
1	5 3/8	5
2	9 3/16	8 7/16
3	13	11 7/8
4	16 7/8	15 5/16
5	20 3/4	18 3/4
6	24 9/16	22 3/16
7	28 3/8	25 5/8
8	32 1/4	29 1/16
9	36 1/8	32 1/2
10	39 15/16	35 15/16
11	43 3/4	39 3/8
12	N/A	42 13/16
13	N/A	46 1/4

Standard widths. Standard lengths same as shown on page 12. Optional lengths available. Surface area: Double embossed, 2.15 x length x width. Single embossed, 2.08 x length x width.

INTERNAL OPERATING PRESSURES FOR LARGE PASS PLATECOIL

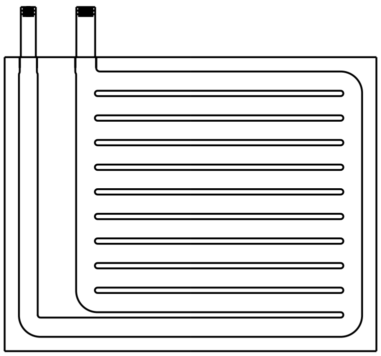
Fig. 21-4

Gauge		Style 30	Pattern 200
Double Embossed		PSI	PSI
14		40	50
12		90	115
10		140	175
Single Embossed			
Embossing	Companion	PSI	PSI
14	12	30	40
14	10	50	65
12	12	45	60
12	10	80	100
10	10	100	125
10	7	130	165

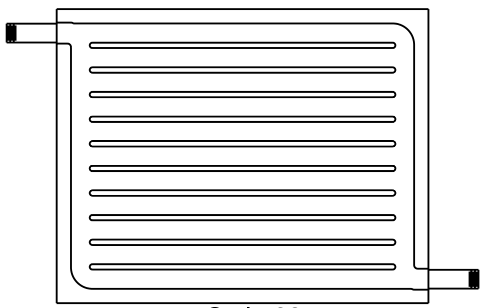
ASME code pressure ratings are available from the factory upon request. For external design pressures, single or double embossed, use above double embossed internal pressure ratings.

PARALLEL PASS PLATECOIL

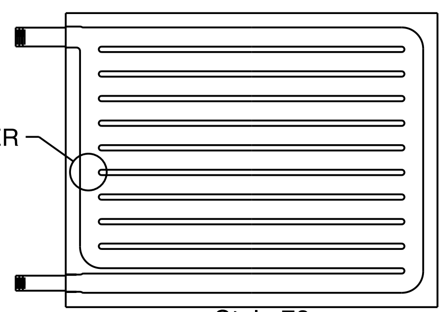
For widths other than the seven standard widths given in Figure 14-5 (pg. 14), the *Multi-Zone* pass configuration is not available. In these situations, we supply parallel pass PLATECOIL as illustrated below.



Style 93



Style 83



Style 73

The “3” in the two digit style number refers to the 320 header which distributes flow to the passes in parallel. A cross section of the 320 header is shown in Fig. 14-3 (pg. 14). Parallel pass PLATECOIL are also available with the larger 667 header design, which is depicted in Fig. 14-3. With the 667 header, the style designations are 96, 86, and 76. The optional variations available with parallel pass PLATECOIL are the same as their *Multi-Zone* counterparts.

In addition to non-standard widths, parallel pass PLATECOIL may be offered when the length of the coil is less than the width. For example, a 36” wide x 23” long coil is not available in the *Multi-Zone* design but can be furnished as a parallel pass PLATECOIL. It is also common to use the parallel pass design where portholes are required in the PLATECOIL. Portholes (cutouts) in PLATECOIL are discussed further on page 26.

PATTERN 400 PLATECOIL

Pattern 400 PLATECOIL are characterized by a shallow pass design. This low profile was originally selected for its superior performance with evaporating refrigerants. However, it has also found application in many immersion installations as well as ice making banks and evaporative coolers for process equipment. In some applications, the low profile prevents product build-up which would impede heat transfer and require frequent cleaning of other types of heat exchangers.

The closer center-to-center spacing (see Fig. 23-1) allows for higher pressure ratings with lighter gauge materials meaning reduced weight and cost. Pattern 400 PLATECOIL are available in both double embossed pattern 402 and single embossed pattern 401 designs. A series parallel configuration as shown in figure 23-2 below is standard. For other pass circuitry such as *Serpentine* or parallel pass, contact the factory.

PATTERN 400 PLATECOIL INTERNAL OPERATING PRESSURES

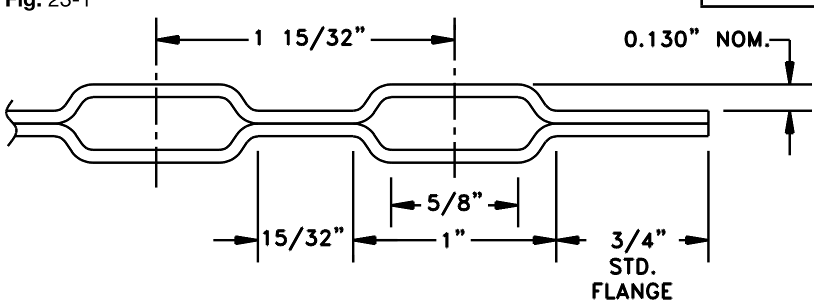
Gauge		CARBON STEEL	304, 304L, 316, 316L, MONEL
Double Embossed (402)		**PSI**	**PSI**
16		175	200
18		125	150
20		100	125
Single Embossed (401)		**PSI**	**PSI**
Embossing	**Companion**		
16	16	150	175
16	14	160	200
18	18	100	115
18	16	125	125
18	14	140	140
20	18	85	100

Note: Contact the factory for alternate header designs to achieve higher pressure ratings.

PATTERN 400 PLATECOIL WIDTH vs. NUMBER OF PASSES

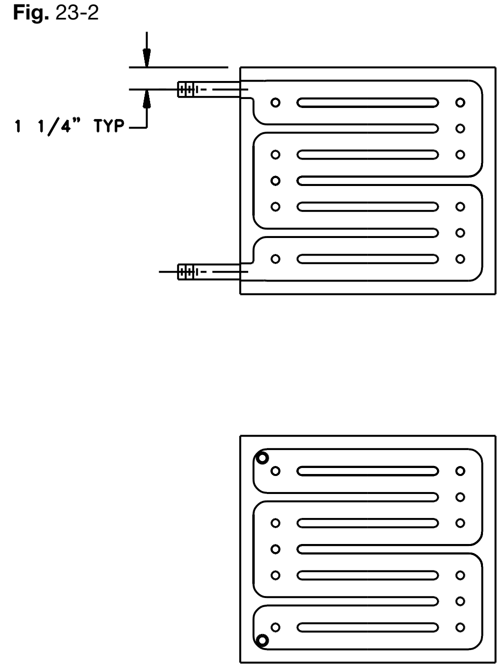
No. Passes	Actual Width (in.)	No. Passes	Actual Width (in.)
1	2 1/2	13	20 1/8
2	4	14	21 5/8
3	5 7/16	15	23 1/16
4	6 7/8	16	24 1/2
5	8 3/8	17	26
6	9 7/8	18	27 1/2
7	11 5/16	19	28 15/16
8	12 3/4	20	30 3/8
9	14 1/4	21	31 7/8
10	15 3/4	22	33 3/8
11	17 3/16	23	34 13/16
12	18 5/8	24	36 1/4

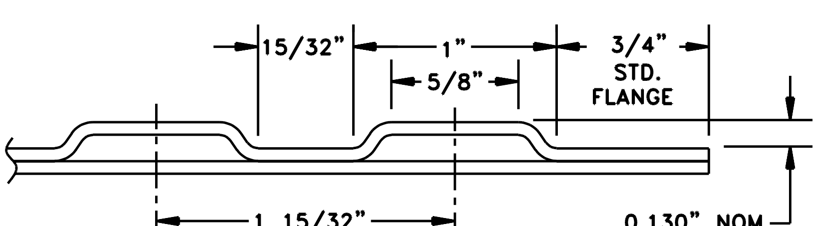
Fig. 23-1



Internal Cross Sectional Area: Double Embossed .22 sq. in. nom.

Fig. 23-2





Internal Cross Sectional Area: Single Embossed .11 sq. in. nom.

Platecoil Accessories and Optional Features

MOUNTING LUGS

PLATECOIL mounting lugs are used extensively for mounting purposes. Standard lugs are illustrated in Fig. 24-1 and adaptations and attachment locations are shown in Fig. 24-2. These lugs are generally used as follows:

L-1 E - Used on end or side of PLATECOIL for clamping them tightly to tanks or vessels, the usual lug spacing on the side is 30 inches. Generally the PLATECOIL are single embossed and rolled.

L-2 F - Foot type support for PLATECOIL installed on end.

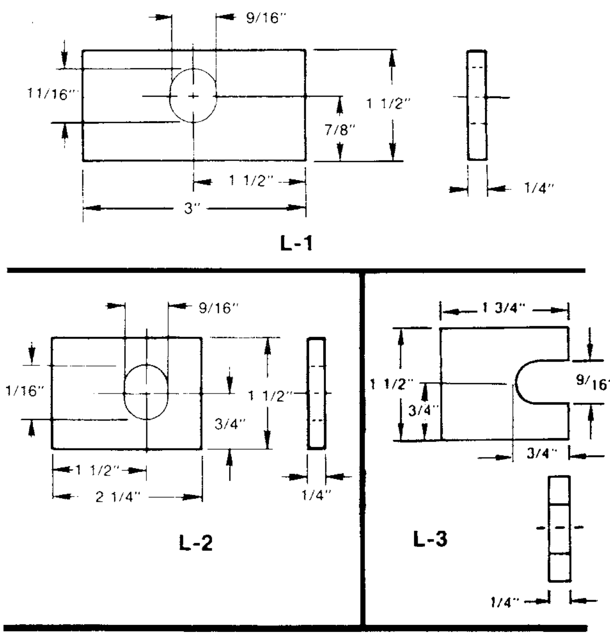
L-2 FX - Same as L-2 F except a 3-inch leg is added (height can be varied) to provide clearance above tank bottoms, especially in agitated tanks.

L-2 S - Generally used to attach flat PLATECOIL to flat or nearly flat surfaces.

L-3 S - Generally used to attach PLATECOIL to dished heads.

Lug Dimensions

Fig. 24-1



Standard Mounting Dimensions for All Lugs on Ends of PLATECOIL

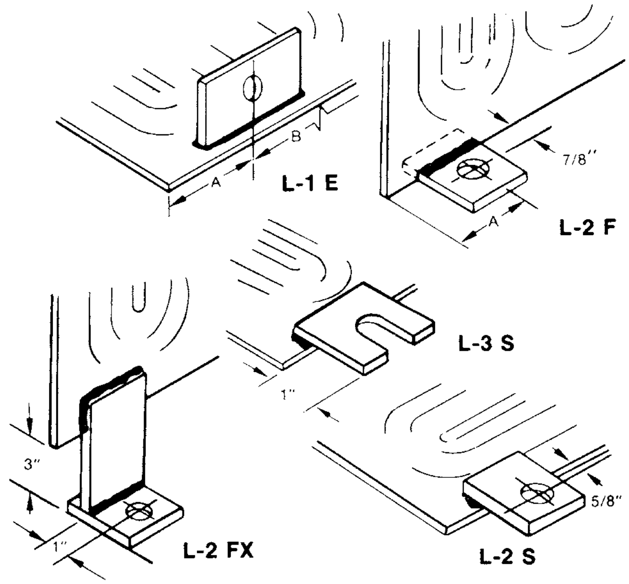
Fig. 24-5

PLATECOIL Width	A Dim. See Fig. 24-2	B Dim. C/L of Lugs
12" 2 Lugs/End	4"	4"
18" 2 Lugs/End	4 1/8"	10 1/2"
22" 2 Lugs/End	4 1/8"	14"
26" 2 Lugs/End	4 7/8"	16"
29" 2 Lugs/End	5 9/16"	18"
36" 3 Lugs/End	5"	13"*
43" 3 Lugs/End	5 7/16"	16"*

* Three lugs on these widths, third lug on C/L of PLATECOIL.
B Dim. doesn't apply to lugs on sides.

Lug Designs

Fig. 24-2

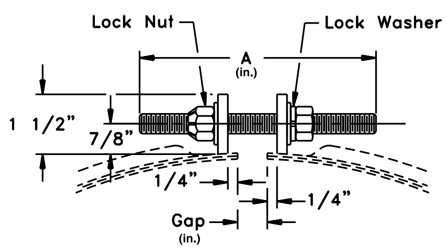


TIE ROD ASSEMBLIES

Standard tie rod assemblies are available with or without springs. In cases where thermal expansion or contraction may be appreciable, the spring loaded tie rods help maintain maximum contact.

Installed View L-1 E Lugs with Tie Rod Assembly

Fig. 24-3

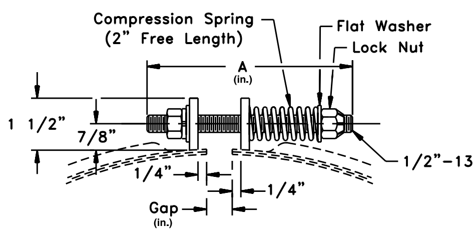


A	GAP
4	1.5
6	3.5
8	5.5
10	7.5
12	9.5
14	11.5
16	13.5

Installed View L-1 E Lugs with Spring Loaded Tie Rod Assembly

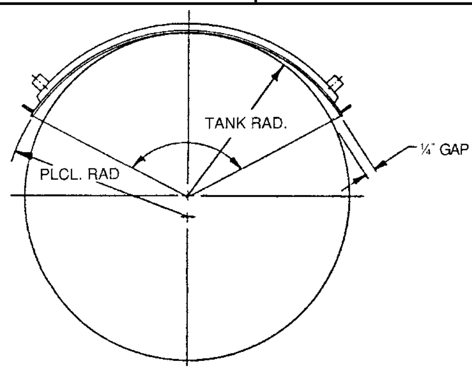
Fig. 24-4

A	GAP
6	1.5
8	3.5
10	5.5
12	7.5
14	9.5
16	11.5



PLATECOIL's unique design versatility allows it to be curved and/or rolled to specific radii. Both single and double embossed units can be furnished with either dimension curved. Normal tolerances are:

Angle of Coverage Ø	Radius Tolerance
0 - 30°	+2", -0
31° - 60°	+1", -0
61° - 90°	+3/4", -0
91° - 110°	+1/2", -0
111° - 180°	+1/4", -0



When PLATECOIL is clamped to the outside of a tank, using Tranter's standard mounting lugs, the PLATECOIL radius is designed to allow a 1/4" gap at the ends of the PLATECOIL. Tranter PHE, Inc. has developed this method to ensure proper fit-up at installation. The PLATECOIL radius is selected using individual PLATECOIL dimensions and the tank radius.

Standard 3/4" Pass PLATECOIL Curving Limits
(Minimum Radii)

Fig. 25-1

Style	Single Embossed*	Double Embossed
50 & 60 *Serpentine*	4"	8"
Multi-Zone & No. 320 Header	6"	9"
No. 667 Header	8"	10"

*Companion plate may be on either inside or outside of curvature. Specify when ordering.

PERIMETER SEAL WELD

When fabricating PLATECOIL, a slight separation may occur between the outside edges of the two metal plate components. If necessary, these outside edges can be sealed utilizing the following processes:

a. #160 PERIMETER WELD. The edge is sealed by means of a bead weld. The bead weld is wire brushed, but not ground or polished. Handles are rod type. In some instances, this weld is achieved by shearing through the center of a resistance weld.

b. #180 PERIMETER WELD. This is basically the same as the #160, but in addition, all welds are ground to eliminate sharp edges, burrs and sharp depressions. Handles are rod type.

c. CRYOGENIC EDGE WELD. This process includes a skip seam structural weld, plus a fillet bead weld. See page 63 for further details.

SURFACE FINISH OPTIONS

A variety of surface finishes can be provided on PLATECOIL units to comply with specific application requirements. These include the following:

A. Electropolish. This is an economical, chemically applied finish for stainless steel. The finish is bright and generally considered to provide an emissivity of about .1. It is generally equivalent to a 2B finish, but does not entirely eliminate seam and spot weld marks. Electropolished PLATECOIL are regularly used in phosphatizing solutions to reduce scaling and permit easier cleaning. It is also used in some food processes, white water heating, and for reflective surfaces on cryogenic shrouds.

B. Paint. PLATECOIL are occasionally painted for surface protection, prime coats, or for reflective or absorptive purposes. Baking facilities are available.

C. Galvanizing and Zinc Metalizing. These protective coatings are frequently used with carbon steel PLATECOIL, particularly where rusting is objectionable. Of the two, galvanizing is a denser, smoother finish. A #160 perimeter seal weld is required for PLATECOIL that are to be galvanized. Tranter does not normally furnish these coatings but will ship direct to an applicator.

D. Coating. Various customers throughout the country apply plastic or glass enamel coatings to PLATECOIL. A perimeter weld and rod handles are required for PLATECOIL which are to be coated. Such coatings can be damaged by rough handling or use, and users should be careful to guard against such damage. Plastic and enamel coatings are used more to reduce fouling than for corrosion resistance. Tranter PHE, Inc. prepares PLATECOIL for coating by others and each is individually leak tested before shipment. BECAUSE OF DAMAGE THAT MAY OCCUR TO THE COATING DURING HANDLING OR OPERATION, TRANTER PHE, INC. ACCEPTS NO RESPONSIBILITY FOR ANY PLATECOIL OR THE C0ATING.

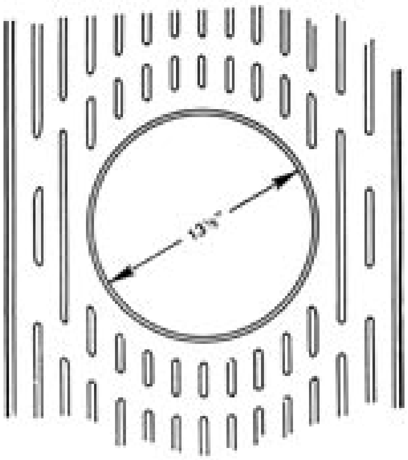
PLATECOIL FOR REFRIGERATION

A. INTERNAL CLEAN, DRY AND SEAL is generally desirable for PLATECOIL being used with a refrigerant. Sealing is by means of plastic caps.

B. HELIUM leak testing is often desirable. See page 16. Both A and B above are recommended and should be specified for PLATECOIL to be used in refrigeration service.

OPENINGS IN PLATECOIL

Many PLATECOIL applications require openings in the pass area. Typical circular openings, or portholes, are shown in Fig. 26-1 and 26-2. Figure 26-3 tabulates four standard size portholes and the number of passes that enter the header around the porthole. Note that 13 1/2 inch diameter and larger portholes have double headers. Round openings are used in the body of the PLATECOIL. Rectangular openings as shown below are used near edges and headers.



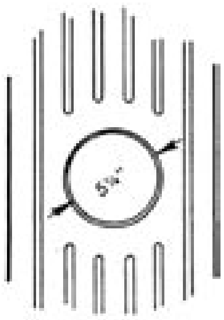


Fig. 26-2

Fig. 26-1

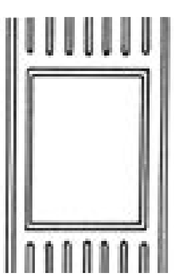
These portholes are not available in *Serpentine* PLATECOIL.

PORTHOLE TABULATION

Fig. 26-3

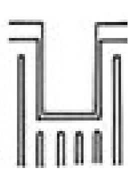
Maximum Hole Size (in.)	Passes Required	
	Round Portholes	Rectangular Openings
1 3/4	5	3
5 1/4	7	5
8 1/2	9	7
13 1/2	16	10

Rectangular Openings



Square opening. These are sized to suit requirements.

Fig. 26-4

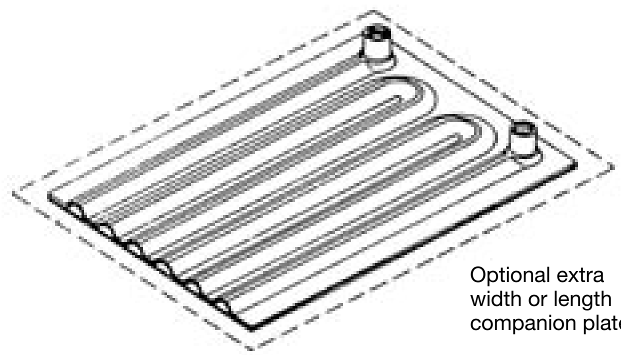


Notch-type opening in the end (or side) of a PLATECOIL.

SINGLE EMBOSSED (FLAT ONE SIDE) PLATECOIL

Single embossed PLATECOIL has one flat side, designated as the “companion plate.” In addition to the standard styles shown on pages 6 through 10 they can be supplied with heavy gauge companion plates, or with width and/or length dimensions greater than the embossings to allow for formed flanges or other special features. There is great flexibility in the types of fittings available and their location.

Single embossed PLATECOIL have many applications. Some of the more common ones are: on the outside of tank walls; as integral components of tanks; to form conveyors or chutes; for use as platens or other working surfaces.



Optional extra width or length companion plate

Fig. 26-5

Single Embossed

Tangent Bends

PLATECOIL with tangent bends on 2” radius are available (up to 36” width). These are often used in fabricating rectangular tanks, pans, etc.

Fig. 26-6

Tangent bend PLATECOIL fabrications for rectangular tanks.

3/4" PASS PLATECOIL IN NON-STANDARD SIZES

Width vs. Number of Passes

Fig. 27-2

No. Passes	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Actual Width	3 3/8	5 1/16	6 3/4	8 1/2	10 1/4	11 15/16	13 5/8	15 3/8	17 1/8	18 13/16	20 1/2	22 1/4	24	25 11/16	27 3/8	29 1/8
No. Passes	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**						
Actual Width	30 7/8	32 9/16	34 1/4	36	37 3/4	39 7/16	41 1/8	42 7/8	44 5/8	46 5/16						

Notes:
1. This table is based on 1 23/32" standard pass centers, with approximately 1 inch flanges. All dimensions subject to manufacturing tolerances.
2. All Standard lengths can be reduced up to approximately 1" by shearing both ends. Any intermediate lengths less than those produced by shearing can be supplied also.
3. Most Standard widths can be reduced up to approximately 1" by shearing both sides. Exceptions are style 60E and all styles 70 and 80 in lengths over 47" for which about 3/4" is the maximum reduction.
4. Stock PLATECOIL cannot be sheared to these special widths and lengths. They must be fabricated on special order.

MOUNTING SLOTS & HOLES

Holes may be drilled or punched in the perimeter flange for use in mounting instead of handles. Maximum hole and slot dimensions are shown in Fig. 27-1. If holes are drilled at the time of installation, care should be taken not to penetrate the seam weld. Wider flanges can be provided if larger holes are required.

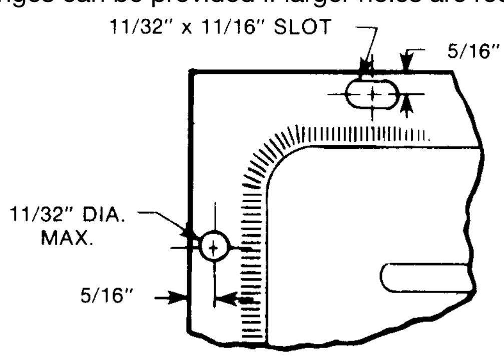


Fig. 27-1
Perimeter Hole and Slot Details

SPECIAL INLET/OUTLET PIPE LENGTHS

The length of the inlet and outlet pipes as indicated on pages 6 through 10 for standard PLATECOIL styles can be altered to meet installation requirements at a small additional charge. Pipes can be lengthened to a maximum of 36" without bracing. Extra long pipe lengths up to approximately 6 feet can be furnished with bracing.

EXTRA AND/OR SPECIAL FITTINGS

Extra fittings, plus a variety of special fittings, other than those normally furnished, can be specified to meet a variety of application requirements. The types of special fittings are described and illustrated as follows:

1. Fittings available (any combination)
   a. Pipes - NPT or NPT with 4" long locknut thread or weld end, 2" NPS maximum size of any available schedule pipe.
   b. Couplings - Full, half or socket, 2" NPS 6000# class maximum size.
   c. Elbows - internally threaded, street or weld end. 2" NPS maximum size.
   d. Tubes - Plain end or flared with nut attached 1" maximum size.
   e. Flange Fittings (not shown)- any type, 2" NPS 2500# class maximum size
   f. Extra Long Pipe Lengths (not shown) - as in "a" and up to approx. 6 feet long with necessary bracing.

2. Fitting material available
   a. Same as PLATECOIL in all cases except as specified.
   b. Copper fittings are available.

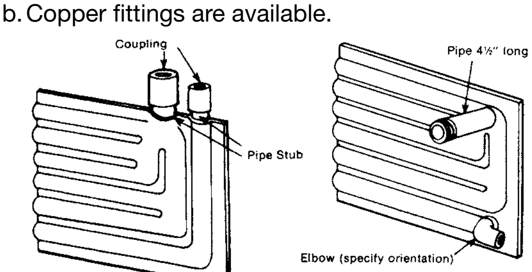


Fig. 27-3
Optional Fittings

Platecoil Materials Selection & Fabrication Techniques

OPTIONAL PLATECOIL MATERIALS

In addition to carbon and stainless steels, PLATECOIL can also be fabricated from the materials listed below. The nominal compositions are shown as well as the most common applications. Consult the Material Selection Chart (page 29-32) for detailed application data. The evaluations shown below are general and are not specific recommendations.

MONEL 400 (SB-127)

This nickel-copper alloy is most commonly used for medium-concentration caustic solutions, and for miscellaneous applications in the chemical and other industries. Composition: 67% nickel, 30% copper, 1.4% iron, 1 % manganese,. 1 % silicon, .15% carbon.

NICKEL 200 (SB-162)

Nickel 200 can be used with concentrated caustics over a wide temperature range as well as other industrial usages,

INCONEL 600 (SB-168)

Resists corrosion by many inorganic and organic compounds throughout wide ranges of acidity and alkalinity. Remains bright under exposure to sulfur compounds in the atmosphere, provides resistance to oxidizing atmospheres at elevated temperatures. Composition: 76% nickel, 14 to 17% chromium, 6 to 10% iron, 1% manganese, small amounts of copper, silicon, carbon, and sulfur.

ALLOY B-2 (SB-333)

A nickel based alloy developed primarily for corrosion resistance to hydrochloric acid. However, the presence of ferric and cupric salts can cause rapid corrosion. All potential applications should be checked with coupons, which are available from the factory. Also possesses valuable high temperature properties. Composition: 60% nickel, 1% chromium, 26 to 30% molybdenum, 4 to 7% iron and maximum of 1% silicon, 1% manganese, .12% carbon.

ALLOY C-276 (SB-575)

One of the more universally corrosion-resistant alloys and has excellent high temperature properties. Particularly useful where parts are either highly stressed or subject to repeated thermal shock at high temperatures. Composition: 50% Nickel, 15 to 17% chromium, 16 to 18% molybdenum. The balance consists of iron.

ALLOY G (SB-582)

It can handle both acid and alkaline solutions and will resist pitting and stress-corrosion cracking in chloride solutions. Composition: 44 to 47% nickel, 2 1/2% cobalt, 21 to 23% chromium, 5 to 7% molybdenum, 1% tungsten, about 18% iron and small amounts of silicon, manganese, and carbon.

TITANIUM

A highly corrosion-resistant material for use in many chemical solutions, especially those containing chlorides. See page 99 and our separate Bulletin on titanium heating and cooling coils. (Available only in ECONOCOIL® construction.)

ALLOY 20CB-3 (SB-463)

Primarily used in sulfuric acid pickling solutions. Composition: 35% nickel, 3% copper, 20% chromium, 2% molybdenum. The balance consists of iron and small amounts of silicon, manganese, carbon and columbium.

PLATECOIL fabricated from Alloy 20Cb-3 is a logical choice for highly corrosive applications such as sulfuric acid steel pickling. However, slight variations in operating conditions can cause severe adverse effects with regard to corrosion rates of this alloy.

Alloy 20Cb-3 PLATECOIL are typically constructed of 14 gauge material for extra life. Other gauges are available. They can be furnished full solution annealed and passivated at additional charge for the more severe conditions.

Since corrosion rates increase greatly with temperature, steam pressures of 15 psig or less are desirable for corrosive duty. Also, the PLATECOIL should be sized for a one hour heat up time or less so the steam will be on less.

AL-6XN OR 254-SMO

These alloys are high molybdenum austenitic stainless steels developed for superior corrosion resistance in chloride environments such as seawater. Composition: 18-24% nickel, 20% chromium, 6% molybdenum, small amounts of nitrogen, silicon, copper, manganese, and carbon. These alloys may be an alternate to titanium construction in some applications and can generally be ASME code stamped.

PRECAUTIONARY CLAUSE - IMPORTANT

"Because Alloy PLATECOIL are normally used in very corrosive solutions in which small variations in operating conditions can substantially affect the corrosion rates of these PLATECOIL, Tranter PHE, Inc. assumes no responsibility for corrosion resistance or life span of these PLATECOIL in any solution. We warrant the PLATECOIL to be free from defects in material and workmanship for a period of one year from shipment.

PLATECOIL MATERIAL SELECTION CHARTS

Material selection charts are presented here to assist in determining the most suitable material for various environments.

The first chart (Fig. 29-1) is a practical listing of Common Metal Finishing Solutions. Many of these involve complex mixtures of chemicals so they are presented separately.The materials shown are generally used for the solutions shown.

Some ratings shown in the General Material Selection Chart (page 30) are the result of laboratory tests conducted by suspending samples of the material in the solution. Therefore, they are not subject to the high temperatures often encountered when heating with PLATECOIL. In additon, operating conditions present many variables such as aeration, solution contaminants, and galvanic action which may alter the ratings given. The metallurgical departments of each of the suppliers of the materials listed have either given or approved the ratings assigned, but because of the points mentioned above, the ratings should be considered as only a guide.

In no instance, for either chart, should the ratings be considered as the basis for a guarantee of PLATECOIL life.

Material Selection Guide for Common Metal Finishing Solutions

Fig. 29-1

SOLUTION	PREFERRED MATERIAL	POSSIBLE
1. Aluminum Bright Dip	316L SS (if sulphuric acid is not present)	347SS
2. Aluminum Anodizing Hot Seal Tank	316L SS	304 SS
3. Brass Plating	Carbon Steel	
4. Bronze Plating	Carbon Steel	
5. Caustic or Alkali Cleaner (5% and below)	Carbon Steel	
6. Caustic or Alkali Cleaning to 15%	Monel	Stress relived Carbon Steel
7. Caustic Paint Stripper 15-30%	Nickel or Monel	Stress relieved Carbon Steel
8. Chromic Acid Rinse (below 130F & 0.5%)	Carbon Steel	
9. Sulphate Type Chromium Plating	Titanium	
10. Cyanide Cadmium Plating	Carbon Steel	
11. Cyanide Zinc Plating	Carbon Steel	
12. Cyanide Copper Plating	Carbon Steel	316L SS

Material Selection Guide for Common Metal Finishing Solutions (cont'd)

SOLUTION	PREFERRED MATERIAL	POSSIBLE
13. Dichromate Seal Tank	Carbon Steel	
14. Dye for Coloring Anodized Aluminum	316L SS	
15. Dye Seal Tank	316L SS	
16. Fluoborate Copper Plating	None	
17. Galvanizing Flux (Zinc Ammonium Chloride)	Titanium	
18. Nickel Plating (all but high Fluorine types)	Titanium	
19. Electroless Nickel	316L SS is suitable but it will scale	
20. Phosphatizing	316L SS (electropolished)	
21. Sulphuric Acid Anodizing 72F	316L SS	Cathodically Connected (see Fig. 53-2)
22. Sulphuric Acid Copper Plating	C-20 or Alloy 20Cb-3	316L SS
23. Sulphuric Acid Pickling of Steel Parts (no Chlorides)	Alloy 20Cb-3 or Alloy 825 (with caution)	
24. Sulphuric Acid Pickling with Copper Sulphate (non-ferrous parts)	316L SS or Alloy 20Cb-3	
25. White Brass Alloy Plating	Carbon Steel	

Key to Metals
1. Carbon Steel
2. 316L Stainless Steel
3. Alloy 825
4. Monel
5. Nickel
6. Alloy 20Cb-3
7. Alloy B-2
8. Alloy C-276
9. Titanium

NOTE: Pitting may occur particularly if scale is allowed to build up.

CP=Chemically Pure

Fully resistant is less than .0044 inches per year.

General Materials Selection Chart

Fig. 30-1 (NOTE: this is a greatly reduced chart)

Corrosive Media	Temperature Degrees F	Fully Resistant	Satisfactorily Resistant	Slightly Resistant	Non Resistant
Acetic Acid 80 - 100%	Boiling	3, 6, 8, 9	2, 7	4, 5	1
Alcohol - Ethyl		2, 3, 4, 5, 9	1		
Aluminum Chloride	70	7	3, 4, 5, 6, 8, 9	2*	1
Aluminum Hydroxide Saturated		2, 3, 4, 5	9		
Aluminum Sulphate 10%	Boiling	3, 6, 8	2, 4, 9	5	1
Saturated	Boiling	3, 6, 8	2, 4, 9	5	1
Ammonium Hydroxide		2, 3, 5, 6, 7, 8, 9	1		4
Ammonia (All Conc.)	Boiling	1, 2, 3, 9	5		4
Dry	Boiling	2, 3, 9	4, 5, 7, 8		
Ammonium Sulphate 10%	Boiling	3, 6, 8, 9	2*, 4	5	1
Saturated	Boiling	3, 6, 8, 9	2*, 4	5	1
Ammonium Sulphate (Conc.)	Boiling	2*, 3, 6	4, 8, 9	5	1, 7
Aniline 3%	70	2, 3, 6, 7, 8, 9	1, 5		
Conc. Crude	70	2, 3, 6, 7, 8, 9	5		
Asphalt		2, 3, 4, 5, 9	1		
Barium Chloride 5%	70	3, 6*, 8, 9	2*, 4, 5, 7		1
Saturated	70	3, 6*, 7	2*, 4, 5, 8, 9		1
Beer (All Conc. & Temp.)		2, 3, 5, 7, 8, 9	4		1
Benzene	70	2, 3, 4, 5, 9	1, 7, 8		
Borax 5%	Hot	2, 3, 4, 9	1, 5, 7, 8		
Boric Acid (Conc.)	Boiling	2*, 3, 6, 7, 8	4, 5		1
Calcium Brine Adulterated with Sodium Chloride	70	2*, 3, 5, 6*, 7, 9	4, 8		1
Calcium Chloride Dilute	70	2*, 3, 4, 5, 6*, 7, 8, 9			1
Conc.	70	2*, 3, 5, 6*, 7, 8, 9	4		1
Saturated	212	2*, 3*, 6*, 7, 8	4, 5, 9		1
Calcium Hydroxide 50%	Boiling	2, 3, 4, 5, 7, 8, 9			1
Carbonic Acid Phenol	72	2, 3, 5, 9			
CP	Boiling	2, 3, 5	4		1
Raw	Boiling	2, 3, 5	4		1
Carbon Dioxide Dry		2, 3, 4, 5, 7, 8,9			
Wet		2, 3, 9	4, 5		
Carbonated Water		2, 3, 4, 5, 6, 7, 8, 9			
Carbon Disulphide		2, 3, 9	4, 5		
Carbon Tetrachloride Pure (Dry)	Boiling	2, 3, 4, 5, 6, 7, 8, 9	1		
Aqueous Solution 5 - 10%	70	3, 4, 5, 9			
Chlorinated Water Saturated	70	8, 9	2, 6	3*, 4, 5	1, 7
Chlorine Gas Dry	70	2, 3, 4, 5, 6, 7, 8	1		9
Moist	70	8, 9		2	1, 3, 4, 5, 6, 7
Moist	212	9	8		2, 3, 4, 5, 6, 7
Chromic Acid CP 0.5% Free of SO_3	130	1, 3, 8, 9	2	6	4, 5, 7
CP 10% Free of SO_3	Boiling	9		3, 6	1, 2, 4, 5, 7, 8
CP 50% Free of SO_3	70	3, 8, 9	2	6	1, 4, 5, 7
CP 50% Free of SO_3	Boiling			3, 6	1, 2, 4, 5, 7, 8
Commercial 50%	70	3, 8, 9	2	6	1, 4, 5, 7
(Contains SO_3)	Boiling			3, 6	1, 2, 4, 5, 7, 8
Citric Acid 10%	Boiling	2, 3, 6, 7, 8, 9	4, 5		1
50%	Boiling	2, 3, 6, 7, 8, 9	4, 5		1
Copper Chloride 10%	Boiling	8, 9			2, 3, 4, 5
Copper Cyanide 5%		9	1		
Saturated	Boiling	2, 3, 6, 7, 8, 9	4, 5		
Copper Nitrate 50%	Hot	2, 3, 6, 9			1, 4, 5, 7
Copper Sulphate (Sat.) (Blue Vitriol)	Boiling	2, 3, 6, 8, 9		4	1, 5
Creosote (Coal Tar)	Hot	2, 3, 9	1, 5	4	
Cupric Chloride		9	2*, 8		1, 3, 4, 5, 6, 7
Dowtherm	Hot	2, 3, 4, 5	1		
Dyes	190	2	4, 5		
Esters		2, 3, 4, 5, 9			
Ether	70	2, 3, 4, 5, 7, 8, 9	1		
Ethylene Glycol Conc.	70	2, 3, 4, 5, 7, 8, 9	1		
Fats	to 500	2, 3, 6, 9	4, 5		1
Ferric Chloride 1%	70	9	2*	3*, 5, 8	1, 4, 6, 7
1%	Boiling	9		2, 8	1, 3, 4, 5, 6, 7
5%	70	8, 9		2, 3*	1, 4, 5, 6, 7
Ferric Nitrate to 5% Aerated	70	2, 3, 8, 9			1, 4, 5, 7
Ferrous Chloride Saturated	70	7, 8, 9	3, 4, 5	2	
Fluorine	70	5 dry only	3, 4 dry only, 7, 8		1, 2, 9
Fluoborate Plating Sol.			3, 6	2, 5	
Formaldehyde 40%	70	2*, 3, 5, 6, 7, 8, 9	1, 4		
	Boiling	2*, 3, 6, 9	1, 4, 5, 7, 8		

* Coupon testing important to check for possible presence of ferric or cupric ions.
(a) Aeration will have very detrimental effect on Monel.
(b) May be fully resistant when oxidizing inhibitors are present.
(c) Both 316L SS and Alloy 20Cb-3 may be subject to stress corrosion cracking.
(d) Titanium may be subject to Hydrogen embrittlement under certain conditions.
(e) Titanium may be fully resistant under certain conditions while it may react violently with others. Consult Manufacturer and USE CAUTION IN TESTING.
(f) Small traces of chlorides, particularly in sulphuric acid steel pickling solutions may cause excessive pitting.
(g) Titanium may be fully resistant when traces of oxidizing inhibitors are present.
(h) Provided no moisture is present.
In no instance should the ratings be considered as the basis for a guarantee of PLATECOIL life.

General Materials Selection Chart (cont'd.)

Fig. 31-1 (NOTE: this is a greatly reduced chart)

Corrosive Media	Temperature Degrees F	Fully Resistant	Satisfactorily Resistant	Slightly Resistant	Non Resistant
Freon		2, 3, 4, 5, 9	1		
Fruit Juices	Hot	2, 3, 5, 9	4		1
Fuel Oil	Hot	2, 3, 4, 5, 7, 8, 9	1		
Glue	Hot	2, 3, 4, 5, 7, 8, 9			1
Glucose	70	3, 5, 9	4		
Hydrochloric Acid 1:85	70	7*, 8*, 9	2, 4 (a), 5		1, 3, 6
	Boiling	7*	8 to 122*, 9 (b)	4 (a), 5	1, 2, 3, 6
Diluted 1:10	70	7*, 8*	4 (a), 5	2	1, 3, 6
Diluted 1:10	Boiling	7	8 to 122*	9 (b)	1, 2, 3, 4 (a), 5, 6
Vapors	70		4 (a), 5	2	1, 3, 6
Vapors	212		4 (a), 5		1, 2, 3, 6
Hydrofluoric Acid	70		3, 4, 5	2, 6, 7, 8	1
Vapors	212		4	3, 5	1, 2, 6, 7, 8, 9
Hydrogen		2, 3, 4, 5, 7, 8, 9 (d)			
Hydrogen Peroxide	70	2, 3, 6, 8	5, 7	4, 9	1
	Boiling	8	2, 3, 5, 6, 7	9	1
Hydrogen Sulphide Dry	70	2, 3, 6, 9	1, 4, 5, 7, 8		
Wet	70	3, 6, 9	2, 4,5, 7, 8		1
Iodine Dry	70	2, 3, 5, 6	8		1
Moist	70		8		1, 2, 3, 4, 5, 6
Lacquers & Lacquer Solvents		3, 4, 5, 9			1
Magnesium Chloride 1 & 5%	70	2*, 3, 6*, 7, 8 to 122*, 9	4, 5	2 (c), 5	1
1 & 5%	Hot	7, 8 to 122*, 9	3*, 4, 6* (c)		1
Magnesium Chloride 10 - 50%	Boiling	6* (c), 7, 8 to 122*, 9	2* (c), 3*	4, 5*	
Magnesium Sulphate	70	2, 3, 6, 7, 8, 9	1, 4, 5		
	Hot	2, 3, 6, 7, 8, 9	4	5	1
Mercury (Liquid)	70 & 125	2, 3, 9	5, 7, 8	4	
Methyl Alcohol (Methanol)	70	2, 3, 4, 5, 7, 8, 9	1		
	Hot	2, 4, 5, 7, 8, 9			1
Milk (Fresh or Sour)		3, 7, 8, 9		4, 5	1
(Hot or Cold)		2, 3, 7, 8, 9		4, 5	1
Molasses		2, 3, 4, 5, 7, 8, 9	1		
Mixed Acids % by Wt.	140	2, 3, 9			1, 4, 5
50% Sulphuric + 50% Nitric	200		2, 9	3	1, 4, 5
75% Sulphuric + 25% Nitric	140	2, 3, 9			1, 4, 5
	200		2, 3, 9		1, 4, 5
	Boiling			2, 3, 9	1, 4, 5
	315		9		
70% Sulphuric + 10% Nitric	140	2, 3, 9			1, 4, 5
+ 20% Water	200		2, 3, 9		1, 4, 5
	Boiling			3, 9	1, 2, 4, 5
	335		9		
Naphtha	70	2, 3, 4, 5, 7, 8, 9	1		
Nickel Chloride Solutions	70	2*, 3, 7, 8, 9		5	1, 4
Nickel Sulphate Solution	70	2*, 3, 9	4, 5, 8		1
Diluted	70				
Nitric Acid	70	2, 3, 6, 9	8		1, 4, 5, 7
Diluted	Boiling	2, 3, 6, 9	8 to 150*		1, 4, 5, 7
Diluted 1:10	70	2, 3, 6, 9	8		1, 4, 5, 7
Diluted 10%	Boiling	2, 3, 6, 9	8 to 150*		1, 4, 5, 7
Conc.	70	2, 3, 6, 9			1, 4, 5, 7
	Boiling	9	2, 3, 6		1, 4, 5, 7
Fuming	70	2, 3, 6, 9		5	1, 4
	Boiling	9 (e)	6	2, 3	1, 4, 5
Nitrous Acid 5%	70	2, 3, 9	7		1, 4, 5, 7
Oil Crude, Asphalt Base	Hot	2, 3, 4, 9	1, 5	1	
Paraffin Base	70	2, 3, 4, 5, 9	1	1	
Oil Lubricating, Lgt. or Hvy.		2, 3, 4, 5, 9	1		
Oil Mineral, Hot or Cold		1, 2, 3, 4, 5, 9			
Oil Vegetable, Hot or Cold		2, 3, 4, 5, 9	1		1
Oxalic Acid	70	2, 3, 4, 6	5, 7, 8		1
	Boiling		3, 4, 7, 8	2, 5, 6	1, 9
25%	Boiling		3, 4, 7, 8	2, 5, 6	1, 9
50%	Boiling		3, 6, 7, 8	2, 4, 5	1, 9
Paraffin, Hot or Cold		2, 3, 4, 5, 7, 8, 9	1		
Petroleum		2, 3, 4, 5, 7, 8, 9		1	
Phosphoric Acid 1%	70	2, 3, 6, 7, 8, 9	4, 5		1
1%	Boiling	2, 3, 6, 7, 8		4, 5	1
10%	Boiling	2, 3, 6, 7, 8	9	4, 5	1
45%	Boiling	2, 3, 6, 7, 8		4, 9	1, 5
80%	140	2, 3, 6, 7, 8		9	1, 4, 5
80%	230	3, 6, 7, 8		2, 9	1, 4, 5
Photographic Developers all have reducing properties, hydroquinone, amidol, ferrous, potassium, oxalate	70	2*, 3, 7, 8, 9	5	4	
	Boiling	2*, 3, 7, 8, 9	5	4	
Potassium Chloride 1%	70	2*, 3, 5, 6*, 7, 8, 9	4		1
	Boiling	2*, 3, 6*, 8, 9	4, 5, 7		1
5%	70	2*, 3, 5, 6*, 7, 8, 9	4		1
	Boiling	2*, 3*, 6*, 8, 9	4, 5, 7		1
Potassium Dichromate 25%	Boiling	2*, 3, 6, 9	8	5	1, 4
Potassium Hydroxide (Caustic Potash) 27%	Boiling	2, 3, 4, 5, 6	7, 8, 9		1
50%	Boiling	3, 4, 5, 6	2, 7, 8, 9		1
	Melting 675	4, 5, 6	3, 7, 8		1, 2
Potassium Nitrate (Salt Peter) 50%	70	2, 3, 6	4, 5, 8		
50%	Boiling	2, 3, 6	4, 5, 8		

Key to Metals
1. Carbon Steel
2. 316L Stainless Steel
3. Alloy 825
4. Monel
5. Nickel
6. Alloy 20Cb-3
7. Alloy B-2
8. Alloy C-276
9. Titanium

NOTE: Pitting may occur particularly if scale is allowed to build up.

CP=Chemically Pure

Fully resistant is less than .0044 inches per year.

In no instance should the ratings be considered as the basis for a guarantee of PLATECOIL life.

General Materials Selection Chart

Fig. 32-1 (NOTE: this is a greatly reduced chart)

Corrosive Media	Temperature Degrees F	Fully Resistant	Satisfactorily Resistant	Slightly Resistant	Non Resistant
Potassium Sulphate 1%	70	2, 3, 6, 7, 8	1, 4, 5		
5%	70	2, 3, 6, 7, 8	1, 4, 5		
Rosin (Molten)		2, 3, 4, 5, 7, 8, 9			1
Salt Brine 3%	70	2*, 3, 6*, 7, 8, 9	4, 5		1
Sea Water	70	2*, 3, 4*, 5*, 6*, 7, 8, 9			1
Silver Chloride		8, 9			1, 2, 7
Shellac		2, 3, 4, 5, 9		1	
Silver Nitrate 10%		2, 3, 9	7, 8	4, 5	1
Soap	70	2, 3, 4, 5, 7, 8, 9	1		
Sodium Bicarbonate Baking Soda	70	2, 3, 5, 6, 7, 8, 9	4	1	
All Conc.					
5%	150	2, 3, 5, 6, 7, 8, 9	4	1	
Sodium Carbonate (Soda Ash) 5%	Boiling	2, 3, 5, 7, 8, 9	1, 4		
50%	Boiling	2, 3, 5, 7, 8, 9	1, 4		
Sodium Chloride (Sat.) Cold	70	2*, 3, 4, 5, 9	6, 7, 8		1
	Boiling	2*, 9	3, 4, 5, 6, 7, 8		1
At 212	Hot	9	2*, 3, 4, 5, 6, 7, 8		1
Sodium Cyanide	70	2, 3, 9	1, 4, 5		
Sodium Hydroxide 1 - 5%	130	1, 2, 3, 4, 5, 6, 7, 9	1, 8		1
20%	230	2, 3, 4, 5, 6, 9	7, 8		1
34%	212	2, 3, 4, 5, 6	7, 8, 9		1
34%	Boiling	4, 5, 6	2, 7, 8, 9		
Sodium Sulphate (Gauber's Salt) All Conc.	Hot	2, 3, 6, 7, 8, 9	4, 5		1
Starch Solution		2, 3, 5, 9	1, 4		
Stearic Acid	70	2, 3, 5, 6	4	1	1
	350	3, 5, 6, 7, 8, 9	2, 4		
Sugar Solution	Hot	2, 3, 5, 9	4		1
Sulphur, Molten	265	1 (h), 9	4, 5		
Sulphur Dioxide Gas Moist	70	2, 3, 6, 8 to 158, 9			1, 4, 5
Sulphuric Acid Diluted 1:20	70	2, 3, 6, 7, 8	4, 5, 9 (g)		1
	Boiling		3, 7	2, 4, 6 (f), 8, 9 (g)	1, 5
1:10	70	2, 3, 6, 7*, 8*	4	5, 9 (g)	1
	180		3 (f), 6 (f), 7*	4, 8*, 9 (g)	1, 2, 5
1:1	Boiling		7*	3 (f), 4, 6 (f), 8*, 9 (g)	1, 2, 5
	70	2, 3, 6, 7*, 8*	4	5, 9 (g)	1
	Boiling		7*	3 (f), 4, 8*, 9 (g)	1, 2, 5, 6 (f)
Conc. (93-98%)	70	2, 3, 6, 7*, 8*	1, 5	4, 9 (g)	
	212			2, 3 (f), 5, 6 (f), 9 (g)	1, 4, 7*, 8*
	300			9 (g)	1, 2, 3 (f), 4, 5, 6 (f), 7*, 8*
Fuming (11% Free SO_3)	212		2		1, 4, 8*
(60% Free SO_3)	70	2, 8*		1	4
(60% Free SO_3)	160	2	8*	1	4
Sulphurous Acid Saturated	70	2, 3, 6, 8		5	1, 4, 7
Sweet Water	Hot	2, 3, 5			
Tartaric Acid 10%	70	2, 3, 6, 7, 8, 9	4, 5		1
Toluene or Toluol	70	2, 3, 4, 5		1	
Trichiorethylene Dry	70	2, 3, 4, 5, 6, 8, 9	7		
	Boiling	2, 3, 4, 5, 6, 8, 9	1, 7		
Tri Sodium Phosphate 35%	70	2, 3, 7, 8, 9	4, 5	1	
Turpentine Oil	95	2, 3, 4, 5, 7, 8	1		
Varnish	70	2, 3, 4, 5, 7, 8			
	Hot	2, 3, 4, 5, 7, 8			1
Vegetable Juices		2, 3, 5, 6, 7, 8, 9	4		
Vinegar	Hot	2, 3, 6, 9	4, 5		1
Water	Hot	2, 3, 5, 7, 8, 9	1, 4		
	Oily	2, 3, 5, 9	1, 4		
	Salt	3, 5, 7, 8, 9	2*, 4		
Whiskey		2, 3, 5, 9		4	1
White Liquor		2, 3, 6	5	1	
Wood Pulp		2, 3, 9	8 - 105 degrees	1	
Wort		2, 3, 5			1
Yeast		2, 3, 5			
Zinc Chloride Solution	100				
Sp. Grav. 2.05	100	6*, 7, 9	2*, 3, 4, 5, 8		1
1.09	Boiling	6*, 7, 9	2*, 3*, 4, 8	5	1
78 Degree Be	95	6*, 7, 9	2*, 3*, 4, 5, 8		1
Zinc Cyanide Solution	70	2, 3	1, 5		
Zinc Sulphate (White Vitriol) to 50%		2, 3, 6	4, 7, 8	5	1

Key to Metals
1. Carbon Steel
2. 316L Stainless Steel
3. Alloy 825
4. Monel
5. Nickel
6. Alloy 20Cb-3
7. Alloy B-2
8. Alloy C-276
9. Titanium

NOTE: Pitting may occur particularly if scale is allowed to build up.

CP=Chemically Pure

Fully resistant is less than .0044 inches per year.

* Coupon testing important to check for possible presence of ferric or cupric ions.
(a) Aeration will have very detrimental effect on Monel.
(b) May be fully resistant when oxidizing inhibitors are present.
(c) Both 316L SS and Alloy 20Cb-3 may be subject to stress corrosion cracking.
(d) Titanium may be subject to Hydrogen embrittlement under certain conditions.
(e) Titanium may be fully resistant under certain conditions while it may react violently with others. Consult Manufacturer and USE CAUTION IN TESTING.
(f) Small traces of chlorides, particularly in sulphuric acid steel pickling solutions may cause excessive pitting.
(g) Titanium may be fully resistant when traces of oxidizing inhibitors are present.
(h) Provided no moisture is present.
In no instance should the ratings be considered as the basis for a guarantee of PLATECOIL life.

WELDING METHODS USED TO FABRICATE PLATECOIL

Resistance Welding. PLATECOIL embossings are normally joined by resistance welding wherein the work pieces are part of an electrical circuit and the weld is made by the heat produced by the resistance of the work to the current, plus the application of pressure. Spot welding is a resistance welding process using rod shaped electrodes and is normally used at the end of passes and other restricted areas. Seam welding is a series of overlapping spot welds produced by using circular, rotating electrodes and is used between the passes and to seal the perimeter. If flatness is critical, stitch or roll spot seam welding can be used to reduce the heat, with about 1 nugget per inch.

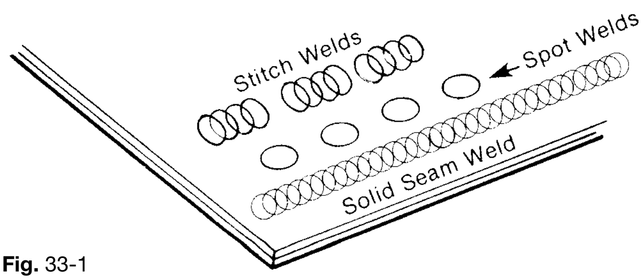


Fig. 33-1
Examples of Resistance Welds

The principal methods used to join heavier sections, to seal edges, to attach fiftings, and for general assembly work are: Tungsten Inert Gas (TIG) (uses non-consumable Tungsten electrodes to maintain an arc which is shielded by an inert gas, usually Argon or Helium) and Metal Inert Gas (MIG) Consumable Electrode Process (bare wire is fed from a spool through a gun type device which provides contact with the power source and introduces the shielding medium, usually carbon dioxide).

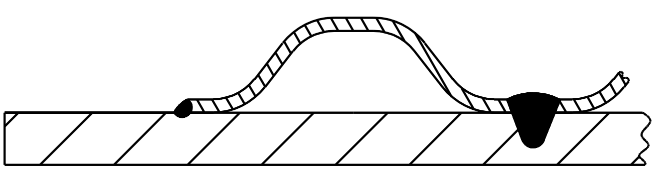


Fig. 33-2
Section showing heavy gauge companion plate with MIG seam and spot welds welded by the MIG process.

This latter process is known either as MIG seam welding, (which has a continuous weld) or MIG spot welding, (which can be used to reduce warpage from heat). For spot type MIG welding, the top (or penetrated) work piece can normally be from a minimum of 18 gauge to a maximum of 10 gauge. The bottom work piece can be 3/16” thick or any heavier material.

Some typical uses are for fabricating heavy wall PLATECOIL tanks, platens or other units that must be flat on one side with no weld marks or discoloration on the flat side.

Shielded Metal Arc (SMAW), often called “open arc,” is the most widely used method for applying filler metal. Normally used to join fittings to PLATECOIL embossings and other general fabrication welding.

POST WELD TREATMENT OF PLATECOIL - ANNEALING

Stainless steel PLATECOIL can be full solution annealed at 1900°F to 2100°F, principally for the removal of forming and welding stresses and as a safety precaution against chromium carbide precipitation (sensitization). Annealing dissolves any carbides that may have formed. The full anneal includes a quick water quench and is followed by a special scale removal and passivating process. This restores the metal to its maximum corrosion resistant conditon.

Stainless steel PLATECOIL are fabricated from low carbon grades to minimize the potential for carbide precipitation. However, in certain environments stresses set up by cold working can cause premature failure due to stress corrosion cracking. Annealing, however, relieves these stresses and produces a homogeneous structure.

PLATECOIL may also be passivated only to remove all weld discoloration and any surface contaminants.

STRESS RELIEVED CARBON STEEL PLATECOIL

Carbon Steel PLATECOIL can be stress relieved on a special order basis. The service life of carbon steel can often be extended substantially, particularly in caustic applications, by stress relieving at 1100°F. Contact your Sales Representative or the factory for additional information.

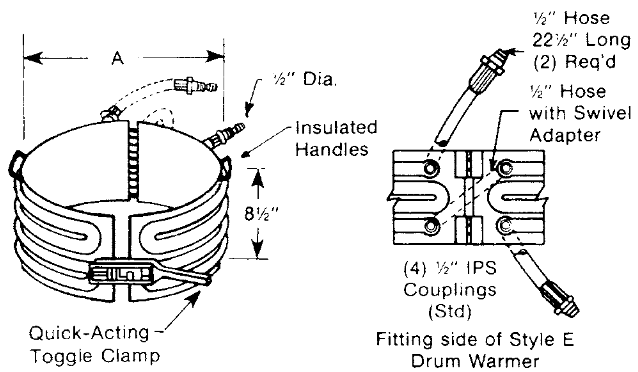
Platecoil Standard Assemblies

DRUM WARMERS

All PLATECOIL Drum Warmers are designed for use with steam, hot water, hot oil, or the high temperature heat transfer liquids. They are equally adaptable for cooling by using cold water or a refrigerant.

EXTERNAL CLAMP-ON TYPE - STYLE E

Hinged Type E55



Spring Open Type E55NH*

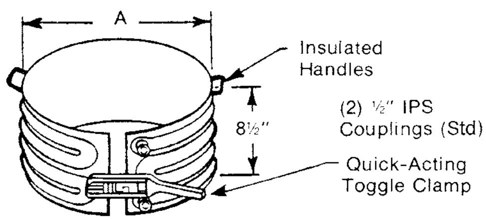


Fig. 34-1

1/2" I.D. x 22 1/2" steam hoses, rubber with multiple wire braid reinforcement, are optional. The hose is suitable for pressures up to 200 psig at 380°F.

Style E Specifications & Part Numbers

Fig. 34-2

Drum (gal.)	A (in.)	Weight (lbs.)		Part No.	Surface Area (sq. ft.)
		Net	Shipping		
55	22 3/4	22	41∆	E55	4.13
*55	22 3/4	21	40	E55NH	4.13
30	18 1/2	18	35∆	E30	3.33
16	14 1/8	14	29∆	E16	2.56
*5	11 7/8	12	26	E5NH	2.17

If hoses are desired indicate by adding letter "H" to end of Part No.

* Slip-over type, one piece, no hinges. With a quick-acting toggle clamp. Add 6 lbs. for 2 hoses, this model.

∆ Add 8 lbs. for 3 hoses.

Carbon Steel construction 18/16 ga.

Maximum recommended operating pressure: 150 psig

EXTERNAL CLAMP-ON TYPE — STYLE M

Style M Warmers combine three Style E units into one assembly by means of welded-on tie bars and jumpers.

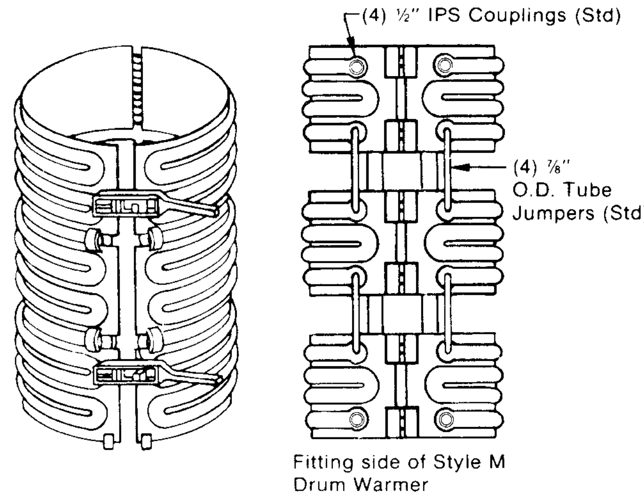


Fig. 34-3

Style M Specifications & Part Numbers

Fig. 34-4

Drum (gal.)	A (in.)	Weight (lbs.)		Part No.	Surface Area (sq. ft.)
		Net	Shipping		
55	22 3/4	65	107•	M55	12.30

If hoses are desired indicate by adding letter "H" to end of Part No.

• Add 11 lbs. for 4 hoses.

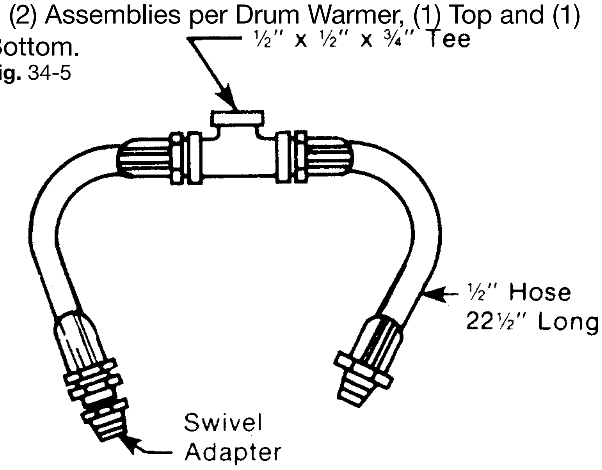
Carbon Steel construction — 18/16 ga.

Maximum recommended operating pressure: 150 psig

Style M Hose Assembly

(2) Assemblies per Drum Warmer, (1) Top and (1) Bottom.

Fig. 34-5



SADDLE TYPE—STYLE S

Style S Drum Warmers are convenient for horizontal heating and have heating surface covering about half of the drum.

The warmer is sloped slightly for easy draining in place if desired.

The end rockers, handle and casters make them ideal for one-man loading and transporting. Fittings are on the bottom for out-of-the-way convenience.

The drum warmer is designed to contact the drum between the reinforcing rings. It is painted with one coat red oxide primer. The drum warmer construction is 18/16 ga. Carbon Steel construction.

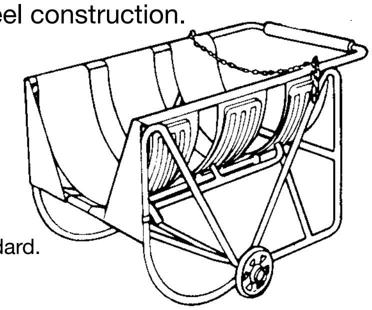


Fig. 35-1
Saddle Type—Style S Drum Warmer

Maximum Recommended Operating Pressure: 150 psig

(2) 3/4” MPT fittings are standard.

Drum (gal.)	Weight (lbs.)		Part No. With Wheels	Part No. Without Wheels	Surface Area
	Net	ShippingΔ			
55	80	125	S55W	S55	6.3

If hoses are desirable indicate by adding letter “H” to end of Part No.
Δ Add 11 lbs. for (2) 3/4” I.D. x 42” steam hoses.

EXTERNAL DRUM WARMERS HEAT-UP DATA

Figure 35-3 is intended as a guide to estimating time required for heat-up of Style E, M and S Drum Warmers. The table is based on heating a 55-gallon drum with a Style E-55 Warmer.

Heat-Up Data

Fig. 35-3

Substance Heated (A) from 10F to 70F (B) from 60F to 160F	Heat-up Times in Hours					
	15 psig steam		150 psig steam		400F hot oil or HTHW*	
	A	B	A	B	A	B
Water	-	8	-	4	-	5
#6 Fuel Oil (Bunker C)	6	15	3	5	4	6
Asphalt RC-2	6	16	3	5	4	6
Asphalt MC-5	-	12	3	4	3	5

These heat-up times are approximate and assume that the cover is not removed.
* HTHW = high temperature hot water.

A Style S Cart-Type Warmer will heat in about 2/3 of the tabulated times; a Style M three-ring Type in about 1/3 of Fig. 35-3 times. The smaller Style E Warmers should heat-up in less time due to the lesser volume of liquid contained in the corresponding drum sizes.

The heating surfaces on the smaller sizes are larger in proportion to drum capacities than in the case of Style E-55.

IMMERSION TYPE—STYLE I

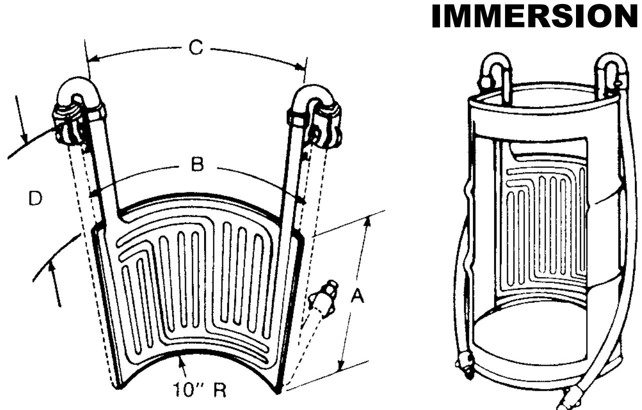


Fig. 35-2 Immersion Type—Style I

3/4” MPT connections standard on units furnished without hoses.

Maximum recommended operating pressure for immersion type without hoses, 250 psig with 5 to 1 safety factor.

3/4” I.D. x 42” steam hoses, rubber with multiple wire braid reinforcement for 200 psig working pressure at 380°F (furnished with swivel adaptor) are optional.

Style I Specifications & Part Numbers

Nominal Size	A	Dimensions B (in.)	C (in.)	D (in.)	Surface Area (sq. ft.)	Weight (lbs.)		Part No.	
						Net	ShippingΔ	Carbon Steel 14 Ga.	316L SS 16 Gs.
12 x 23	23	11 15/16	8 1/8	15 1/2	4.3	17	26	I-41	I-42
18 x 23	23	18 13/16	15 3/16	15 1/2	6.8	24	35	I-61	I-62
22 x 23	23	22 1/4	18 5/8	15 1/2	8.0	28	40	I-71	I-72
12 x 29	29	11 15/16	8 1/8	9 1/2	5.4	20	30	I-51	I-52
18 x 29	29	18 13/16	15 3/16	9 1/2	8.5	28	40	I-81	I-82
22 x 29	29	22 1/4	18 5/8	9 1/2	10.1	33	47	I-91	I-92

If hoses are desired indicate by adding letter “H” to end of Part No.
Δ Add 11 lbs. to weight for hoses.

PLATECOIL PIPE HEATERS

Clamp-on PLATECOIL for pipe lines offer an economical means of adding heat for process heating or to prevent freezing. The carbon steel single embossed PLATECOIL as detailed below are designed for up to 150 psig steam pressures and provide high percentages of pipe surface coverage. Almost total coverage can be obtained if desired by using more than one unit. Banding or strapping is generally the best means of attaching, however lugs can be supplied. The use of a heat transfer mastic will usually improve performance particularly with the smaller sizes for which curvature will not be exact. (See page 46 for details on mastic.)

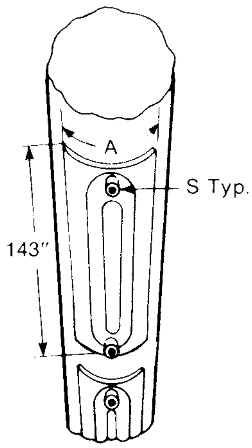


Fig. 36-1 PLATECOIL Pipe Heater

Fittings are on opposite ends and passes are in parallel on all sizes. This facilitates draining and/or connecting several in series where sizes and heat loads are not excessive, Alternate embossing patterns, fittings, lengths and higher operating pressures can be supplied. Available in alloy materials on special order.

Pipe Heater Specifications & Part Numbers

Fig. 36-2

For Pipe Size (in.)	A Dim PLATE-COIL Width (in.)	sq. ft. Surface	% Pipe Covered	No. of Passes	S Dim FPT (in.)	Net Wt. (lbs.)	Part Number
5	8 1/2	8.45	48	4	3/4	50	x5
6	10 1/4	10.20	49	5	3/4	60	x6
8	12	11.90	44	6	1	70	x8
10	15 3/8	15.30	45	8	1	90	x10
12	18 3/4	18.60	47	10	1	110	x12
14	20 1/2	20.40	47	11	1 1/4	120	x14
16	24	23.80	48	13	1 1/4	140	x16

PLATECOIL JACKETED PIPE SECTIONS

Fig. 36-3 PLATECOIL Jacketed Pipe

PLATECOIL fully jacketed pipe sections offer controlled flow of the heat transfer media in direct contact with the pipe wall. Available in 6-inch pipe, or larger, in lengths to 20 feet. Available in all PLATECOIL materials.

PLATECOIL VALVE HEATERS

These specially formed PLATECOIL provide a convenient means of heating valves. The radius (R) dimension is based on normal standard flanged typed 125# and 150# class valves. The unique embossing pattern develops maximum performance with only one steam inlet located at the bottom out of the way. Available in carbon steel and suitable for up to 150 psig.

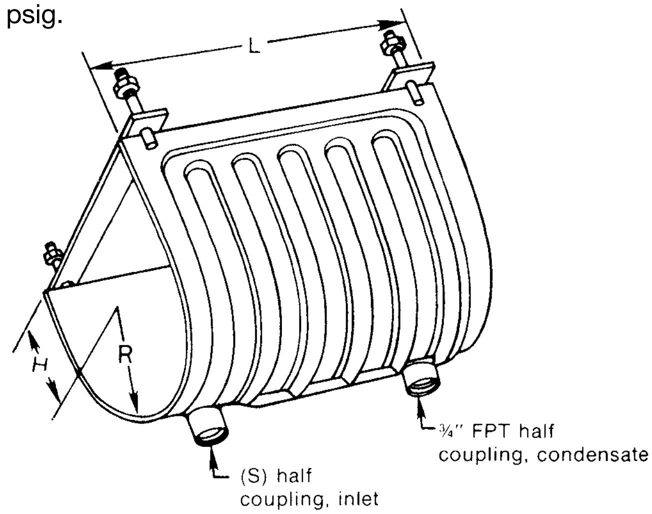


Fig. 36-4 PLATECOIL Valve Heater

Valve Heater Specifications & Part Numbers

Fig. 36-5

For Pipe Size (in.)	L Dim (in.)	R Dim (in.)	H Dim (in.)	Net Wt. (lbs.)	S Dim FPT (in.)	Part Number
2	8 1/2	3	2 1/2	8 1/2	3/4	V 2
2 1/2	8 1/2	3 1/2	3	9 1/2	3/4	V 25
3	10 1/4	3 3/4	3 1/4	11 1/2	3/4	V 3
3 1/2	10 1/4	4 1/4	3 1/4	13	3/4	V 35
4	10 1/4	4 1/2	4	13 1/2	3/4	V 4
5	12	5	4 1/2	16 1/2	3/4	V 5
6	12	5 1/2	5	18	3/4	V 6
8	12	6 3/4	6 1/4	21 1/2	1	V 8
10	13 5/8	8	7 1/2	28	1	V 10
12	15 38	9 1/2	9	36 1/2	1	V 12
14	15 3/8	10 1/2	10	40	1	V 14
16	17 1/8	11 3/4	11 1/4	49	1	V 16

NOTE-If there is any uncertainty about above dimensions being suitable submit complete dimensional data on valve. Special sizes and alloy materials available on special order.

SCREW CONVEYOR TROUGHS

PLATECOIL type screw conveyor troughs are excellent for heating and cooling applications because of the high operating pressures possible with relatively light gauge material. A choice of gauges is available. In some cases heavier material may be preferred for rigidity, abrasion and higher pressures. For maximum heat transfer, troughs are embossed all around and up to within 1” to 2” of the top flange. The embossing pattern is designed for use with steam, thermal fluids, water, hot oil, etc. and will drain if properly sloped. Standard embossings are 16 ga. type 304L stainless steel or 14 ga carbon steel.

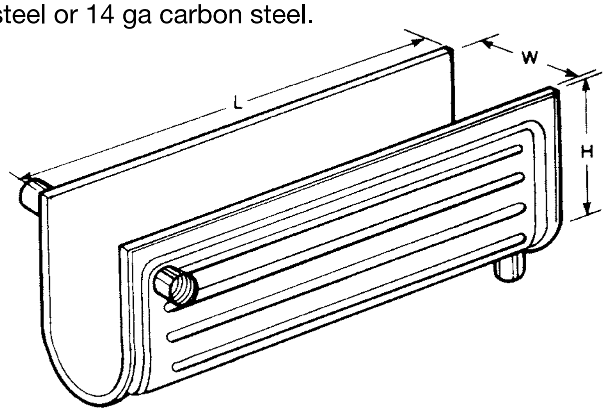


Fig. 37-1 PLATECOIL Screw Conveyor Trough

HEATING SURFACE (sq. ft.)

Fig. 37-2

Screw Dia. (in.)	For L=60”	For L=120”
6	7.5	15.0
9	10.8	21.6
10	11.7	23.4
12	14.1	28.2
14	16.7	33.4
16	19.1	38.2
18	21.7	43.4
20	24.2	48.4
24	29.3	58.6

CONVEYOR TROUGH OPTIONS

End Flanges - 3/16” angle or 1/4” plate. Factory option if not specified.

Top Flanges - May be angle if special tolerances are required. Special prices apply.

Fittings - 2 inlets 1” - NPS couplings for L=60”.
2 inlets 1 1/4” NPS couplings for L=120”.
1 outlet 1” coupling - all sizes.

Holes can be supplied in end and top flanges on request.

Heavier embossings, other diameters and other lengths can be supplied.

Screw Conveyor Troughs Specifications & Part Numbers

Fig. 37-3

DIMENSION L=60”						
For Screw Having Dia. of (in.)	Inside Width (in.)	Straight Side H (in.)	Gauge Flat Side	Approx. Wt. (lbs.)	MAPICS Part No. Carbon Steel	MAPICS Part No. 304L SS
6	7	4 1/2	14	65	C1A141	C1A142
	7	4 1/2	12	77	C1A121	C1A122
9	10	6 1/8	14	93	C2A141	C2A142
	10	6 1/8	12	108	C2A121	C1A122
10	11	6 3/8	14	98	C3A141	C3A142
	11	6 3/8	12	115	C3A121	C3A122
	11	6 3/8	10	132	C3A101	C3A102
12	13	7 3/4	12	141	C4A121	C4A122
	13	7 3/4	10	162	C4A101	C4A102
14	15	9 1/4	12	158	C5A121	C5A122
	15	9 1/4	10	181	C5A101	C5A102
16	17	10 5/8	12	178	C6A121	C6A122
	17	10 5/8	10	204	C6A101	C6A102
18	19	12 1/8	12	205	C7A121	C7A122
	19	12 1/8	10	235	C7A101	C7A102
	19	12 1/8	3/16	283	C7A081	C7A082
20	21	13 1/2	12	225	C8A121	C8A122
	21	13 1/2	10	258	C8A101	C8A102
	21	13 1/2	3/16	311	C8A081	C8A082
24	24	16 1/2	10	308	C9A101	C9A102
	25	16 1/2	3/16	372	C9A081	C9A082
	25	16 1/2	1/4	452	C9A061	C9A062

DIMENSION L=120”						
For Screw Having Dia. of (in.)	Inside Width (in.)	Straight Side H (in.)	Gauge Flat Side	Approx. Wt. (lbs.)	MAPICS Part No. Carbon Steel	MAPICS Part No. 304L SS
6	7	4 1/2	14	125	C1B141	C1B142
	7	4 1/2	12	150	C1B121	C1B122
9	10	6 1/8	14	178	C2B141	C2B142
	10	6 1/8	12	208	C2B121	C2B122
10	11	6 3/8	14	186	C3B141	C3B142
	11	6 3/8	12	221	C3B121	C3B122
	11	6 3/8	10	255	C3B101	C3B102
12	13	7 3/4	12	266	C4B121	C4A122
	13	7 3/4	10	306	C4B101	C4B102
14	15	9 1/4	12	303	C5B121	C5B122
	15	9 1/4	10	350	C5B101	C5B102
16	17	10 5/8	12	342	C6B121	C6B122
	17	10 5/8	10	395	C6B101	C6B102
18	19	12 1/8	12	390	C7B121	C7B122
	19	12 1/8	10	449	C7B101	C7B102
	19	12 1/8	3/16	546	C7B081	C7B082
20	21	13 1/2	12	428	C8B121	C8B122
	21	13 1/2	10	494	C8B101	C8B102
	21	13 1/2	3/16	601	C8B081	C8B082
24	24	16 1/2	10	591	C9B101	C9B102
	25	16 1/2	3/16	719	C9B081	C9B082
	25	16 1/2	1/4	878	C9B061	C9B062

SUCTION HEATER

This PLATECOIL product is especially designed for the heating of viscous products for drawoff and movement. The primary surface type PLATECOIL design minimizes fouling tendencies. The outer PLATECOIL also help preheat surrounding product for easier flow into the heater. Fabricated of 14 ga. double embossed carbon steel as standard. Other gauges and material are available. Units without shrouds and suction pipes can be supplied as "Bayonet Heaters" for bulk storage tank heating.

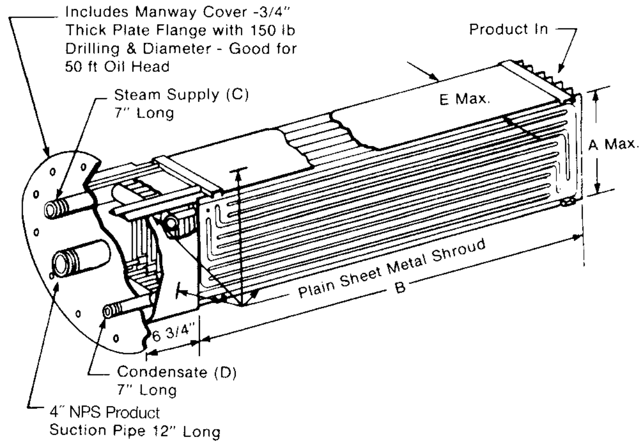


Fig. 38-1 PLATECOIL Suction Heater

NOTE: PLATECOIL suction heaters are designed for use in a horizontal position, Special piping is required if they are to be installed in an upright (vertical) position.

Sizes and Dimensions

Fig. 38-2

Manway Size (in.)	A Dim. (in.)	E Dim. (in.)
18	12 11/16	11
24	19 9/16	12 5/8
30	19 9/16	19 1/8

SUCTION HEATER OPTIONS

1. Supporting saddles or legs.
2. For pressure ratings, see page 16.
3. *Serpentine* PLATECOIL are used for liquid heating media.
4. API Manway covers available. Specify if required.

Suction Heater Specifications and Part Numbers

Fig. 38-3

For 18" Manways—7 PLATECOIL 12" Wide

B Dim. (in.)	Effective Surface Area (sq. ft.)	C Dim. NPS (in.)	D Dim. NPS (in.)	Net Weight (lbs.)	Part Number
47	62	2	1 1/2	380	B 1747
59	78	2 1/2	1 1/2	440	B 1759
71	93	2 1/2	1 1/2	500	B 1771
83	109	2 1/2	1 1/2	540	B 1783
95	125	2 1/2	1 1/2	595	B 1795
107	141	2 1/2	1 1/2	650	B 17107
119	156	2 1/2	1 1/2	700	B 17119
131	172	2 1/2	1 1/2	760	B 17131
143	188	3	2	820	B 17143

PLATECOIL on 1 5/8" centers

For 24" Manways—8 PLATECOIL 18" Wide

B Dim. (in.)	Effective Surface Area (sq. ft.)	C Dim. NPS (in.)	D Dim. NPS (in.)	Net Weight (lbs.)	Part Number
47	111	2	1 1/2	600	B 2347
59	139	2 1/2	1 1/2	700	B 2359
71	168	2 1/2	1 1/2	795	B 2371
83	196	3	2	875	B 2383
95	225	3	2	975	B 2395
107	253	3	2	1075	B 23107
119	282	3	2	1160	B 23119
131	310	3	2	1250	B 23131
143	338	3	2	1345	B 23143

PLATECOIL on 1 5/8" centers

For 30" Manways—12 PLATECOIL 18" Wide

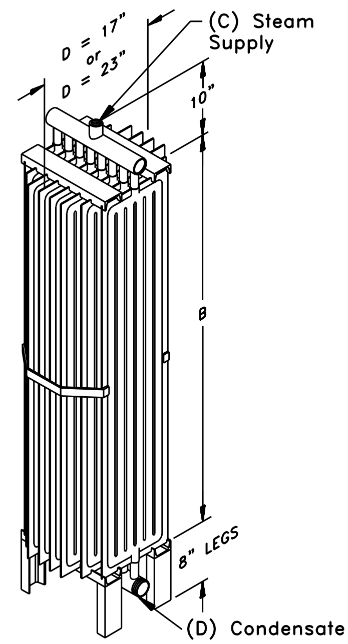
B Dim. (in.)	Effective Surface Area (sq. ft.)	C Dim. NPS (in.)	D Dim. NPS (in.)	Net Weight (lbs.)	Part Number
47	167	3	2	845	B 3047
59	209	3	2	990	B 3059
71	252	3	2	1125	B 3071
83	294	3	2	1245	B 3083
95	337	3	2	1390	B 3095
107	379	3	2	1535	B 30107
119	422	3	2	1670	B 30119
131	464	3	2	1800	B 30131
143	508	3	2	1945	B 30143

PLATECOIL on 1 5/8" centers

STORAGE TANK HEATERS

PLATECOIL storage tank heaters provide a large amount of efficient primary heating surface in a single unit with one steam inlet and one condensate fitting. These units pass through standard manways and are used generally for maintaining temperatures in storage tanks. The height of these vertically installed heaters helps promote convection currents for better heat transfer rates and tank temperature uniformity. All units are fabricated from 14 ga. carbon steel. Heavier gauge construction is available as an option. Refer to page 16 for operating pressures.

Fig. 39-1 PLATECOIL Storage Tank Heater



Specifications and Part Numbers

Fig. 39-2

17" Diameter Heater for 18" and 24" Manways

B Dim. (in.)	sq. ft. Surface	C Dim. MPT (in.)	D Dim. MPT (in.)	Net Weight (lbs.)	Part Number
59	95	1 1/2	1 1/4	320	AT 17059
71	114	2	1 1/2	380	AT 17071
83	133	2	11/2	440	AT 17083
95	153	2	1 1/2	500	AT 17095
107	172	2	1 1/2	555	AT 17107
119	196	2	1 1/2	610	AT 17119

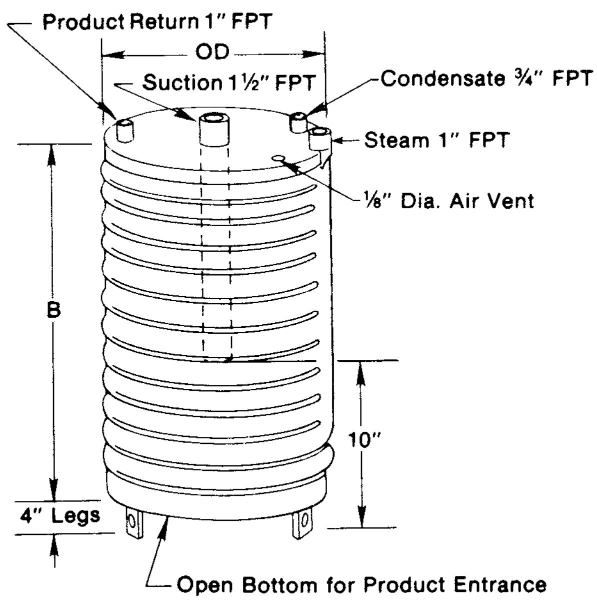
23" Diameter Heaters for 24" Manways

B Dim. (in.)	sq. ft. Surface	C Dim. MPT (in.)	D Dim. MPT (in.)	Net Weight (lbs.)	Part Number
59	165	2	1 1/2	545	AT 23059
71	198	2	1 1/2	640	AT 23071
83	232	2	1 1/2	740	AT 23083
95	265	3	2	850	AT 23095
107	298	3	2	950	AT 23107
119	332	3	2	1050	AT 23119

SUCTION BELL HEATERS

These PLATECOIL heaters are for small suction heater applications usually having some hot product returned to the tank. Frequently used in underground #6 fuel oil tanks. The hood-type construction assures a quantity of hot oil readily available for pumping, or in the case of cold startups, pumping can begin soon after the steam is turned on. Fabricated of 14 ga. double embossed carbon steel. Refer to page 16 for operating pressures.

Fig. 39-3 Suction Bell Heater



Suction Bell Heater Specifications and Part Numbers Standard Sizes

Fig. 39-4

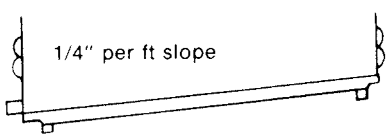
O.D. Dim. (in.)	B Dim. (in.)	sq. ft. Surface	Net Weight (lbs.)	Part Number
17	22	17.6	32	F 1722
	36	28.4	46	F 1736
23	22	24.2	44	F 2322
	36	39.1	61	F 2336

JACKETED VESSELS

- PLATECOIL jacketed vessels by Tranter present a wide range of design advantages. Included are the following built-in efficiencies and economies.
- PLATECOIL jacketed vessels are compact, lightweight and yet have high jacket operating pressures. (See page 16 for jacket pressure ratings.)
- PLATECOIL embossings control flow patterns to increase velocities for improved heat transfer and reduced fouling. Extensive tests show PLATECOIL jacketing provides approximately 28% higher U values than dimpled jackets when using steam for heating, and approximately 15% higher U values when using water for cooling.
- PLATECOIL jackets can easily be designed with 2, 3 or more zones to efficiently satisfy diverse process requirements.
- The "building block" approach to design variable available with standard model PLATECOIL jacketed vessels reduces and simplifies customer engineering.

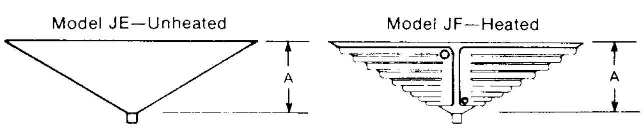
ALTERNATE MODELS WITH VARIOUS BOTTOM DESIGNS

Fig. 40-1 **Model JB Heated Slope Bottom**



Gauges same as in Fig. 40-5

Fig. 40-2 **Models JE and JF Cone Bottoms**

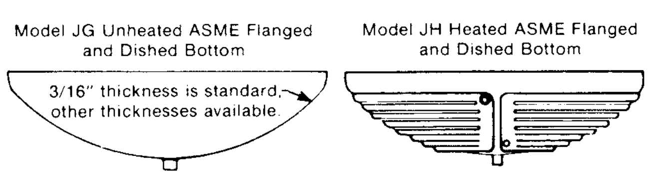


12 ga companion standard for 50 thru 200 gal. 10 ga. companion standard for 250 thru 1000 gal.

Vessel O.D. (in.)	Dim. A (in.)	Vessel O.D. (in.)	Dim. A (in.)	Vessel O.D. (in.)	Dim. A (in.)
24	4	38	6	60	10
30	5	42	7	66	11
34	6	54	9	-	-

Other "A" dimensions are available on special order.

Fig. 40-3 **Models JG and JH Dished Bottoms**



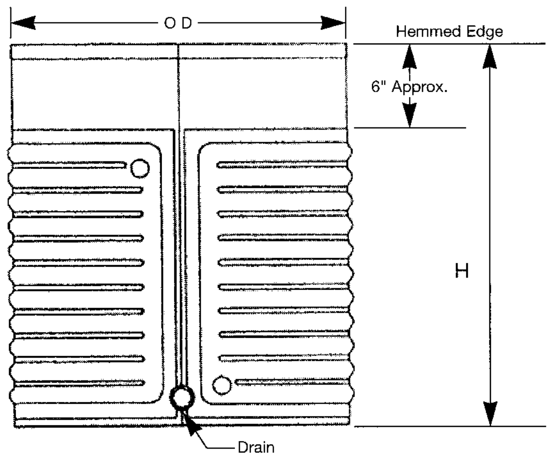


Fig. 40-4
Drain sizes 2" FPT for 50 through 250 gal. capacity; 3" FPT for larger sizes.

Specifications and Part Numbers Model JA Unheated Sloped Bottom

Fig. 40-5

Capacity (gal.)	O.D. (in.)	H (in.)	Material Wall	Thickness Bottom	Approx. Net Wt. (lbs.)	Part Numbers		
						carbon steel	304L stainless	316L stainless
50	24	26	14 ga.	12 ga.	100	JA 1005	JA 4005	JA 6005
100	30	32	14 ga.	12 ga.	150	JA 1010	JA 4010	JA 6010
150	34	38	14 ga.	12 ga.	205	JA 1015	JA 4015	JA 6015
200	38	40	12 ga.	12 ga.	285	JA 1020	JA 4020	JA 6020
250	42	45.	12 ga.	3/16"	360	JA 1025	JA 4025	JA 6025
500	54	51	12 ga.	3/16"	535	JA 1050	JA 4050	JA 6050
750	60	62	10 ga.	3/16"	760	JA 1075	JA 4075	JA 6075
1000	66	70	10 ga.	3/16"	945	JA 1100	JA 4100	JA 6100

All PLATECOIL embossings are 14 ga. in carbon steel and 16 ga. in stainless steel. Other gauges and materials available on special order.

OTHER FEATURES ALSO AVAILABLE

1. ASME "U" Stamp for jacket.
2. Heavier gauge material for jacket pressures up to 400 psig.
3. Electropolish finish on stainless steel vessels.
4. Flanges on fittings.
5. Insulation support rings, clips with jacket.
6. Larger capacity vessels.
7. Special interior finishes. (Contact factory for details.)

GENERAL SPECIFICATIONS

1. Stainless steel vessels are furnished as welded. A passivated finish is also available.
2. All welds are wire brushed.
3. All carbon steel parts on stainless steel vessels are prime painted.
4. Carbon steel vessels are shipped with preservative oil finish.

JACKETED VESSELS
OPTIONAL FEATURES AND ACCESSORIES (CONT'D.)

Optional features and accessories can be added to any of the vessel models described on page 40. This add-on approach offers the design flexibility necessary to obtain vessels that meet particular specifications and requirements. In many cases the need for submission of drawings by customers will be unnecessary. Complete detailed approval drawings will be supplied by Tranter, Inc. on receipt of order.

Fig. 41-1 **Legs (Part No. JL)**
Number and size as listed below. Legs are carbon steel for all vessel materials.

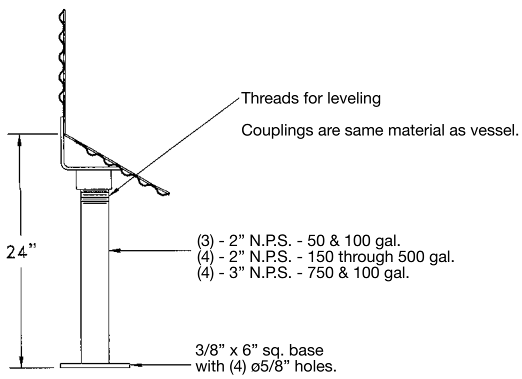
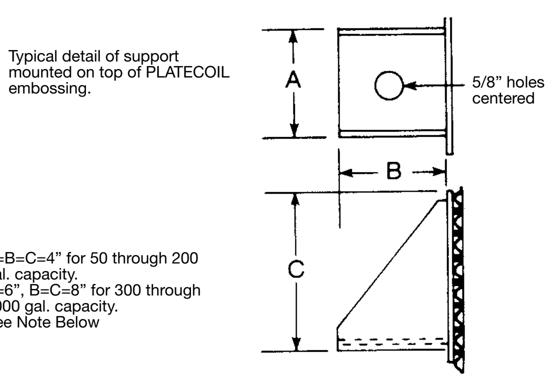


Fig. 41-2 **Side Supports (Part No. JS)**
Four per vessel for all sizes. Supports are carbon steel for all vessel materials.



NOTE: On all optional features, be sure to give plan view and/or side view orientation with respect to vessel centerlines and suggested PLATECOIL fitting locations.

Fig. 41-3 **Top Flange (Part No. JT)**
Must be included with cover JR.

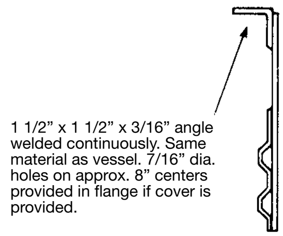


Fig. 41-4 **Top Cover (Part No. JR)**
All parts—same material as vessel except as noted.

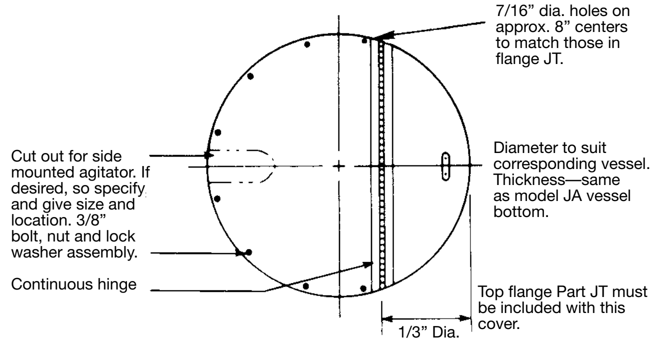


Fig. 41-5 **Agitator Mount (Part No. JQ)**

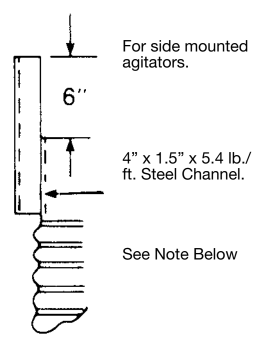
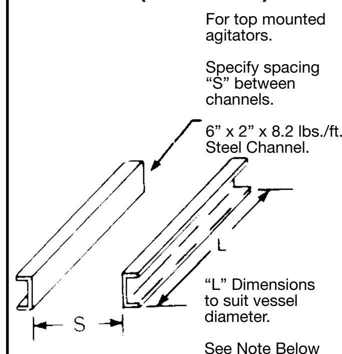


Fig. 41-6 **Agitator Support (Part No. JO)**



ELECTROPOLISH FINISH FOR STAINLESS STEEL VESSEL INTERIORS

For applications where a non-fouling surface is needed, consider the advantages of electropolishing. An electropolish finish, particularly when applied over a stainless steel cold reduced or #4 finish, is very smooth, durable and provides excellent "anti-stick" properties.

The non-fouling surface provided by electropolishing means cleaning time is reduced. Problems that can result from the cleaning and maintenance of fragile glass-lined vessel interiors are also eliminated.

JACKETED TANK BOTTOMS

PLATECOIL Pancakes are available in a variety of standard sizes to provide efficient heating or cooling surfaces for flat bottom circular containers. Standard materials and gauges are shown in chart (Fig. 42-3) for both *Serpentine* and header type flow arrangements. Series parallel pass configurations, other gauges and materials are also available. All are standard 3/4" pass size.

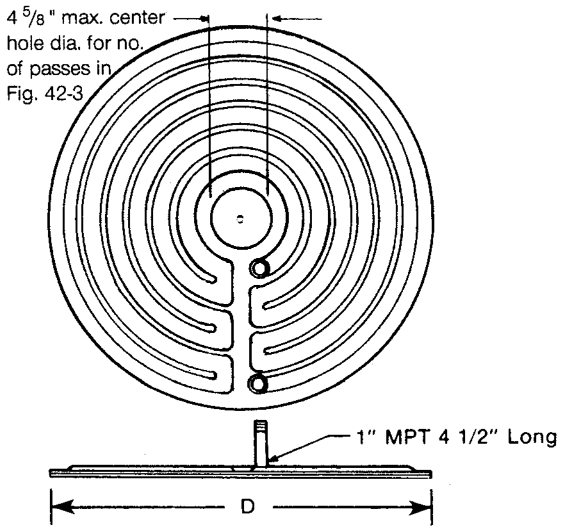


Fig. 42-1
***Serpentine* Type**

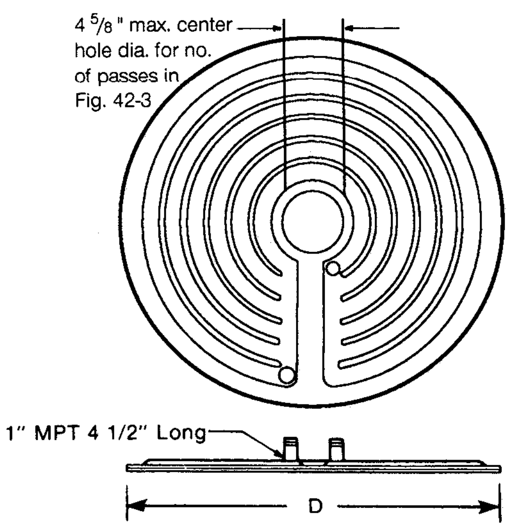


Fig. 42-2
Header Type

Refer to page 16 for operating pressures.

Specifications & Part Numbers

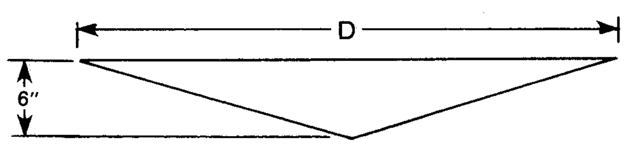
Fig. 42-3

ADD H FOR HEADER TYPE AND S FOR *SERPENTINE*			
diameter D (in.)	**number of passes**	**carbon steel**	
		all 14 ga.	**14 and 10 ga.**
18	3	A2W	A2X
24	5	B2W	B2X
30	6	C2W	C2X
36	8	D2W	D2X
42	10	E2W	E2X
48	11	F2W	F2X
54	13	G2W	G2X
60	15	H2W	H2X
66	17	J2W	J2X
72	18	K2W	K2X

ADD H FOR HEADER TYPE AND S FOR *SERPENTINE*			
diameter D (in.)	**number of passes**	**type 316L stainless steel**	
		all 16 ga.	**16 and 10 ga.**
18	3	A3Y	A3Z
24	5	B3Y	B3Z
30	6	C3Y	C3Z
36	8	D3Y	D3Z
42	10	E3Y	E3Z
48	11	F3Y	F3Z
54	13	G3Y	G3Z
60	15	H3Y	H3Z
66	17	J3Y	J3Z
72	18	K3Y	K3Z

PLATECOIL Cones

Conical-shaped Pancakes, 6" deep, can be furnished in sizes listed in Fig. 42-3 at an additional charge. Add a "C" to the part number to specify a cone.



Other cone depths are also available on a special order basis.

Custom Platecoil Fabrications

PLATECOIL VESSEL COMPONENTS

Single embossed PLATECOIL, in both 3/4” and 1 1/2” pass size, is ideally suited for use as jacketing that can be welded to vessels and tanks. A variety of pass arrangements are available to meet requirements for controlled circuitry and pressure containment. The Series-Parallel pass arrangement is particularly well suited for jacketing applications.

Depending on vessel size and particular requirements, PLATECOIL offers the following design advantages:

1. Can be furnished as complete or partial cylinders for tank wall applications.
2. Can be rolled and/or curved to cover vessel heads or cones.
3. Can be furnished flat to cover circular tank bottoms or sections thereof.
4. Companion plates can be of any required thickness.
5. Can be furnished with edges bevelled, to accommodate welding.

Here are additional built-in design advantages:

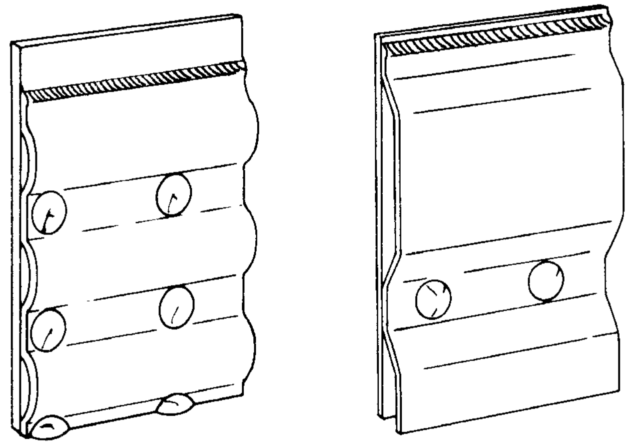
- PLATECOIL jacketing is light in weight, yet inherently strong. It is ASME approved and can be Code stamped for pressures up to 400 psi. Compared to a double-wall style jacketed unit with a like pressure rating, a tank, vessel or reactor fabricated with PLATECOIL jacketing weighs much less.

- PLATECOIL jacketing allows efficient and economical vessel design. ASME requirements are met without resorting to excessively thick shell material. Double-wall jacketed vessels, on the other hand, usually demand a thick vessel wall to meet high jacket pressure requirements, thus adversely affecting both cost and heat transfer capability.

- PLATECOIL jacketing provides design versatility. Regardless of vessel size or configuration of the jacketed area, the variety of embossed patterns and pass sizes available with PLATECOIL means vessel jacketing that is tailor-made to meet exact media flow rates, velocities and pressure drop specifications.

PLATECOIL jacketing is strong, light in weight, versatile and available in a wide selection of materials, and can satisfy the most exacting specifications for jacket geometry and performance excellence.

Fig. 43-1 **Tank & Vessel Shell Sections**



PLATECOIL 3/4” pass jacketing **PLATECOIL 1 1/2” pass jacketing**

Fig. 43-2 **Dished Heads**

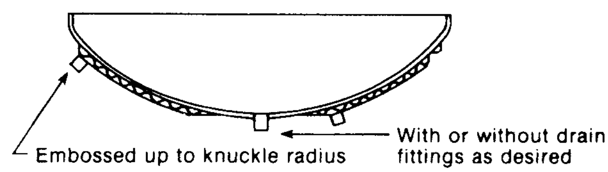


Fig. 43-3 **Cones**

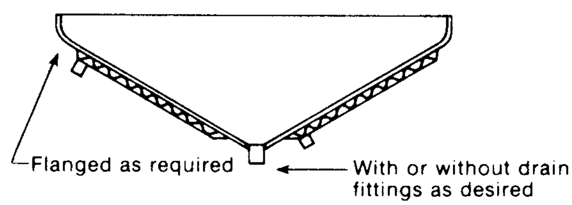
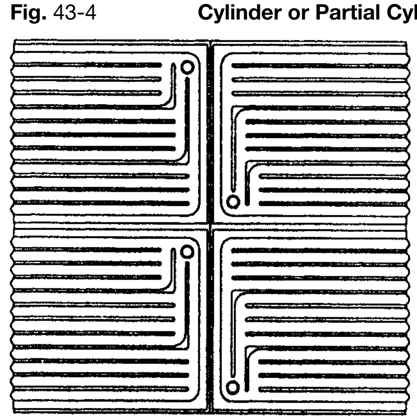


Fig. 43-4 **Cylinder or Partial Cylinders**



Multiple circuits as desired for zone control.

Up to about 8’ dia. x 20‘ high.

When resting on a flat surface no point may be up more than 1/8” (both ends of cylinder) to facilitate final assembly to heads by customer.

Ends tack welded only for trimming and/or final welding by customer, or may be supplied fully welded with circumference to close tolerance.

CLAMP-ON PLATECOIL

Clamp-On PLATECOIL is unequaled as an economical means of providing jacketing for new and existing tanks. PLATECOIL construction allows high pressure ratings with light gauge construction—for instance, 14 gauge carbon steel PLATECOIL is rated for 190 psig operating pressure. Availability of PLATECOIL makes it easy to convert an existing unjacketed vessel, or to procure a low cost plain tank and add PLATECOIL jacketing at the jobsite. The sketches below illustrate some of the configurations that can be used in adding PLATECOIL jacketing to existing tanks and reactors.

Clamp-On PLATECOIL for tank sidewalls are available as standard in any of the seven widths and twelve length combinations shown in the table below. In addition to these 84 sizes, lengths and widths can be varied when needed.

Fig. 44-1

FLAT SIDE TRANSFER AREA IN SQ. FT.												
WIDTH (in.)	LENGTH (in.)											
	23	29	36	47	59	71	83	95	107	119	131	143
12	1.9	2.4	2.9	3.9	4.9	5.9	6.9	7.9	8.9	9.9	10.9	11.9
18	3.0	3.8	4.6	6.1	7.7	9.3	10.8	12.4	14.0	15.5	17.1	18.7
22	3.6	4.5	5.4	7.3	9.1	11.0	12.8	14.7	16.5	18.4	20.2	22.1
26	4.1	5.2	6.2	8.4	10.5	12.7	14.8	16.9	19.1	21.2	23.4	25.5
29	4.7	5.9	7.1	9.5	11.9	14.4	16.8	19.2	21.6	24.1	26.5	29.0
36	5.7	7.2	8.7	11.7	14.7	17.7	20.7	23.7	26.7	29.7	32.7	35.7
43	6.8	8.6	10.4	14.0	17.6	21.1	24.7	28.3	31.9	35.4	39.0	42.6

CONE SHAPED PLATECOIL

Usually at least 2 PLATECOIL sections are supplied for cones up to 3' major dia. More sections are required for larger sizes.

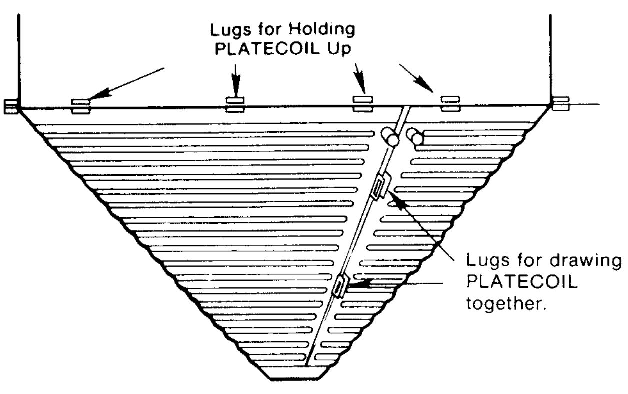


Fig. 44-2

CLAMP-ON ARRANGEMENTS FOR VERTICAL TANKS

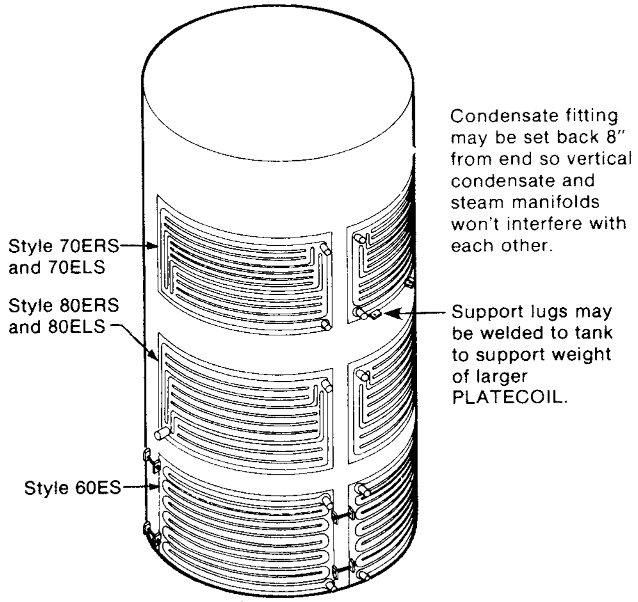


Fig. 44-3

CLAMP-ON ARRANGEMENTS FOR HORIZONTAL TANKS

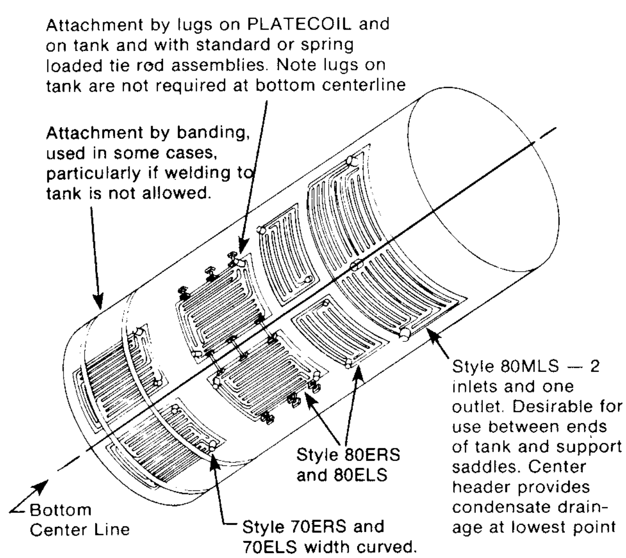


Fig. 44-4

CLAMP-ON PLATECOIL FOR DISHED HEADS

Fig. 45-1 shows a maximum coverage approach to clamp-on PLATECOIL for dished heads. Note that coverage can extend out to the start of the knuckle radius. These sections are fabricated with curvature in two directions to fit the shape of the specific head. For proper fit-up it is essential that the type of head and its principal dimensions (dish radius and knuckle radius) be supplied.

Number of PLATECOIL Sections Required for Maximum Coverage	
Tank Diameter	**Usual No. of Sections**
Up through 4' diameter	2
Over 4' through 5' diameter	4
Over 5' through 7' diameter	6
Over 7' through 9' diameter	10
Over 9' through 14' diameter	16

Fig. 45-2 shows a method that can be used when less than complete coverage is adequate or where multiple nozzles must be cleared. This method is somewhat lower in cost. 30% to 45% coverage can be obtained with this approach. 12" wide PLATECOIL, length curved, are used.

L-3 S lugs, as detailed on page 24, are included. Studs welded to the head are usually employed. Other lug types, if preferred, and tie rod assemblies are shown on page 24.

For best heat transfer the use of non-hardening heat transfer mastic is highly recommended for either of these methods. See page 46 for details on mastics.

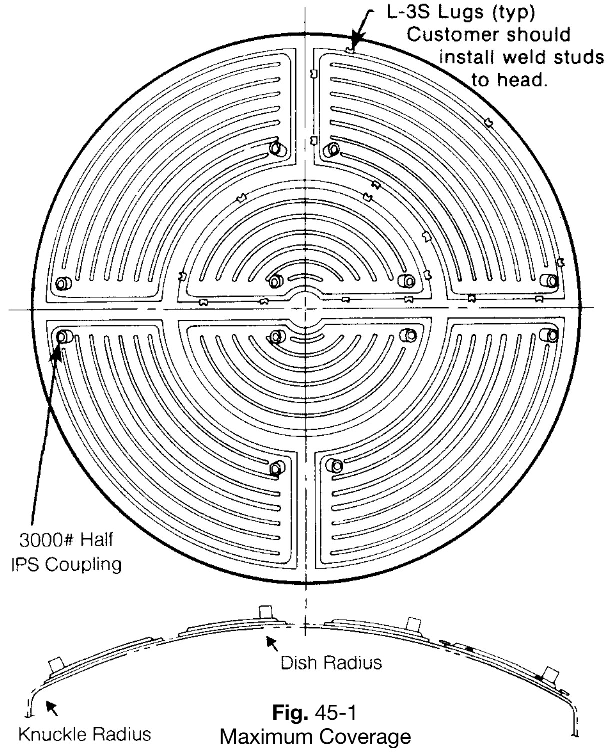


Fig. 45-1
Maximum Coverage

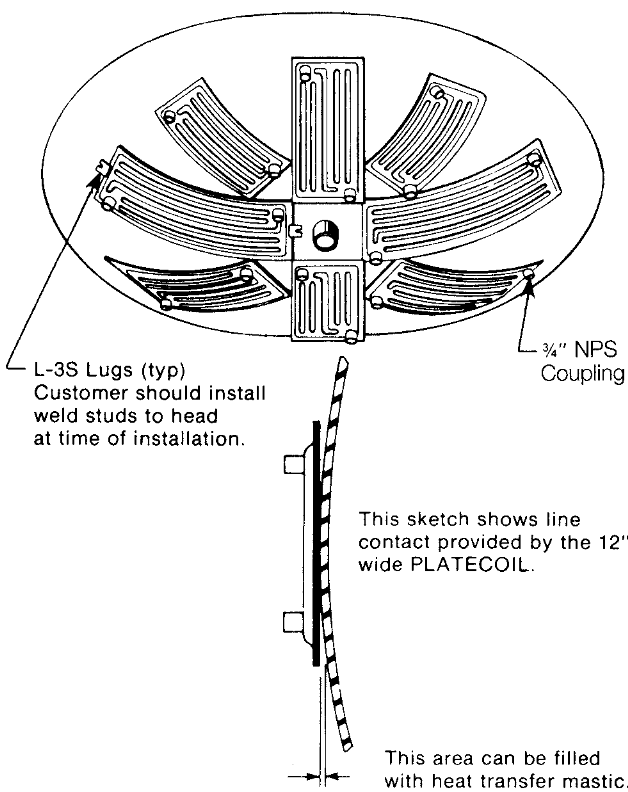


Fig. 45-2
Moderate Coverage

CLAMP-ON PLATECOIL APPLICATION DATA

HEAT TRANSFER MASTICS

The thermal resistance of the air gaps between clamp-on PLATECOIL and tank surfaces may be reduced by the use of a heat transfer mastic, applied at the time of installation. This will provide improved perfomance by increasing the overall coefficients of heat transfer as shown in Fig. 46-1.

Average Overall Heat Transfer Rates U = Btu/hr. sq. ft. F For Clamp-on PLATECOIL

Fig. 46-1

WATER AND SOLVENTS	Heating	Cooling
With heat transfer mastic	30-40	20-30
Without heat transfer mastic	15-25	10-15
VISCOUS PRODUCTS	**Heating**	**Cooling**
With heat transfer mastic	10-20	5-12
Without heat transfer mastic	6-12	3-8
AIR AND GASES	**Heating**	**Cooling**
With heat transfer mastic	1-3	1-3
Without heat transfer mastic	1-3	1-3

By applying the mastic to the tank at the time of installation, its thickness can be generally controlled to fill voids and low spots with less at weld beads or high points. The purpose is to eliminate air gaps, and only as much as is needed to do this should be used. The strong PLATECOIL and lug construction facilitates pulling the PLATECOIL tightly into the mastic and with the consistency of these products any excess can generally be squeezed out.

Non-hardening mastics are preferable for long range maximum heat transfer. However, non-hardening mastics are not available for higher temperature requirements.

The following Fig. 46-2 and Fig. 46-3 are basic summaries of data on several mastics. Note the temperature limits.

Heat Transfer Mastics

Fig. 46-2

Moderate Temperature Applications		
Mastic suggested for use with PLATECOIL	Tracit #1000* (or equivalent)	Tracit #1100 (or equivalent)
Type	Non-Hardening	
Temperature Limits	Up to 200°F	Up to 400°F
Waterproof	No	No
Use on aluminum or copper tanks	Yes	Yes

*Note: Tracit #1000 is only recommended for cooling applications or where the ambient temperature conditions do not exceed 200°F.

Curing: None required. PLATECOIL may be installed as soon as mastic is in place and heat can be applied at once.

Fig. 46-3

High Temperature Applications		
Mastic suggested for use with PLATECOIL	Tracit #300 (or equivalent)	Tracit #600A (or equivalent)
Type	Hardens. but stays flexible enough to absorb metal expansion and contraction	
Temperature Limits	Up to 750°F	Up to 1250°F
Waterproof	No	No
Use on aluminum or copper tanks	Yes	Yes

Curing: None required. PLATECOIL may be installed as soon as mastic is in place, and heat can be applied at once.

Coverage based on 1/8” average thickness = 13 sq. ft./g

TYPICAL CLAMP-ON PLATECOIL INSTALLATIONS

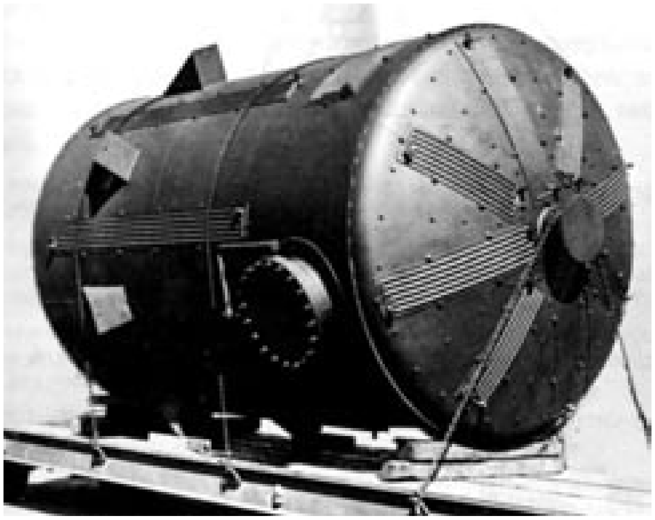


Fig. 47-1 **PLATECOIL on sides and head provide overall heating.**

Fig. 47-2 **A storage tank.**

Fig. 47-3 **PLATECOIL being pulled in place, and excess mastic is squeezed out.**

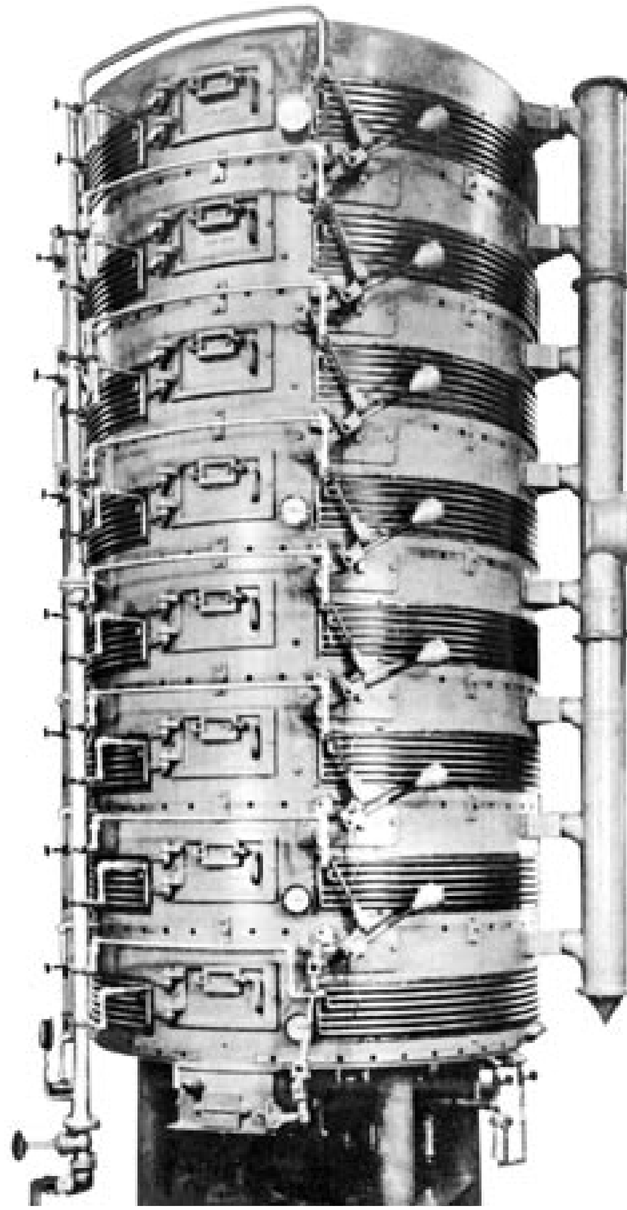


Fig. 47-4 **A soybean processor with PLATECOIL at all levels.**

PLATECOIL FOR USE IN VESSELS

The use of PLATECOIL in the dual role of baffles as well as heat transfer surfaces, both for heating and cooling applications, has found wide acceptance. They are used in food processing, chemical, pharmaceutical, synthetic rubber and other industries.

There are many PLATECOIL styles specially adapted for use in agitated vessels. Some of these are illustrated below.

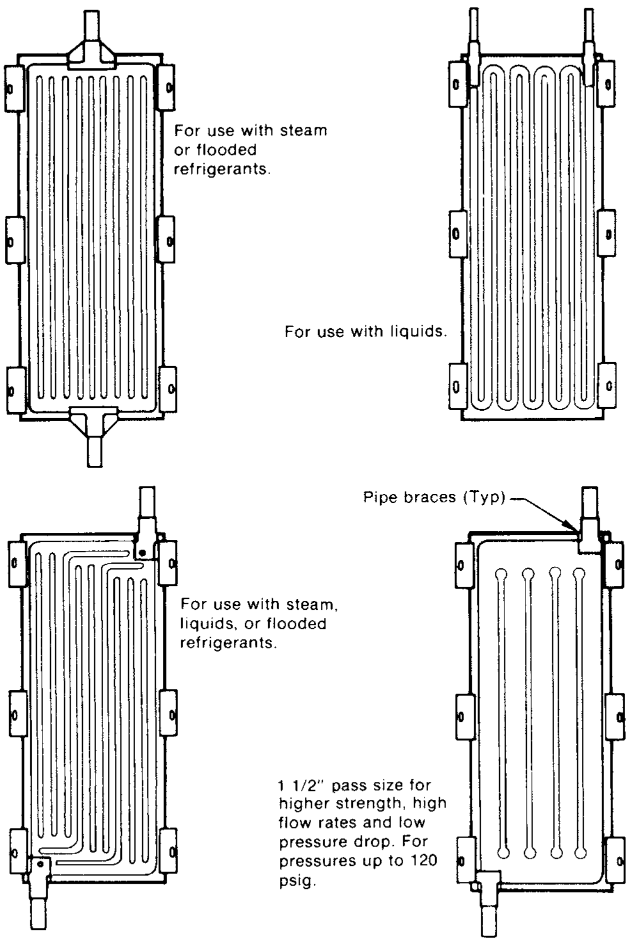


Fig. 48-1 **PLATECOIL Embossing Options**

The above PLATECOIL styles, with pipe braces, hemmed edges and stress distribution pads are commonly used in agitated tanks and reactors. Material should not be lighter than 14 ga. stainless steel or 12 ga. carbon steel. When large forces are involved, special attention must be placed on adequate structural support of the PLATECOIL. Pipe braces are 2-piece clamshell type for extra strength.

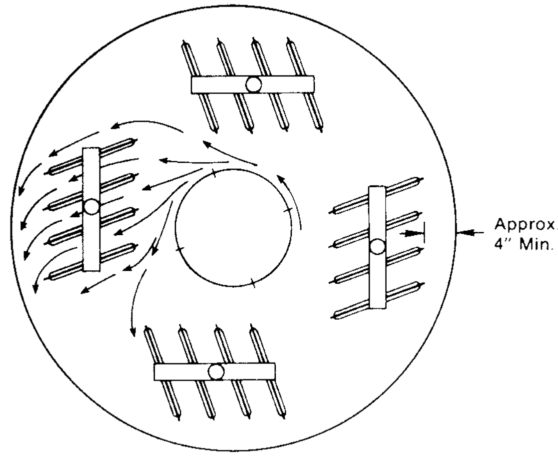


Fig. 48-2 **Typical PLATECOIL banks in an agitated vessel.**

PLATECOIL baffle assemblies are fabricated to minimize field installation work. Bracing in the above illustration has been omitted for clarity.

Since the application involves many variables, it is difficult to establish exact design criteria. The agitator supplier should always be consulted with respect to angularity of mounting, baffling effect, etc.

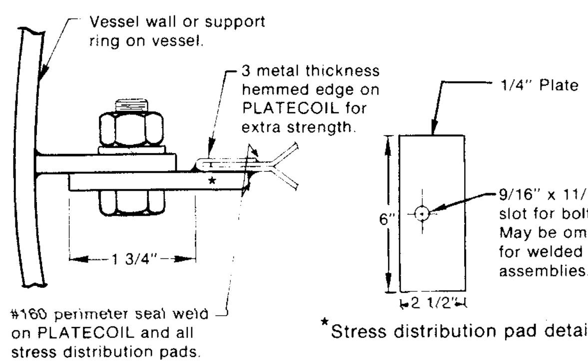


Fig. 48-3
Mounting Lug Detail

Fig. 48-4

Standard Number of Pads for PLATECOIL						
Length (in.)	**23**	**29**	**35**	**47**	**59**	**71**
Pads per Side	2	2	2	3	3	3
Pads per PLATECOIL	4	4	4	6	6	6
Length (in.)	**83**	**95**	**107**	**119**	**131**	**143**
Pads per Side	4	4	5	5	5	6
Pads per PLATECOIL	8	8	10	10	10	12

PLATECOIL FOR USE IN VESSELS (cont'd)

Proper bracing and installation of PLATECOIL in agitated tanks is very important. Note specific basic suggestions as follows. Many of these points are illustrated on these two pages.

1. Brace the PLATECOIL so they cannot vibrate under operating conditions. If vibrations exist, stress failure may develop.
2. Use PLATECOIL with hemmed edges to distribute stresses at mounting points. In cases of very heavy agitation structural members will be needed.
3. Make adequate provision for expansion and contraction. This is particularly true for applications involving alternate heating and cooling.
4. A-Frame type braces are desirable. When agitation is extreme, do not consider the PLATECOIL as part of an A-Frame.
5. Do not consider PLATECOIL fittings as structural support members unless specially fabricated and reinforced for this purpose.
6. Flexible connections to fittings are desirable when practical.
7. Generally, PLATECOIL should be installed so that they tend to shear the product rather than stop its flow. This will reduce the stress forces on the PLATECOIL and promote better heat transfer.
8. Inner edges of the PLATECOIL should not be installed too close together, particularly in viscous solutions.

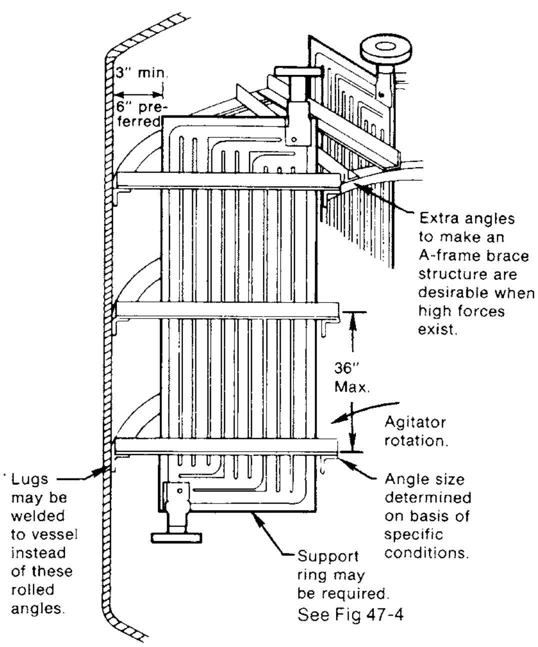


Fig. 49-1 **Elevation view.**

This illustrates individual *Multi-Zone* PLATECOIL as typically installed in agitated vessels. The stress pads, hemmed edges and manifolds are omitted for clarity. Installation may be by welding or bolting.

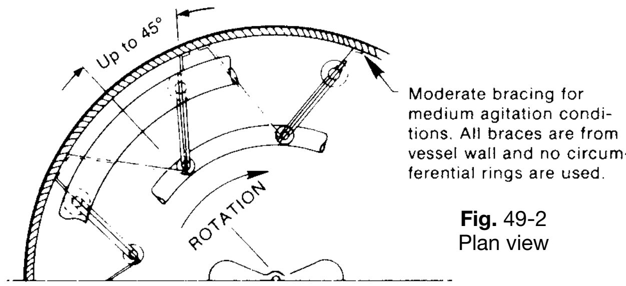


Fig. 49-2
Plan view

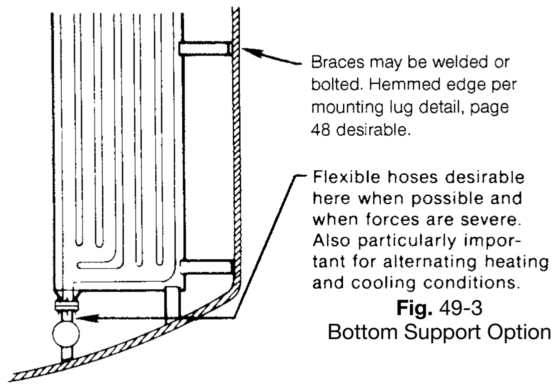


Fig. 49-3
Bottom Support Option

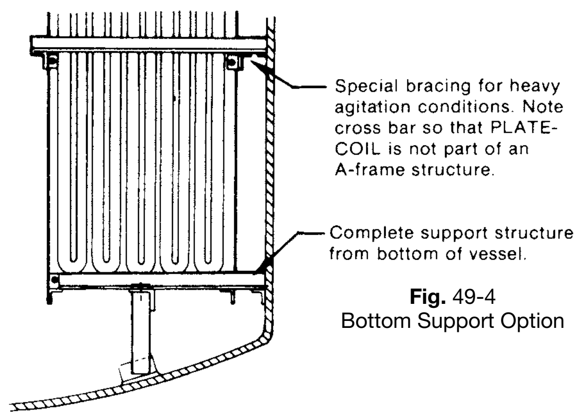


Fig. 49-4
Bottom Support Option

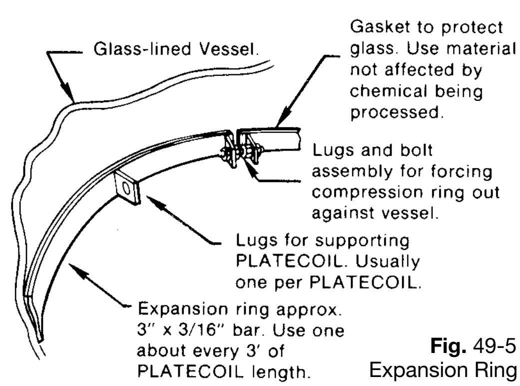


Fig. 49-5
Expansion Ring Detail

PLATECOIL can be installed in glass lined vessels by using an expansion ring, as illustrated above.

PLATECOIL BANKS

PLATECOIL banks provide extensive heat transfer surface in a compact, packaged unit. There is great flexibility in the choice of sizes, styles, spacings, and optional features. Banks are available in all PLATECOIL material. The selection of the proper style and material will depend, of course, on the application. The optional features, such as legs and lifting handles, can be specified for any style—*Multi-Zone* as described on this page, or *Serpentine* as described on page 51.

The following should be specified when ordering PLATECOIL banks:

1. Style, size and material of PLATECOIL.
2. Number of PLATECOIL and center-to-center spacing.
3. Header size if other than standard shown in size chart.
4. Extra features such as legs, lifting handles, etc.
5. Pressure at which bank is to operate.
6. Amount of agitation, if any. (Additional bracing may be required, especially for fluidized bed application.)

STYLE 70 AND 80 *MULTI-ZONE* WELDED CONSTRUCTION

Multi-Zone PLATECOIL banks provide large amounts of heat transfer surface and are ideal for use with steam. Further, the Style 80 banks all carry large quantities of liquid with very low pressure drops.

Typical uses for *Multi-Zone* PLATECOIL banks:

1. Steam heating of water solutions in large spray washers.
2. Heating tar or oils with steam in large outdoor storage tanks.
3. Heating "white water" with steam.
4. Heating brewery processing tanks.
5. Fluidized bed coolers and dryers (see page 60).

Header Size Table for Heating Watery Solutions with Steam

Fig. 50-2

Max. PLATECOIL Surface (sq. ft.)	When Dimension "A" does not exceed 22 inches		When Dimension "A" exceeds 22" but not greater than 43"	
	D INLET NPS (in.)	E OUTLET NPS (in.)	D INLET NPS (in.)	E OUTLET NPS (in.)
50	2	1 1/4	2 1/2	1 1/4
100	2 1/2	1 1/4	2 1/2	1 1/4
250	4	1 1/2	4	1 1/2
500	6	2	6	2
750	8	2 1/2	8	2 1/2
1000	8	3	8	3

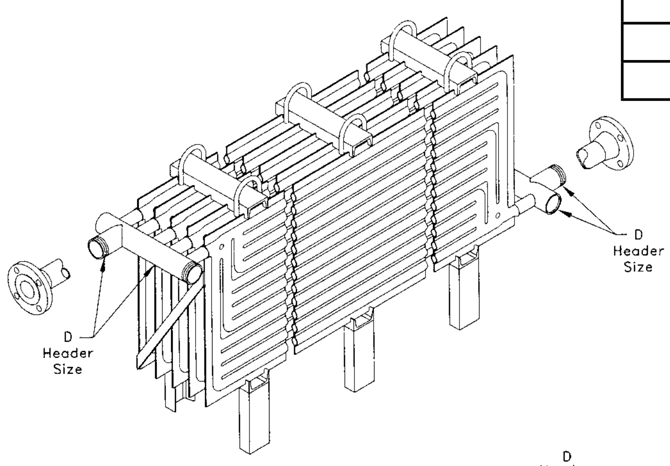


Fig. 50-1
Style 80 PLATECOIL Bank

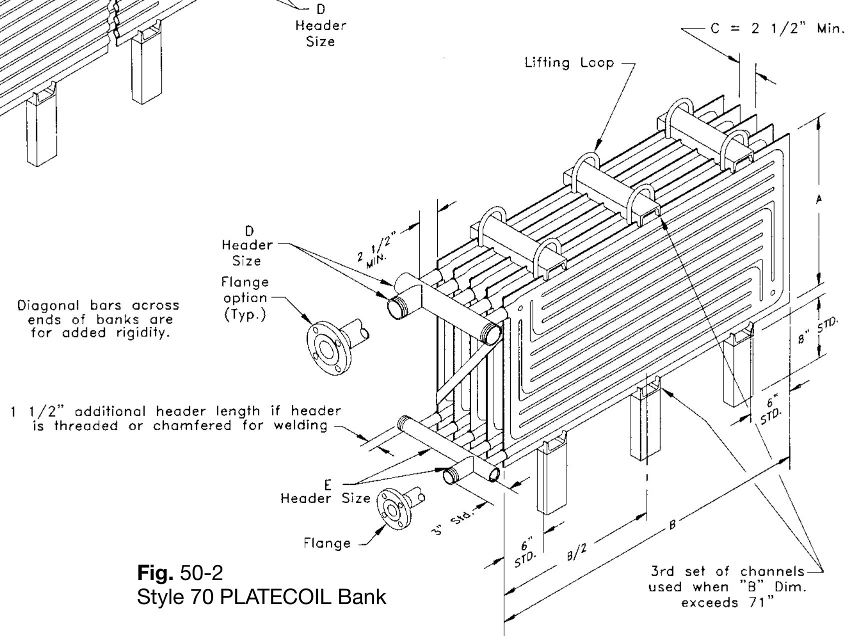


Fig. 50-2
Style 70 PLATECOIL Bank

PLATECOIL BANKS (cont'd)

STYLE 50 AND 60 *SERPENTINE* PLATECOIL

Serpentine PLATECOIL banks provide maximum heat transfer surface area with a single inlet and outlet connection. The design is most efficient for cooling applications for use with hot oil or hot water. Illustrated is the conventional all welded bank. Optional features, unions, flanges, legs, etc., as shown on page 50 are also available for these styles.

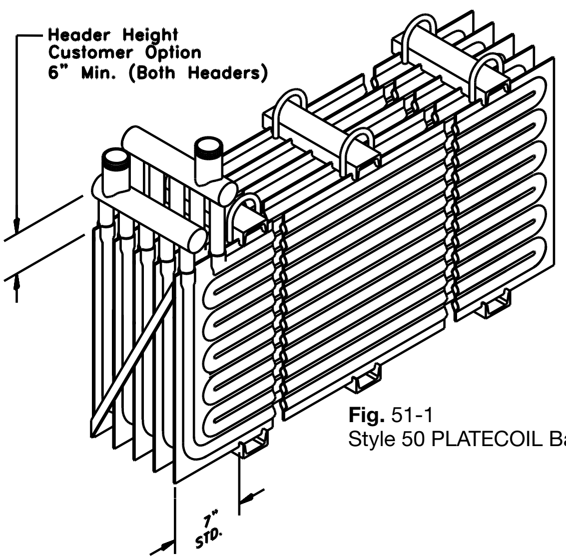


Fig. 51-1
Style 50 PLATECOIL Bank

TYPICAL USES FOR *SERPENTINE* PLATECOIL BANKS

1. Cooling quench oil with water.
2. Cooling paint with water.
3. Cooling air or liquids with refrigerants.
4. Waste heat recovery.
5. Fluidized bed applications (extra bracing may be required).
6. Banks for building up ice.
7. Heating asphalt with hot oil.
8. Heating air or liquids with high temperature hot water.

HEADER PIPE SIZE

Fig. 51-2

Max. Number of PLATECOIL	D NOMINAL PIPE SIZE (in.)
2 through 4	1 1/4
5 through 7	1 1/2
8 through 10	2
11 through 15	2 1/2
16 through 20	3
21 through 25	3 1/2

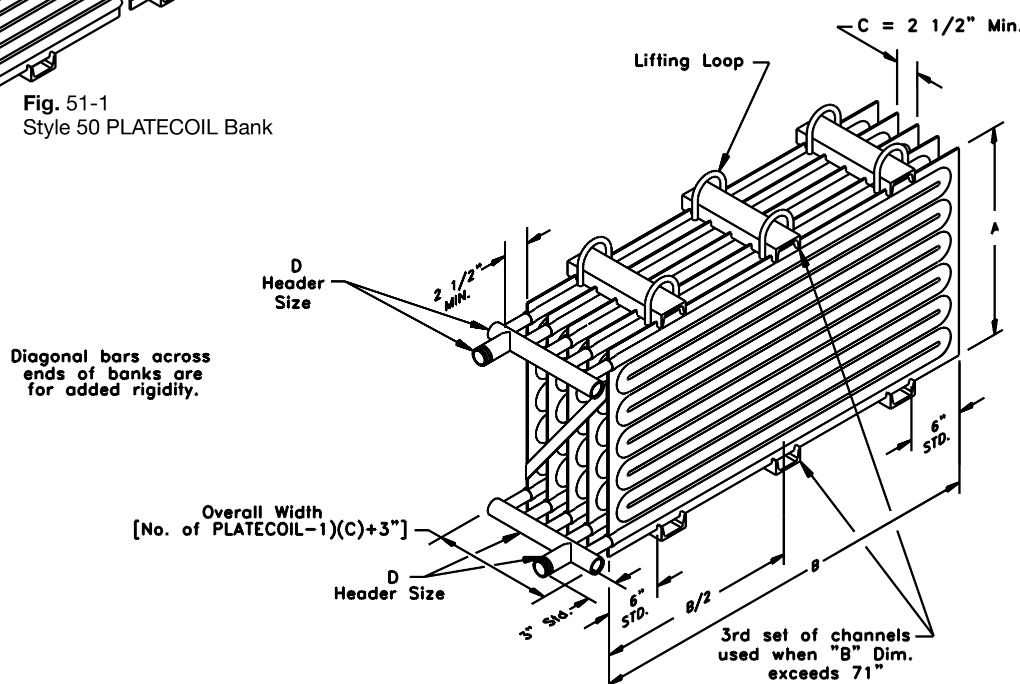


Fig. 51-3
Style 60 PLATECOIL Bank

Alternate PLATECOIL can be offset lengthwise to obtain serpentine flow around the PLATECOIL when in a rectangular tank.

Installation and Maintenance Tips

STEAM HEATED PLATECOIL

POSITIONING, PIPING, TRAPPING

The inherent flexibility of PLATECOIL design permits a wide variety of satisfactory installation procedures. However, to ensure maximum efficiency, there are a few precautions that should be observed.

1. Individual PLATECOIL of *Multi-Zone*, or parallel pass design, present no problems when installed in the conventional manner. The condensate line may be extended any reasonable distance vertically provided the steam pressure is in excess of 1 psig for each 2 feet of vertical lift.

This is with the proviso that the PLATECOIL size not exceed approximately 50 sq. ft. for steam to watery solutions if steam pressure is below 15 psig. This is also covered by Note 8 on page 79.

2. Individual PLATECOIL of *Serpentine* pass design installed in the conventional manner are in some instances used with steam, particularly in the smaller sizes and with low U values. A rough calculation of the condensate in gpm will indicate whether or not flooding will be a problem.

3. Style 80 PLATECOIL may be installed in a flat position. This should be avoided if sediment may be deposited on the upper surface. Elevation above the tank bottom should be sufficient to allow free circulation of the liquid. The inlet side should be elevated at least 1" for improved condensate drainage.

SUMMARY

Ideally, each PLATECOIL should be individually trapped. However, several reasonable adjacent PLATECOIL, as shown in Fig. 52-4, may be connected to a single trap provided all the condensate flows by gravity to a common low point. Never attempt to lift condensate through more than one riser to a single trap. Float and Thermostatic (F & T) type traps are typically best suited for PLATECOIL applications. Consult with a steam system expert to ensure the system design is proper.

NOTE: The sketches shown here are to illustrate positioning only and do not indicate bracing often required.

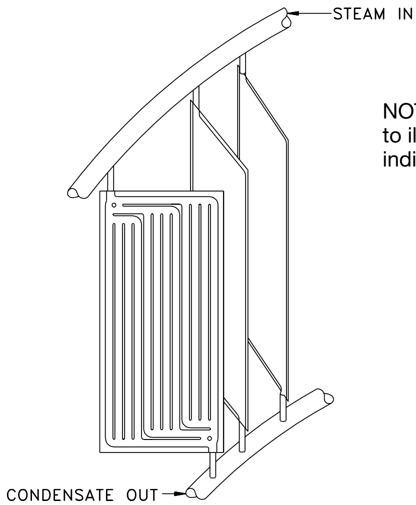


Fig. 52-1
Style 80 should be used when vertically banked PLATECOIL are installed in processing tanks.

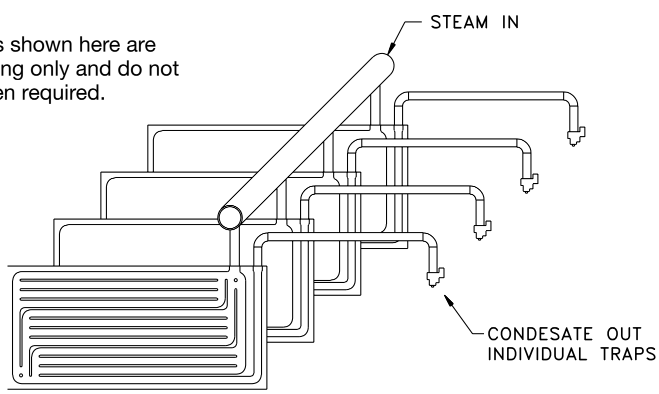


Fig. 52-3
Style 70 are generally used for banks, Fig. 50-3. If Style 90 are used, each should be trapped individually.

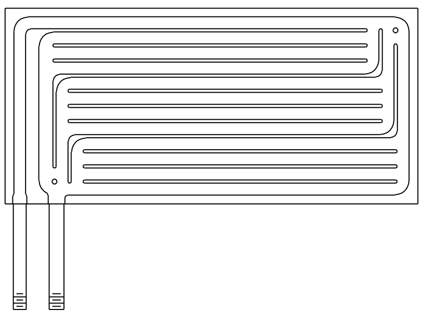


Fig. 52-2
Installations of *Multi-Zone* styles with the pipe fittings down are not recommended unless the condensate fitting is used for the steam inlet.

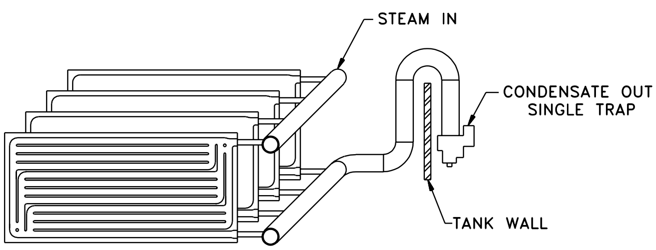


Fig. 52-4
Condensate must flow to a common low point before lifting.

PROTECTION AGAINST ELECTROCHEMICAL CORROSION

Electrochemical corrosion involves the flow of electric current from one metallic surface (anode) through an electrolyte to another metallic surface (cathode). In addition to the electrolyte, there must be a difference in potential and a complete electrical circuit. Except under unusual conditions, corrosion occurs at the anodic surface.

Electrochemical corrosion occuring between two dissimilar metals in contact in an electrolyte is called galvanic corrosion. The International Nickel Company has developed a Galvanic Series (see Fig. 53-1) which gives a realistic indication of what to expect in industrial applications. Metals grouped together are usually safe to use in contact with each other. The coupling of metals from two different groups may result in the galvanic corrosion of the one nearest the anodic end of the series. The farther apart the metals stand, the greater the galvanic action.

Corrosion resistance on some metals can be enhanced by creating a passive film on the surface of the metal. Stainless Steel PLATECOIL can be passivated for this reason.

Galvanic corrosion can be controlled by coating, inhibition, cathodic protection or electrical insulation. Generally, insulating the PLATECOIL from the electrical circuit is the most economical means of protecting PLATECOIL or the metal it is coupled with from this type of corrosion.

One form of electrochemical corrosion is caused by electrolytic solutions carrying "stray currents." These are occasionally found in metal plating and aluminum anodizing processes. Stray currents can also reach other types of tanks through piping, floors and tank walls. Fig. 53-2 illustrates a typical insulated PLATECOIL installation in a plating tank. The principal objective is to isolate the PLATECOIL from all metallic contacts.

GALVANIC SERIES OF METALS AND ALLOYS

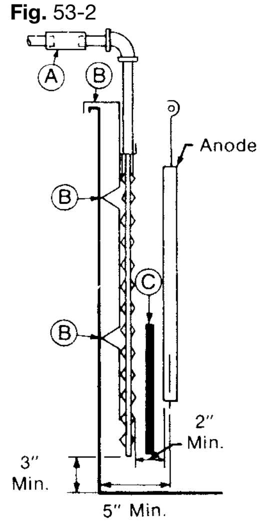
Fig. 53-1

Corroded End (Anodic or Least Noble)
Magnesium
Zinc
Beryllium
Aluminum Alloys
Cadmium
Mild Steel, Cast Iron
Low Alloy Steel
Austenitic Nickel Cast Iron
Aluminum Bronze
Naval Brass, Yellow Brass, Red Brass
Tin
Copper
Pb-Sn Solder (50/50)
Admiralty Brass, Aluminum Brass
Manganese Bronze
Silicon Bronze
Tin Bronzes (G & M)
Stainless Steel - Types 410, 416
Nickel Silver
90-10 Copper-Nickel
80-20 Copper-Nickel
Stainless Steel - Type 430
Lead
70-30 Copper-Nickel
Nickel-Aluminum Bronze
Nickel-Chromium Alloy 600
Silver Braze Alloys
Nickel 200
Silver
Stainless Steel - Types 302, 304, 321
Nickel-Copper Alloys 400, K-500
Stainless Steel - Types 316, 317
Alloy "20" Stainless Steels, cast and wrought
Nickel-Iron-Chromium Alloy 825
Ni-Cr-Mo-Cu-Si Alloy B
Titanium
Ni-Cr-Mo Alloy C
Platinum
Graphite
Protect End (Cathodic or Most Noble)

(Courtesy of International Nickel Co.)

SUGGESTED METHOD OF INSTALLING PLATECOIL IN CURRENT CARRYING SOLUTIONS

Fig. 53-2



A. USE INSULATING JOINTS in both pipe lines.
B. INSULATE HANGERS from metallic contact with tank.
C. INSULATING CURTAIN (P.V.C.) may be used to prevent currents passing from the anode through the PLATECOIL. Be sure to allow for free circulation of the solution under the curtain.

NOTES

1. In the case of cyanide copper plating solutions the chloride content should be low and the pH high (about 13) for good plating. These conditions also contribute to a more economical PLATECOIL life.
2. In sulphuric acid anodizing solutions the PLATECOIL may be made a part of the cathodic area. In such cases the proper electrical contact with the anodizing circuit is necessary.

INSTALLATION OF PLATECOIL TO ALLOW FOR THERMAL EXPANSION

When PLATECOIL is fastened to rigid supports allowance must be made for thermal expansion. Depending on the installation this could involve spacing between PLATECOIL, flexible joints, slotted lugs, etc. to prevent buckling.

Tranter engineers can offer recommendations for specific installations.

Figure 54-1 shows the linear thermal expansion of various metals and alloys, and the example illustrates the use of the coefficients to determine effect of temperature on length.

DETERMINING THERMAL EXPANSION

General Equation:

ΔL = Lo x Coefficient of Linear Expansion x Δt

where

ΔL = change in length

Lo = initial overall length

Δt = difference between temperature limits involved, °F

Example:

Determine the approximate increase in length when a 12' long stainless steel PLATECOIL is heated from 70°F to 350°F.

Solution:

From the table pick the proper coefficient for stainless steel .000108 inches/foot°F.

Then

ΔL = 12 feet x 0.000108 in./ft.°F (350°F - 70°F) = .36 in.

Thus the final length of the PLATECOIL is 12 feet plus .36 inch or approximately 12 ft. 3/8 in.

Coefficients of Linear Expansion Approximate Values

Fig. 54-1

MATERIAL	COEFFICIENT in./ft.°F
CARBON STEEL (1020)	.000083
STAINLESS STEEL (18-8)	.000108
ALUMINUM (5052)	.000161
NICKEL (Pure)	.000088
MONEL 400	.000102
INCONEL 600	.000087
ALLOY 20Cb-3	.000107
ALLOY B-2	.000077
ALLOY C-276	.000084
TITANIUM	.000048

CLEANING AND MAINTAINING PLATECOIL

The useful life of PLATECOIL can be extended by regular cleaning and inspection schedules.

PLATECOIL are subjected to severe conditions of temperature and stress as contrasted to tank walls, rack, etc. When used with 100 psi steam at 338°F the skin temperature (surface temperature) of a PLATECOIL in a 180°F solution can be about 158°F higher than the tank wall temperature.

Scaling and corrosion rates increase with temperature. Also, corrosion is accelerated in the small voids which occur under the scale next to the metal. The stainless steels in particular depend on an oxide surface film for their corrosion resistance. The presence of oxygen is excluded; the oxide film breaks down, and corrosion occurs. Usually this corrosion first takes place as a concentration cell attack and pits develop in the metal under the scale. These pits act as stress risers and hair line cracks emanate from these pits. Even if the PLATECOIL is cleaned before leaks develop, but after severe scaling, the surface has been roughened so that scaling will occur more readily in the future.

Because of these factors it is important to establish regular cleaning schedules. This is necessary, also, to obtain proper heat transfer rates from the PLATECOIL. Lime scale deposits, for example, conduct only 1/30th of the heat of an equivalent thickness of metal.

CLEANING AND MAINTAINING PLATECOIL (cont'd.)

PLATECOIL's basic design simplifies cleaning by brushing in place. Some scales can be removed reasonably well by this process. It is suggested that this method always be tried before removing the PLATECOIL and permitting the scale to dry and harden. When brushing stainless PLATECOIL, a bristle or stainless steel brush should be used. Do not use a plain steel wire brush as steel particles will be embedded in the surface.

Some scales, particularly those encountered in the operation of some phosphatizing processes in metal finishing, may require chemical cleaning, For these cases it is most desirable to consult one of the concerns who supply metal finishing chemicals. Separate cleaning tanks are frequently set up. By using spare PLATECOIL and suitable chemicals in a separate cleaning tank, a systematic cleaning program can be established without down time.

When chemically cleaning stainless PLATECOIL, caution should be observed regarding the use of acids containing chlorides or fluorides. These acids may be satisfactory if used cold, if properly inhibited and/or if properly rinsed off after use. Chlorides and fluorides can severly attack stainless. Extreme corrosion may occur, for example, if the tank is filled with such an acid and then the PLATECOIL is used for heating it to hasten the cleaning process. Sulfamic acid type cleaners may be considerably less dangerous.

The use of hammers and chisels to remove scale is not recommended. PLATECOIL can be damaged beyond repair by such treatment. PLATECOIL are rugged structural units but are not designed to withstand severe blows. If in emergencies this method is necessary, a lead or fiber mallet carefully used is the least apt to cause damage.

Some scales may be removed by use of special equipment designed for high pressure water spraying. Pressures up to 600 psi can be employed. This, however, will not remove the most stubborn phosphate type scales.

Electropolishing will generally reduce the scaling problems encountered with stainless PLATECOIL.

FIELD REPAIR OF PLATECOIL

Through accidental damage, etc., PLATECOIL may occasionally need repair. Some leaks may be repaired and the following welding procedures are suggested.

1. Carbon Steel PLATECOIL: SMAW (open arc) welding is the conventional method. A 1/8" diameter, all position, AC or DC, reverse polarity coated electrode of AWS Class E-60 or E-70 should be used. Extreme care should be exercised to avoid burning through the material. The oxy-acetylene gas torch method can sometimes be used. However, PLATECOIL that have been in use for some time may have deposits from the process on the surface so that the repair point becomes easily contaminated and a leak proof assembly is difficult to obtain.

2. Stainless Steel PLATECOIL: For type 316L, SMAW welding is the conventional method. A 3/32" diameter electrode, AC-DC typical class E-316L AWS 5.4 is recommended. If TIG (heli arc) welding is used, a 1/16" diameter bare rod, typical class E-316L, AWS 5.9 is recommended. Repairing type 304L with either the MIG or TIG process requires E-308L AWS 5.9. All stainless steel welds should be interrupted regularly and the area promptly water quenched. It is important to do this so that the metal temperature cannot exceed 800 degrees for more than 2 minutes to minimize carbide precipitation.

3. Cleanliness of the Weld Area is important. The base metal in the weld area must be free from slag, scale, oil and grease. The edges and general area should be wire brushed and cleaned with a suitable solvent where possible. A clean stainless steel brush should be used as a final preparation in the repairing of stainless steel. A general wire brushing on the completed repair makes a satisfactory surface finish.

Application Information

PLATECOIL FOR METAL PLATING, FINISHING, TREATING

PLATECOIL have been used regularly for over 50 years for heating and cooling many plating, metal finishing and metal treating solutions. The product has been regularly expanded and improved. The following advantages have been proven over the years.

1. **PLATECOIL requires less space than pipecoil.** A 22 x 47 PLATECOIL provides the same heat transfer area as 32' of 1 1/2" pipe requiring approximately 30" x 60". See area table page 12.
2. **Hundreds of styles and sizes in stock for fast shipment.** Thousands in stock in various metals and gauges. See pages 11, 28, 99, 100 and 101. See metal finishing material selection guide on page 29.
3. **Highly efficient *Multi-Zone* styles available.** This popular steam heating PLATECOIL has a proven faster heat up capacity. See pages 6, 7 and 8.
4. **Two *Serpentine* styles for best cooling effectiveness.** See pages 9 and 10.
5. **Styles 40 and 30 available for unusual conditions.** 1 1/2" pass and series parallel offer design flexibility. See pages 19, 20 and 21.
6. **Easy to handle and install, usually without draining the tanks.** Styles 90 and 50 have pipes coming above the solution. This eliminates threaded connections in the solution. See pages 6 and 10.
7. **Electropolished stainless steel surfaces resist fouling.** Phosphate scales, etc., often tend to flake off during heating and cooling cycles. See page 25.
8. **Can be readily isolated from, or made a part of, the electrical circuit.** Insulating joints and hangers are easier than with pipecoil. PLATECOIL also make excellent cathode surface in anodize tanks. See page 57 and sample problem on page 74.
9. **Superior corrosion resistance for longer life.** All stainless steel PLATECOIL are fabricated from low carbon grade material for improved corrosion resistance. Annealing and passivating is available as an option. See page 33. Carbon steel PLATECOIL can be stress relieved for longer life in heating low temperature and low concentration caustic solutions. See page 33.
10. **Quick Selection Charts available for easy sizing.** These methods are simple for heating watery solutions with steam in one or two hours and for cooling plating solutions. See pages 74 and 80. Also see page 73 for a sample spray washer PLATECOIL sizing calculation.

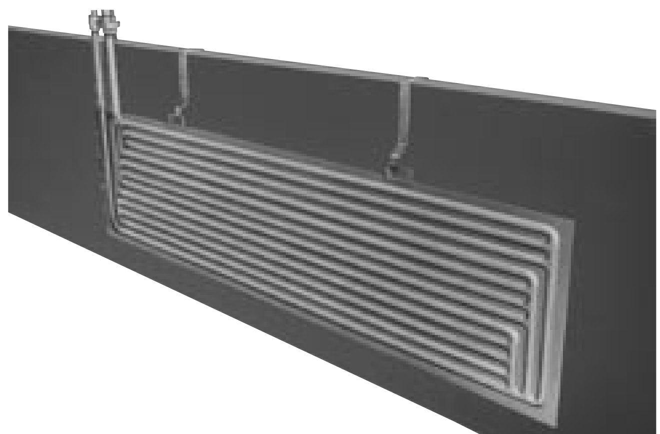


Fig. 56-1
Typical installation in a tank showing the use of QUICK-CHANGE PLATECOIL hangers with a Style 90. See hanger details on Page 15. This method of hanging about 1 3/4" from the tank wall results in a chimney effect causing a natural circulation for improved uniformity of heating in still tanks.

Fig. 56-2
These are Style 50D *Serpentine* PLATECOIL in a falling film chiller for a special anodizing operation.

PLATECOIL FOR METAL PLATING, FINISHING, TREATING (CONT'D.)

THOUSANDS IN USE FOR:

1. Heating and cooling many kinds of plating solutions.

2. Heating cleaner, pickling, stripper and rinse solutions.

3. Heating all stages as necessary in industrial spray washers and phosphatizing systems.

4. Heating and cooling various paints.

5. Heating galvanizing flux solutions.

6. Heating aluminum bright dip, dye and seal solutions.

7. Cooling sulphuric acid anodizing solutions.

8. Cooling quench oil.

9. Various other applications.

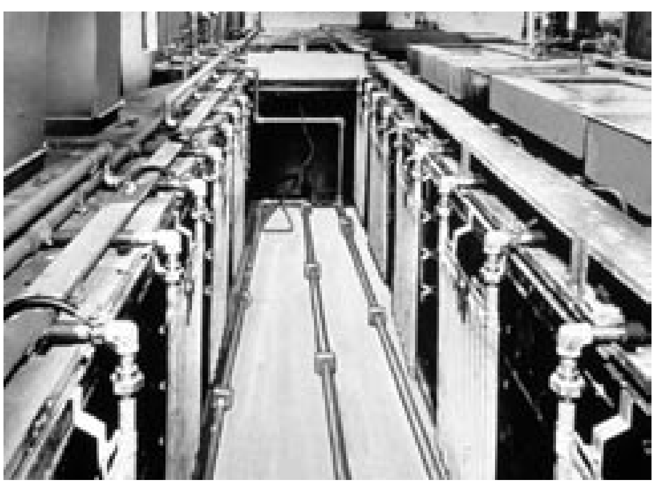


Fig. 57-1
Type 316L stainless steel full solution annealed PLATECOIL for cooling sulphuric acid anodizing solutions. They also act as cathode area.

Fig. 57-2
Plating tank fabricated of integral PLATECOIL for electroless nickel.

TITANIUM HEATING AND COOLING ECONOCOIL®

Working Pressure: 70 psig @ 350°F
Material: 0.0236" Titanium, SB-265.
Connections: Plain end 0.035" Titanium Tubing. Threaded ends available.

	Still	Agitated**
Steam to Water Solutions	175 *	200 *
Water to Watery Solutions	60 *	100 *

* These are typical heat transfer rates shown as U = Btu/hr. sq. ft.°F
* * Special bracing may be required.

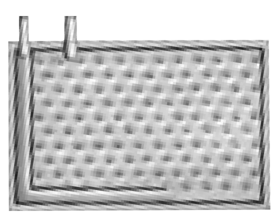


Fig. 57-3
STYLE 90D
Typical titanium ECONOCOIL. Other styles also available. Three handles are supplied on units over 71 " long.

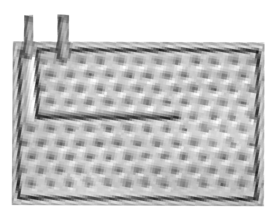


Fig. 57-4
STYLE 50D
All titanium units are now fabricated using this expanded construction.

See pages 99, 100 and 101 for dimensions, weights, etc.

BANKS FOR HEAT RECOVERY FROM HOT MOIST AIR TO LIQUIDS

- Low pressure drops
- A variety of designs
- Precise sizing
- High heat transfer rates
- Smooth, fouling-resistant surfaces
- Compact configuration

RECOVER BTU'S THAT MIGHT OTHERWISE BE WASTED

Now more than ever before, escalating fuel costs make it necessary for industrial plants to look for methods that will allow them to recover and utilize energy that might otherwise be wasted. Pulp and paper mills are no exception. Several are recovering valuable Btu's by installing Tranter Heat Recovery Banks in the exhaust ducts of their paper machines and thermal mechanical pulping (TMP) units and in exhaust ducts from textile dye becks.

Tranter Heat Recovery Banks are designed to recapture a major portion of the high Btu content of the hot, moist exhaust air emitted by these machines. As the exhaust air passes over the surfaces of the plates in the banks, millions of Btu's per hour are transferred to a water or water/glycol solution being pumped through the plates. The hot fluid is then pumped to various other points in the mill and used to heat make-up air, water and other process solutions. The result is a big saving in fuel costs.

A STANDARDIZED CONFIGURATION WITH OUTSTANDING VERSATILITY

The basic design for a typical Tranter Heat Recovery Bank is illustrated in Fig. 59-1. This particular unit provides approximately 3200 sq. ft. of heat transfer surface. Weight is approximately 5120 lbs. (empty) and 6400 lbs. (full). Overall dimensions are 48" x 50" x 120," not including the manifolds.

As shown on page 59, there are many optional designs and features that will provide a variety of answers in meeting heat transfer and installation requirements. In addition, the banks can be constructed with either PLATECOIL or ECONOCOIL heat transfer surfaces. Banks with casings and flanges, ready to set in place for connecting to adjoining ductwork, are also available.

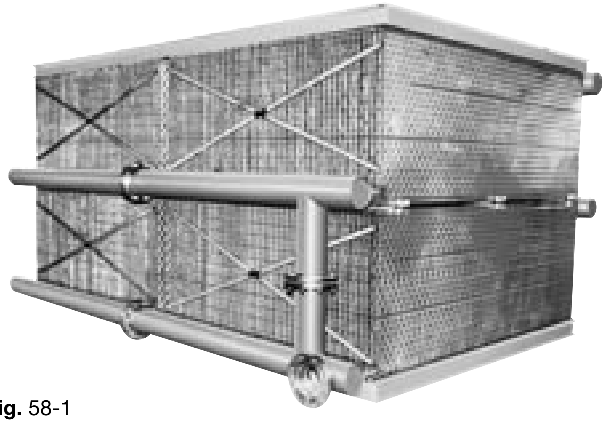


Fig. 58-1
This bank assembly has 9216 sq. ft. of heat transfer surface and recovers approximately 33,000,000 Btu/hr.

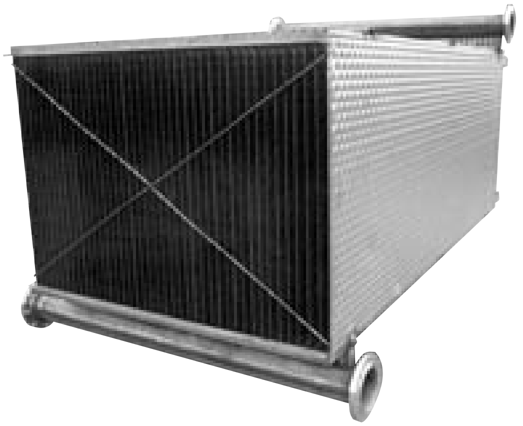


Fig. 58-2
Bank assembly with enclosing casing ready for installation.

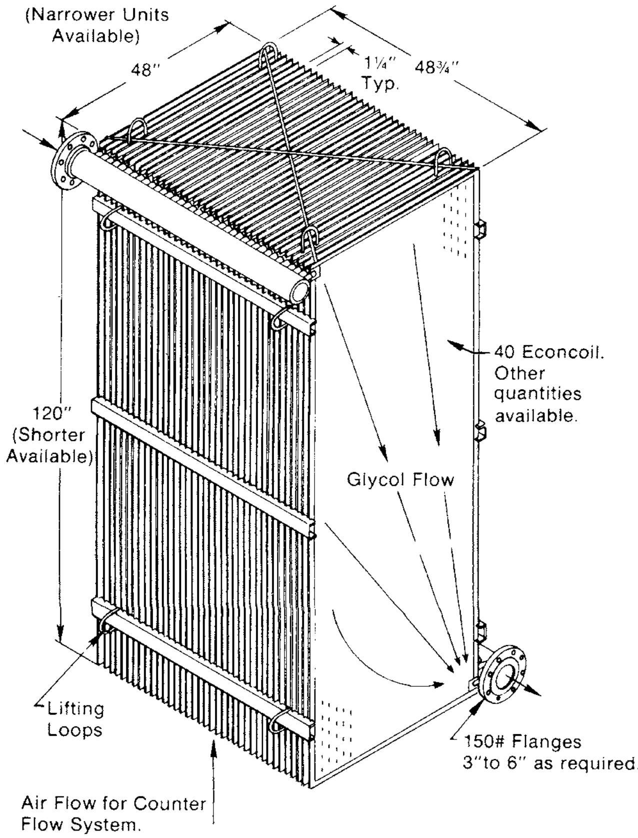


Fig. 59-1 Typical Heat Recovery Bank

SPECIFICATIONS

Materials & Gauges — 304, 304L, 316, 316L Stainless Steel, 18 or 20 gauge.

Pressures — 20 gauge = 75 to 100 psig
18 gauge = 125 to 150 psig

		Empty	Full
Weights per Sq. Ft. —	20 gauge	1.6#	2.0#
	18 gauge	2.3#	2.8#

(Note: Above weights per sq. ft. are based on sq. ft. of heat transfer surface and include nominal amounts for manifolds and channels.)

BANKS FOR HEAT RECOVERY (cont'd.)

Overall U values are also enhanced by high air side/liquid side velocities. Tranter's detailed and precise sizing procedures (developed expressly for this type of two-phase heat tranfer condition) take all velocities, physical properties, partial pressures and other factors into account. U values achieved can range from 50 to 400 Btu/hr. sq. ft.°F, depending on operating conditions. Excellent heat transfer rates (U values) are obtained with Tranter Heat Recovery Banks for this application. The hot exhaust air should be saturated at the entrance to the coils so that the high, air side condensing film coefficient can be obtained over all surfaces. Water is sometimes sprayed into the air stream ahead of the coils to saturate the air.

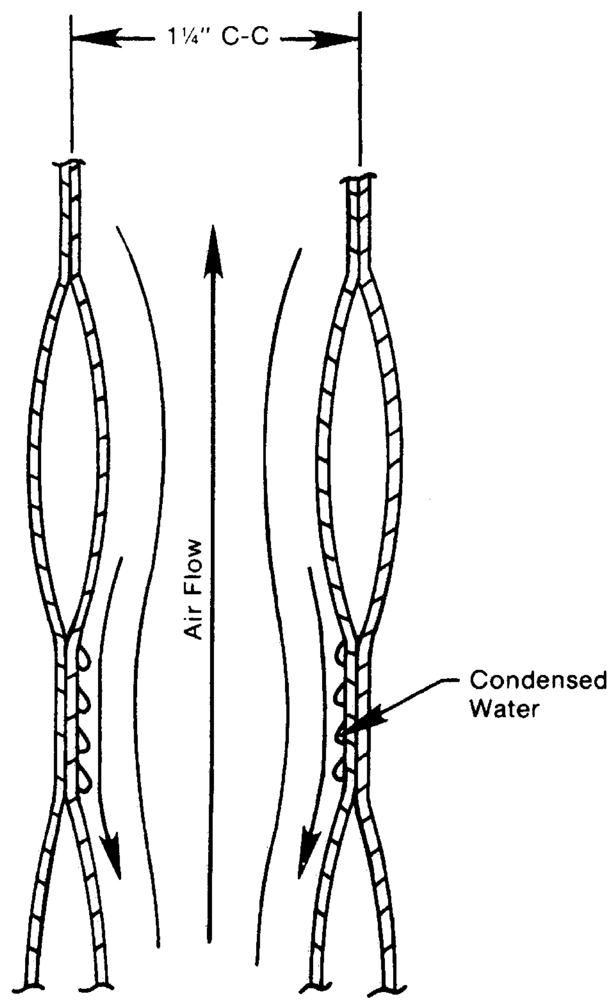


Fig. 59-2 Econocoil (Full Size) Cross Section

PLATECOIL FOR USE IN FLUIDIZED BEDS
FOR SOLIDS —
• COOLING
• DRYING
• HEATING

Fluidized bed heat exchangers are widely used for cooling, heating or drying a variety of solid products. The use of PLATECOIL as heat transfer surface in these exchangers has gained wide acceptance. The product is passed between vertically installed PLATECOIL which carry water or steam for cooling, heating or drying the products. See Fig. 60-1 and 60-2 for typical banks.

The bottom of the exchanger box consists of a porous material or a drilled plate through which air is forced. This keeps the product in a loose or fluid state so that it seeks its own level based on density and will move through the exchanger. The product is easily distributed at the inlet end by use of an opening the width of the box.

Tranter, Inc. customarily furnishes the PLATECOIL in banks with manifolds and the needed bracing to the customer's design. The banks are normally ready for installation. Additional components such as cover plates, mounting brackets and baffles can also be supplied.

Operational forces need to be considered so that a suitable PLATECOIL gauge and adequate bracing or baffle plates can be designed. Tranter has test data available so that the natural frequency of any given band can be supplied as desired. The product density, fluidizing air velocity and rigidity of foundations are all important factors regarding required strength. This data should be provided with an inquiry if Tranter is to be involved in the bracing design.

Allowances should also be made for expansion and contraction of the PLATECOIL, particularly if high temperatures are involved. In such cases it is also desirable to maintain a constant flow of cooling water through the PLATECOIL when the product is being handled.

Heat transfer rates between 8 and 40 Btu/hr. sq. ft.°F have been obtained for varying applications.

TYPICAL USES:
- **DRYING AND COOLING CHEMICALS**
- **COOLING ALUMINA**
- **COOLING CEMENT**
- **COOLING SALT, ETC.**
- **DRYING SOLIDS**

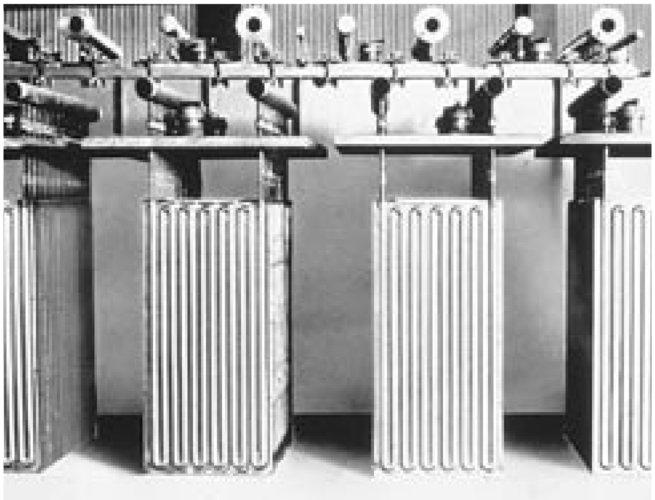


Fig. 60-1 Typical PLATECOIL bank for fluidized bed service.

Fig. 60-2 Special PLATECOIL bank assembly installed in a fluidized bed dryer for soybeans.

PLATECOIL FALLING FILM HEAT EXCHANGERS

PLATECOIL type heat exchangers have been used for falling film type heat exchange and the use is increasing. The reasons for selecting this type design are summarized below.

High Values 1. The thin liquid film on the outside surface with the resulting high velocity promotes high U values.

Will Not Plug 2. Fluids with high solids content which would likely plug. Other heat exchangers can be handled over the outside surfaces with ease.

Low Pressure Drop 3. The falling film method has a low pressure drop for the external fluid with only enough head required to lift the fluid to the top of the exchanger and discharge it through the distribution system.

Two Phase Fluids Inside OK 4. Refrigerants can be utilized internally, whereas this is not practical with some types of exchangers.

Two Phase Fluids Outside OK 5. The open spaces between the plates readily release vapors resulting from evaporative cooling or evaporation processes.

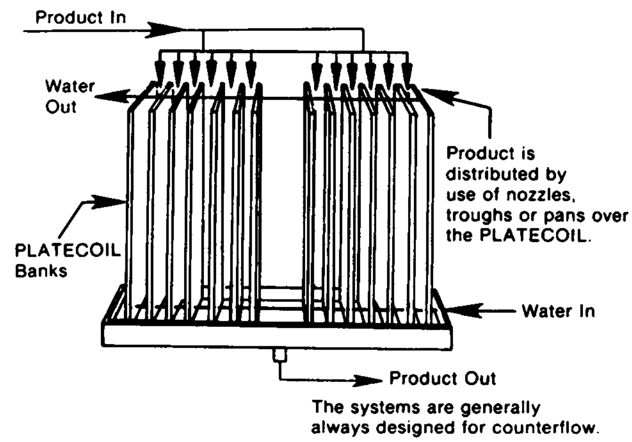


Fig. 61-1 PLATECOIL falling film arrangement sketch.

Easy To Clean 6. Some purchase decisions have been based on the ready accessibility of the external surfaces for inspection and cleaning, including the use of CIP systems.

TYPICAL APPLICATIONS

1. Cooling high solids slurries.
2. Aqua ammonia liquid fertilizer converters.
3. Cooling acids in acid production plants.
4. Cooling wort in breweries.
5. Heating refrigerants with water in heat pump project.
6. Chiling water with refrigerants for carbonation.
7. Heating liquids in evaporators.

Fig. 61-2 Typical PLATECOIL banks used as falling film heat exchangers.

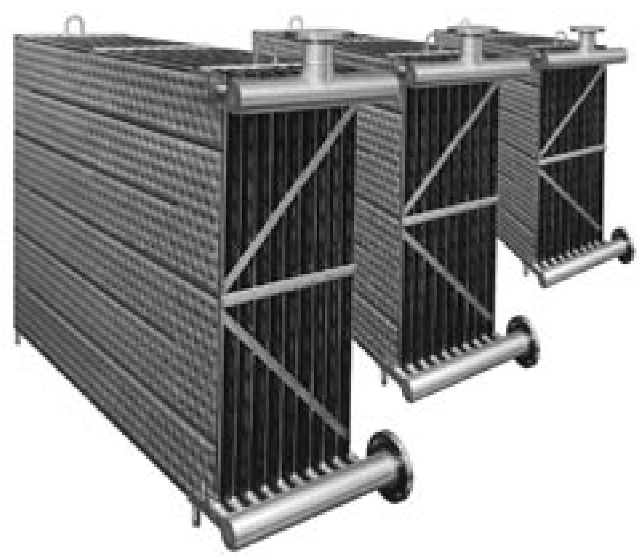


Fig. 61-3 Typical ECONOCOIL bank assemblies.

PLATECOIL FOR REFRIGERATION

PLATECOIL and ECONOCOIL are used as evaporators with various refrigerants. They are generally immersed in a liquid or used in a falling film cascading arrangement.

The usual product advantages of high efficiency, light weight, ease of cleaning and a minimum of joints are pertinent for this service. Both products readily pass the sensitive halogen leak tests as usually required for refrigerant applications. Clean, dry and seal is also a standard requirement. The most common applications are - chilling water, anodize solutions, beverages, food products, and building ice.

The brief descriptions below are intended as general guidelines for the best evaporator selection for the two usual systems. In all cases, the overall set up should be supervised by a knowledgeable refrigeration systems person.

DIRECT EXPANSION SYSTEMS

These systems are often referred to as DX arrangements. Refrigerants are most commonly R-12 or R-22. Fig. 62-1 illustrates a PLATECOIL bank system. Basic design criteria are listed below:

1. Style 60 or 50 *Serpentine* PLATECOIL should always be used for positive refrigerant distribution and highest velocities for best U values and proper oil return. Style 60 *Serpentine* PLATECOIL may be installed on end with the fittings up as long as the Btu loading (pressure drop) does not exceed the capacities of Fig. 90-1.
2. An example problem is worked out on page 75. The U value was selected from Fig. 78-1. Note that the maximum Btu loading as related to pressure drop must also be checked using Fig. 90-1.
3. For most satisfactory oil return, it is customary to utilize a tip feed and bottom suction.
4. When more than one PLATECOIL is involved, it is preferable to provide a separate expansion valve for each unit. An expansion valve with a distributor, as shown in Fig. 62-1, may be used with either approach. Individual inlets are necessary but a common outlet is satisfactory. Copper fittings can be supplied. See page 27.

FLOODED SYSTEMS

These systems are also sometimes referred to as "excess of liquid" or "liquid overfeed" arrangements. There are some variations to the systems. The refrigerant is usually ammonia. Fig. 62-2 illustrates the evaporator portion of the system. With these systems only part of the refrigerant evaporates. The boiling liquid develops excellent internal film coefficients (h_i) which usually result in higher U values than direct expansion systems.

General design guidelines for the evaporator for these flooded systems are -

1. Use of header type PLATECOIL or ECONOCOIL (usually ECONOCOIL) is preferable, for self venting and low pressure drop purposes.
2. Design for bottom inlet, top outlet.
3. The top outlet connection should be large enough to handle the gas volume without significant pressure drop. A coil up to about 48 x 71 with 1 1/2" dia. outlet is usually satisfactory.
4. Cascade (falling film) arrangements are very effective because of the excellent outside film (h_o). Plastic pipe with drilled holes make ideal distributors.

Fig. 62-1 DIRECT EXPANSION SYSTEMS Preferred PLATECOIL Designs and Typical Piping for Banks

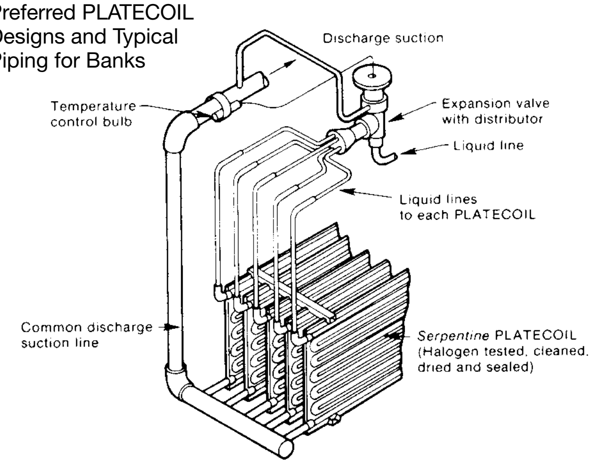
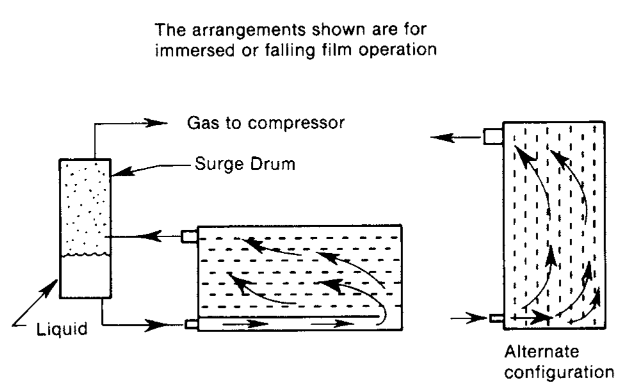


Fig. 62-2 FLOODED SYSTEMS Preferred ECONOCOIL Designs and Arrangements



PLATECOIL FOR CRYOGENIC COLD SHROUDS

Tranter, Inc. has supplied PLATECOIL cryogenic shrouds for many projects over the years. These include LN shrouds for large and small test chambers, surfaces for helium cryopumping and bell jar shrouds. The photo shows a typical medium-sized shroud ready for shipment in an assembled state. Shrouds for large chambers are assembled at the site.

In all cases the design is optically dense with space left for pump out. The PLATECOIL are also fabricated with a cryogenic edge per Fig. 63-2. This is the best design for the very sensitive mass spectrometer leak testing required. The typical specifications following give additional details.

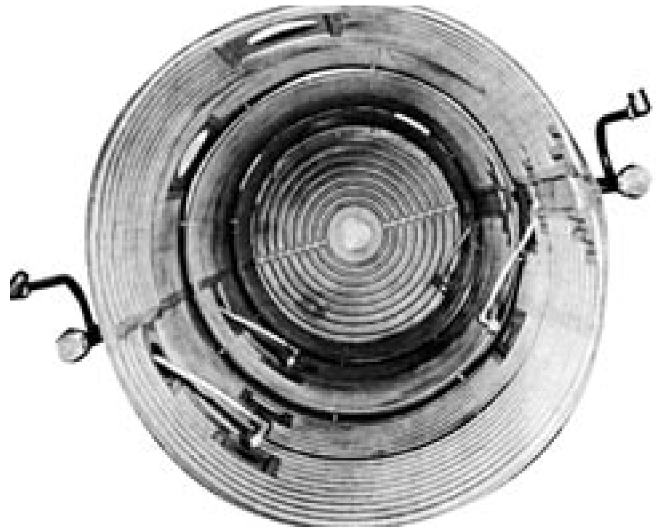


Fig. 63-1 Typical PLATECOIL shroud.

A TYPICAL PLATECOIL SHROUD SPECIFICATION SHOULD READ AS FOLLOWS:

Cryogenic shroud to be of Tranter PLATECOIL using 16 ga. 304L stainless steel. To be single embossed with header type self venting design. Operating pressure ... psig, test ... psig and with cryogenic edges. Inside surfaces grit blasted for painting (by Tranter if specified). Outside electropolished for about .1 emissivity. To have LN cold shock test and mass spectrometer leak test to a leak rate not exceeding 1 x 10^{9} atmos. cc/sec. He.

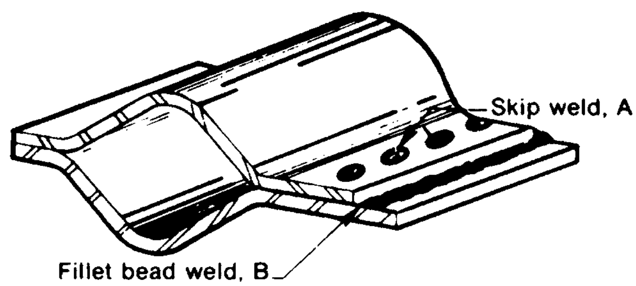


Fig. 63-2
The illustration above shows Tranter standard "cryogenic edge." The skip welds are for structural purposes. The fillet bead weld is for pressure containment and to facilitate testing.

Completed shroud assemblies as fabricated and tested with all cryogenic special features described in the typical specification above.

PLATECOIL HEAVY FABRICATIONS

PLATECOIL has fulfilled many requirements for jacketing on heavy plates and dished heads. This is possible by use of the MIG weld process as discussed on Pages 19 and 33. High operating pressures can be obtained and the ASME Code Stamp is available. Typical products are shown below.

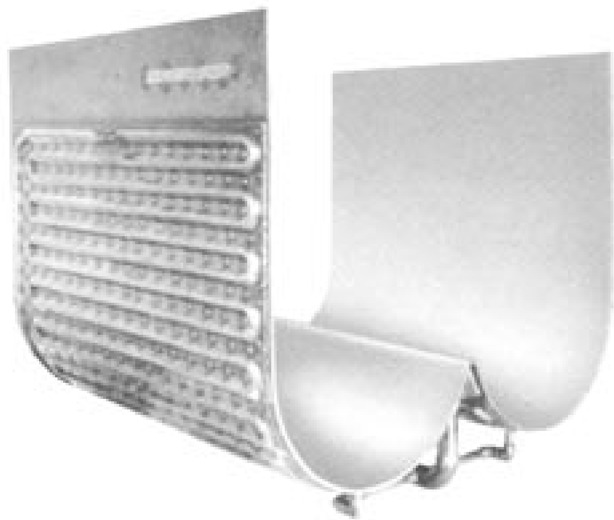


Fig. 64-1
This is a high pressure PLATECOIL shell for a double-bottom mixer.

Fig. 64-3
Steam-heated asphalt trailer tank PLATECOIL section.

Fig. 64-2
Embossing can be provided on heads as well as on plate thickness side wall sections using MIG welding.

Fig. 64-4
Special vessel bottom shown inverted, PLATECOIL circuits designed for high cooling water flow rates.

PLATECOIL FOR SHIPBOARD USE

PLATECOIL have many advantages for shipboard duty including large surface areas per fitting, standard sizes, shop fabricated banks, heavy gauge materials and Coast Guard approval.

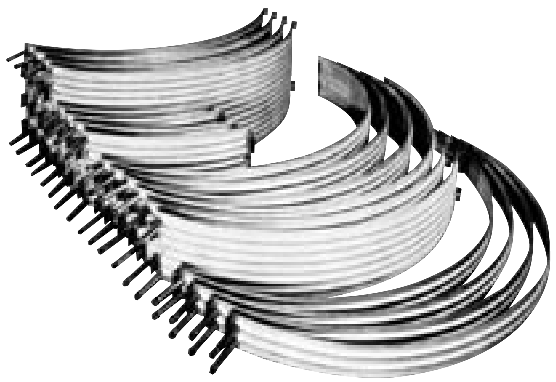


Fig. 65-1
Tens of thousands of these stainless steel PLATECOIL are serving successfully with the Missile Submarine Fleet. Formed to the diameter of, and fastened to the firing tubes they closely control the temperature of the solid propellant.

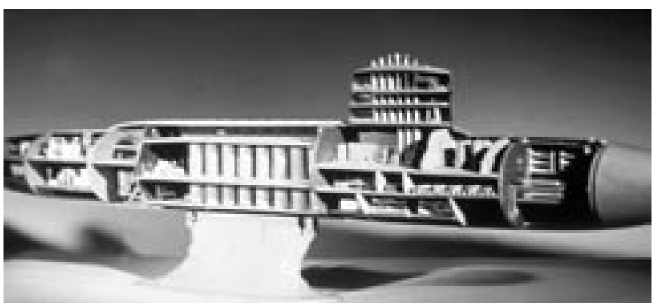


Fig. 65-2
A Polaris submarine showing the missile tubes which have been jacketed with PLATECOIL since original construction.

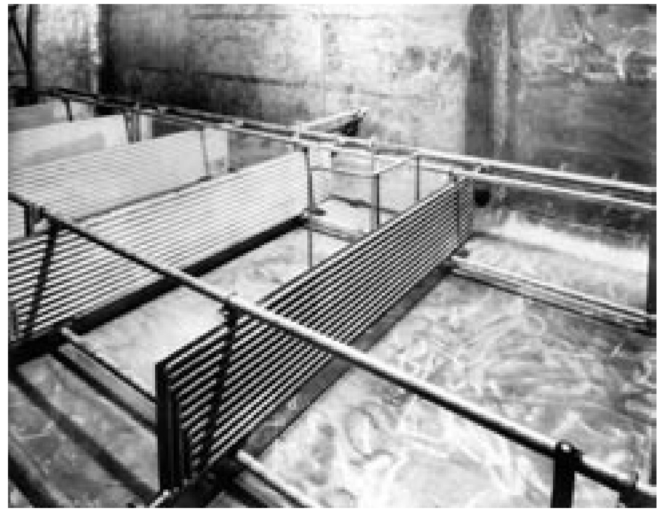


Fig. 65-3
The stainless steel PLATECOIL shown here are in a large compartment of a food products tanker. They are used for heating or for cooling depending on the product being transported.

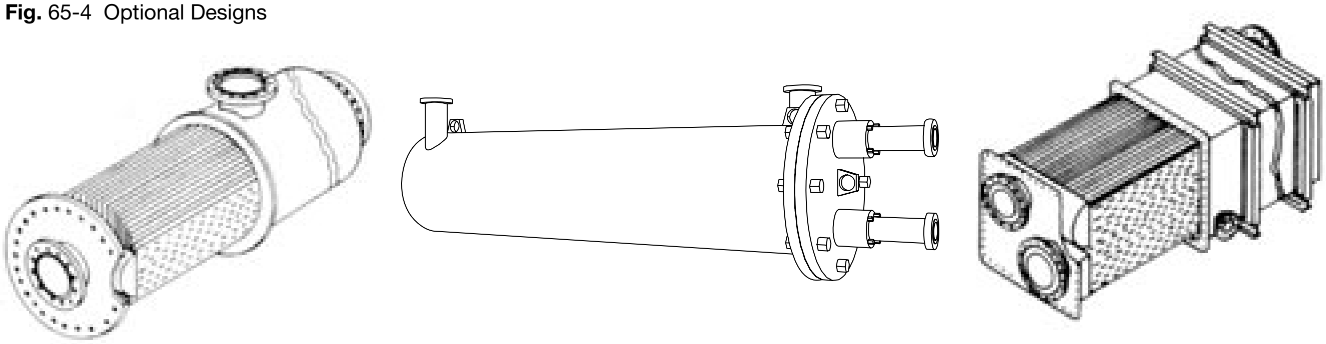
Coast Guard regulations under paragraph 54.01-15 allow use of PLATECOIL for shipboard installation without design approval and without shop inspection by the Coast Guard provided:

1. The ASME Code stamp is supplied.
2. Internal volume is less than 5 cu. ft.
3. Operating pressure is not over 600 psi (PLATECOIL normally cannot be code stamped to this pressure).
4. Temperatures do not exceed 400°F.
5. The media are not hazardous.
6. Provision is made for safety relief valves in the supply line.

Coast Guard approval may be required for conditions exceeding any of the above.

SHELL AND PLATE EXCHANGERS

Fig. 65-4 Optional Designs



The exchangers shown here have ECONOCOIL heat transfer surfaces. The ECONOCOIL are on close centers, such as 3/4". This provides a high surface area to volume ratio. Also efficiency is increased with resulting higher shell side velocities. Ease of cleaning is a principal advantage of this design over shell and tube. They are especially suited for dirty, high solids content streams.

Heat Transfer and Fluid Flow Calculations

HEAT TRANSFER IN INDUSTRIAL PROCESSES

A general knowledge of the factors that govern the flow of heat from one body, or substance, to another is essential for a proper understanding and solution of heating and cooling requirements.

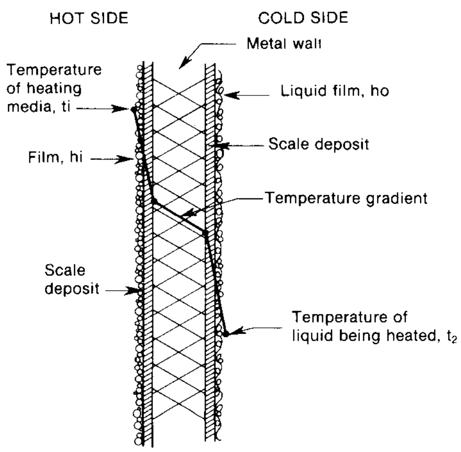


Fig. 66-1 Thermal Drop Through PLATECOIL Metal Wall

The methods by which heat is transmitted are conduction, convection and radiation; and heat always flows from the zone of higher temperature to the zone of lower temperature. In considering the transfer of heat from one fluid to another separated by a metallic wall, as illustrated by the use of a steam heated PLATECOIL installed in a liquid bath or tank, the quantity of heat, Q, that is transmitted from the steam to the liquid is dependent upon the area available to transmit the heat, the overall rate at which heat is transmitted through the area and the log mean temperature difference Δt_L between the source (steam) and the receiver of the heat (liquid). Expressed as an equation:

$$Q = (A)(U)(\Delta t_L) \qquad (1)$$

where Q = Total quantity of heat in Btu/hr. (British Thermal Units)
A = Surface area available to transmit heat, sq. ft.
U = Overall coefficient of heat transfer. Btu/hr. sq. ft. °F
Δt_L= log mean temperature difference between the hot and cold fluids, °F. (See Fig. 82-1 or calculation method, page 68.)

This equation, (1), is general for both heating and cooling and its understanding is essential in the practical solution of industrial heat transfer problems.

Temperature may be considered as "thermal pressure," which propels the heat from the zone of higher temperature to the zone of lower temperature. In the case of the metallic wall mentioned above, there is a definite drop in temperature through the metal and adjacent films just as a pressure drop accompanies the flow of water through a hydraulic system. The drop in temperature is most rapid when heat flows through the sections of greatest thermal resistance. This temperature drop is illustrated by Fig. 66-1. If the metallic wall represents a segment from one side of a PLATECOIL which is immersed in the liquid being heated, the heat liberated by the condensing steam is forced through this wall by the "thermal pressure" and is introduced into the liquid, thus raising the temperature of the latter. The rate at which heat is transferred through the separating wall is expressed by the factor U which is called the overall rate of heat transfer and indicates the number of Btu that are transmitted in an hour for each square foot of heating surface when the temperature difference is one degree F. The value of U may vary greatly depending upon the physical conditions involved and the materials being heated. See Fig. 78-1 and the comments following the table.

Again referring to Fig. 66-1, the most important factors influencing the amount of heat that can be transmitted through the wall are the film and scale resistances on both sides of the plate. It is seen that they account for the greatest temperature drop between t_1 and t_2.The film resistance is dependent upon the type of fluid involved; whether it is steam, water, oil or other material. An oil film introduces a much higher resistance than water or steam, while the velocity along the surface of the metal also influences this film resistance. Generally speaking, the greater the velocity, the lower the resistance. The scale resistance may be caused by corrosion of the metal or by a build up of deposits from the material being heated, the latter usually called "fouling." The amount of fouling at any particular time is directly influenced by plant "housekeeping" and is more or less an indeterminate variable. At its worst the buildup may be sufficient to practically shut-off the flow of heat.

Due to the much higher film and scale resistances, the resistance of the metal wall is relatively unimportant in its effect on overall heat transfer. This is particularly true in the case of PLATECOIL which are fabricated of 16, 14 and 12 gauge material. Regardless of the metal used, its effect is slight as compared to the other factors.

CALCULATING HEAT TRANSFER REQUIREMENTS

When calculating heat transfer requirements, equation (1) is usually rewritten to read:

$$A = \frac{Q\ (\text{Btu/hr.})}{(U)(\Delta t_L)} = \text{sq. ft.} \qquad (2)$$

From equation (2) the number of square feet of surface area required for a specific application can be calculated. Four steps are involved as follows:

1. DETERMINATION OF Q

The total quantity of heat Q involved is usually calculated from known conditions of the problem by the formula:

(Weight in lbs.) (specific heat) (temp. diff. F) = Total Btu's (3)

Since most batch heating problems start with tanks, or other containers, the physical dimensions of which are known, a convenient way to express formula (3) as a rate of exchange is:

$$\frac{(l)(w)(h)(62.4)(\text{sp. gr.})(\text{sp. ht.})(\text{temp. diff. F})}{\text{hours in which heat transfer is to be performed}} = \text{Btu/hr.} \qquad (4)$$

where:
Length, width and height are in ft. (if tank is not full, h = depth of liquid)
62.4 weight (lbs.) of 1 cu. ft. of water at 39.2°F
Specific gravity = density compared to water at 39.2°F
Specific heat = Btu/lb.°F

Sp. gr. and sp. ht. refer to the liquid specific gravity and specific heat. Temperature difference in this case is the number of degrees the material is to be raised in temperature.

2. DETERMINATION OF U

The correct value of U can be selected from page 78 in accordance with the nature of the application. The comments following the table will assist in selecting a U value.

Also, the overall heat transfer coefficient, U, can be calculated from film coefficient and thermal conductivity data by the following formula:

$$U = \frac{1}{\frac{1}{h_o} + \frac{x}{k} + \frac{1}{h_1}} = \text{Btu/hr. sq. ft. °F}$$

where:
h_o and h_1 are the outside and inside fluid film heat transfer coefficients, respectively
x is the thickness of the metal wall of the PLATECOIL
k is the thermal conductivity of the metal in question

Example:

Heating water with saturated steam, using a 14 ga. carbon steel PLATECOIL, where:
h_o = 300 Btu/hr. sq. ft. °F (for water)
h_1 = 1000 Btu/hr. sq. ft. °F (for steam)
x =.0747 inch
k = 312 Btu/hr. sq. ft. °F/in.

The film coefficients were selected from Fig. 68-1. Numbers selected are from the wide range shown but are commonly those used for steam and water.

Applying these values, the formula now reads as follows:

$$U = \frac{1}{\frac{1}{300} + \frac{.0747}{312} + \frac{1}{1000}}$$

$$= \frac{1}{.0033 + .000239 + .001}$$

$$= \frac{1}{.004539} = 220 \text{ Btu/hr. sq. ft. °F}$$

Note that the actual resistance of the metal adds to the total resistance only in the fourth significant figure, so it has little effect on the overall U value. By use of the same formula comparable U values can be determined for other materials and also for heating air which is a low transfer rate condition. The results as summarized in the table below show that even though the metal conductivities vary widely the overall U values are in the same general range.

The steam to water condition shows the greatest variation. In practice this difference would be mainly eliminated by fouling or scale which usually forms and has not been considered in these calculations.

When complete details are known, film coefficients can be calculated or selected from Fig. 68-1.

Usually this data is not available, however, so overall U values are used for most applications. Research studies made by Battelle Memorial Institute, Columbus, Ohio, extensive tests in Tranter's modern laboratory, and field experience have established typical U values for various types of applications. See page 78 for a summary of these and note the first paragraph regarding U = 150 for average open tank heating conditions.

Fig. 67-1
EFFECT OF METAL CONDUCTIVITY OF U VALUES

Applications	Material	Film Coefficients Btu/hr. sq. ft. °F		Thermal Conductivity of Metal (k) Btu/hr. sq. ft. °F/in.	Metal Thick-ness (in.)	U Value Btu/hr. sq. ft. °F
		h_o	h_1			
Heating Water with Saturated Steam	Copper	300	1000	2680	0.0747	229
	Aluminum	300	1000	1570	0.0747	228
	Carbon Steel	300	1000	312	0.0747	220
	Stainless Steel	300	1000	113	0.0747	217
Heating Air with Saturated Steam	Copper	5	1000	2680	0.0747	497
	Aluminum	5	1000	1570	0.0747	497
	Carbon Steel	5	1000	312	0.0747	496
	Stainless Steel	5	1000	113	0.0747	496

CALCULATING HEAT TRANSFER REQUIREMENTS (cont'd.)

2. DETERMINATION OF U (CONT'D.)

FILM COEFFICIENTS - H_1 OR H_0

Film coefficients are necessary when U values are to be calculated. High coefficients indicate high U values. If h_0 is low and h_1 is high , h_o will tend to govern the U value.

Fig. 68-1

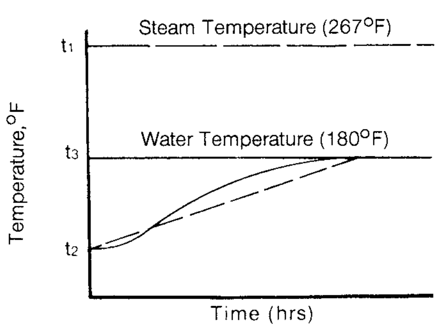
	Film Coefficients (conductance) Btu/hr. sq. ft.°F
No Change in State	
Water	150 to 2000
Gases	1 to 50
Organic Solvents (gasoline, kerosene, alcohol, etc.)	60 to 500
Oils	10 to 120
Condensing	
Steam	1000 to 3000
Organic Solvents	150 to 500
Light Oils	200 to 400
Heavy Oils (vacuum)	20 to 50
Ammonia	500 to 1000
Evaporation	
Water	800 to 2000
Organic Solvents	100 to 300
Light Oils	150 to 300
Heavy Oils	10 to 50
Ammonia	200 to 400
R-12	100 to 600

Coefficient selected should depend on velocity and/or viscosity of the material involved. Select coefficients in the higher range for higher velocities and/or lower viscosities.

3. DETERMINATION OF ΔT_L

A correct understanding of the term Δt_L is essential in the calculation of any heat transfer problem.

Fig. 68-2 Temperature Relationships vs. Time



Assume the simple case of heating a tank of water from 60°F to 180°F, using steam at 25 psig (steam temperature = 267°F) by means of a PLATECOIL suspended in the water. The "thermal pressure" available at the start of the heating cycle is $t_1 - t_2$ (Fig. 68-2) = 267°F - 60°F = 207°F. As the water heats up, this "thermal pressure" reduces until when 180°F is reached it is reduced to $t_1 - t_3$ = 87°F. It, therefore, is necessary to determine what average, or mean temperature, ΔtL applies over the whole heating cycle. If the water temperature increased uniformly, as shown by the dofted line, Fig. 68-2, the arithmetic average of the starting and final temperature differences would apply.

$$\frac{(t_1 - t_2) + (t_1 - t_3)}{2} = \frac{207°F + 87°F}{2} = 147°F = \Delta t_L$$

In practice it is found that the usual heating curve is in the form of the solid line, Fig. 68-2. For accuracy, it is necessary to resort to the logarithmic mean temperature difference. In many cases this can be determined quite accurately from Fig. 82-1. The following example works it out mathematically.

$$\Delta t_L = \frac{\Delta t_1 - \Delta t_2}{\ln \frac{\Delta t_1}{\Delta t_2}} = °F \qquad (5)$$

where

Δt_L = Logarithmic mean temperature difference
Δt_1 = Greater temperature difference between the hot and cold fluids $(t_1 - t_2)$
Δt_2 = Lesser temperature difference between the hot and cold fluids $(t_1 - t_3)$

Apply the conditions of the above problem:

$$\frac{(267 - 60) - (267 - 180)}{\ln \frac{(267 - 60)}{(267 - 180)}} =$$

$$\frac{207 - 87}{\ln \frac{207}{87}} = \frac{120}{.8668} = 138.4°F$$

This value 138.4°F is, therefore, the correct one to apply for Δt_L in equation (2).

CALCULATING HEAT TRANSFER REQUIREMENTS (cont'd.)

4. CALCULATION OF SURFACE AREA

If for U the value 150 is assigned, the product of (U)(Δt_L) then becomes (150) (138.4) = 20,760 Btu/hr. sq. ft. °F which is divided into the total quantity of heat involved, Q, to obtain the sq. ft. of PLATECOIL required.

Once the operating temperature of 180°F is reached, it then becomes the function of the PLATECOIL to maintain this temperature by modulating the supply steam. In this lafter situation there is no longer available a "thermal pressure" of Δt_L = 138.4°F but rather the lower temperature difference of 267°F - 180°F = 87°F. This is an important fact to remember in cases where it is necessary to determine the amount of PLATECOIL area required to maintain operating conditions. Using the simple temperature difference, $t_1 - t_3$ (Fig. 68-2) = 87°F the product of (U)(Δt_L) = 13,050 instead of 20,760 Btu/hr. sq. ft.°F which applies during the heating up cycle.

DETERMINING PLATECOIL REQUIREMENTS

The data generally necessary to accurately calculate PLATECOIL heat transfer surface requirements usually includes the following:

I. Size of tank and solution depth.
2. Tank open or closed.
3. Specific heat, specific gravity, thermal conductivity and viscosity of liquid.
4. Pumping or circulation rate if involved.
5. Starting temperature & final or operating temperature.
6. Amount and kind of work being processed.
7. Time allowed for heat up or cool down.
8. Temperature and type of heating or cooling medium.
9. Amount of insulation, if any.
10. Amount of agitation, if any.
11. Amount of scaling anticipated.
12. Ventilation or wind velocity.

PLATECOIL FOR HEATING APPLICATIONS

GENERAL HEATING CALCULATIONS

Determining the amount of PLATECOIL surface area required for heating water base solutions in open tanks with steam can easily be accomplished by using the Quick Selection Chart appearing on page 80, plus the corresponding charts which appear on page 81. As indicated in the footnotes of these charts, this method is suitable only for heat-up times which do not exceed two hours.

DETAILED HEATING CALCULATIONS

For more precise calculation, as may be required to check a 2-hour heat-up versus an extended heat-up and other certain operating requirements, the examples below provide information on how such calculations can be made.

PROCESS TANK HEATING

Example:

Determine the total area and number of PLATECOIL needed under the following conditions: Aluminum extrusions are processed at the rate of 2000 lbs. per hour through a hot water seal tank maintained at 200°F. The tank is 12' x 4' x 3' deep with a 2 1/2' water depth. This is to be heated in one hour with 15 psig steam. The ambient temperature is 60°F.

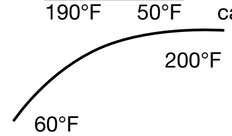
Since this involves heating a watery solution from 60°F with steam, the Quick Selection Chart on page 80 may be used. By L x W x H it is found that the tank contains 120 cu. ft. of water (or 900 gallons). The chart shows that 1 sq. ft. of PLATECOIL will heat 1.75 cu. ft. of water for these conditions.

Therefore, $\frac{120}{1.75}$ = 68.6 sq. ft. of PLATECOIL will be needed.

For conditions for which the chart is not applicable the approach would be per page 66 and as follows:

$$Q = \left(\frac{120\ \text{cu.ft.}}{\text{hr.}}\right)\left(\frac{62.4\ \text{lb.}}{\text{cu.ft.}}\right)\left(\frac{1\ \text{Btu}}{\text{lb.°F}}\right)\left(200°F - 60°F\right)$$
$$= 1{,}048{,}320\ \text{Btu/hr.}$$

$\Delta t_L = \frac{250°F \quad 250°F}{190°F \quad 50°F}$ = 105°F from Fig. 82-1, or this may be calculated per example on pg. 66.



From Fig. 12-1 on page 12, two 18" x 119" Style 90D PLATECOIL having 35.2 sq. ft. each would logically be selected.

The notes on page 80 explain the basis of the U of 150 for the Quick Selection Chart.

DETAILED HEATING CALCULATIONS (CONT'D.)

PRECAUTIONS FOR LONG HEAT-UP PERIODS

If a 2-hour heat-up period is to be considered, it is generally safe to divide the 1-hour requirements in half. This gives 33.3 sq. ft. from the preceeding problem so one PLATECOIL could be used.

For heat-up periods longer than 2 hours a careful evaluation of the average wall and surface losses must be made to determine the needed surface area. This figure should then be compared with the actual surface area required to maintain the solution at operating conditions. A safe rule of thumb for longer than 2-hour heat-up, is to calculate the wall and surface losses encountered for 1 hour and divide this value by two. This heat loss then becomes an average heat loss rate which can be used for any heat-up period. For example, if a 6-hour heat-up were required, the approach to the problem would be as follows:

1. Since the wall and surface losses are being calculated here a U value of 160 for steam to watery solution may be used.
2. Tank wall losses
   Ends, sides and bottom area = 144 sq. ft.
   144 sq. ft. x 320 Btu/hr. sq. ft. (from Fig. 86-2)
   = 46,080 Btu/hr.
3. Liquid surface losses
   Surface area = 48 sq. ft.
   48 sq. ft. x 3300 Btu/hr. sq. ft. (from Fig. 86-3 - for still air) = 158,400 Btu/hr.
   Total = 204,480 Btu/hr.

NOTE: If tank has forced ventilation so that there is appreciable air movement over the liquid surface, select a velocity and read the heat loss figure from the appropriate column in Fig. 86-3.

4. Average wall and surface loss rate

$$\frac{204{,}480 \text{ Btu/hr.}}{2} = 102{,}240 \text{ Btu/hr.}$$

5. Q to heat water solution only to required temperature in 6 hours =

$$\frac{1{,}048{,}320 \text{ Btu/hr.}}{6} = 174{,}720 \text{ Btu/hr.}$$

6. Total heat input rate required on a 6-hour heat-up basis = 102,240 Btu/hr. + 174,720 Btu/hr. = 276,960. Sufficient accuracy will be maintained if this figure is rounded off.

7. Area = $\frac{277{,}000}{160 \times 105} = 16.5$ sq. ft.

Note that dividing the area requirement for 1-hour heat-up of 66.6 sq. ft. by 6 gives an area of 11.1 sq. ft. which is actually too low to bring the solution to its required temperature in the allofted time.

DETERMINING OPERATING REQUIREMENTS

For the operating condition the approach to the problem is as follows:

1. Wall and surface losses at operating conditions = 204,480 Btu/hr.
2. Work load (assume the aluminum enters at 140°F from the hot rinse tank)
   Q = (2000 lbs./hr.) (0.23* Btu/lb.°F) (200°F-140°F)
   = 27,600 Btu/hr.
3. Total operating load = 204,480 + 27,600 = 232,080 Btu/hr. or approximately 232,000 Btu/hr.
4. Δt_L now becomes 50°F (from Fig. 82-1) or since the difference in temperature between the steam and solution is constant, this constant now becomes the Δt_L.

5. Area = $\frac{232{,}000}{160 \times 50} = 29$ sq. ft.

* = sp. ht. from Fig. 97-1

Note that the heating surface requirement for maintaining the operating condition, in this case, is approximately equal to that needed for a 2-hour heat-up.

In all cases the surface areas needed for both heat-up and operating conditions should be determined and compared. The larger of the two figures should always be used in selecting PLATECOIL areas.

OUTDOOR STORAGE TANK HEATING

Outdoor storage tanks present special problems in determining PLATECOIL requirements. These problems include bare vs. insulated tanks; internally vs. externally installed PLATECOIL; holding requirements or pumping requirements; selecting appropriate ambient termperature and wind velocity. The following example will illustrate some of these conditions.

Example:

A welded steel tank with flat roof, 32 ft. dia. by 35 ft. high is used for outdoor storage of 100-120 penetration grade asphalt. The contents are to be held at 100°F under winter design ambient temperature of zero °F using 15 psig exhaust steam. The tank is located among other tanks and buildings so that an average effective wind velocity of 10 mph may be used. The following types of application are considered.

No. 1 Bare tank, PLATECOIL installed internally.
No. 2 Bare tank, PLATECOIL installed externally.
No. 3 Using 1 1/2" insulation, top and sides, PLATECOIL installed internally.
No. 4 Using 1 1/2" insulation, top and sides, PLATECOIL installed externally.

OUTDOOR STORAGE TANK HEATING (CONT'D)

Heat Required:

Since this is a holding application, the heat required is that to overcome the losses through the side walls and top. Bottom losses are ignored unless the tank is elevated. Using formula Q = (A)(U)(Δt) solve for Q_B (bare tank) and Q_I (insulated tank).

As (wall area) = π diameter x height = π x 32 x 35 = 3519 sq. ft.
Ar (roof area) = $\pi r^2 = \pi \times 16^2$ = 804 sq. ft.
Ap = Required PLATECOIL surface area
Δt = product temperature - design ambient temperature = 100°F - 0°F = 100°F

From Fig. 86-1 select the heat loss U for bare tank and the product correction factor; the vapor space correction factor; and U for an insulated tank. From the tables

U_{BS} (side walls) = 4.4 x 0.55 = 2.42 Btu/hr. sq. ft. °F
U_{Br} (vapor space under roof) = 4.4 x 0.55 = 2.2 Btu/hr. sq. ft. °F
U_I = 0.14 Btu/hr. sq. ft. °F

In Applications No. 2 and No. 4 part of the tank wall will be covered by PLATECOIL (Ap), so there will be no wall losses from these areas. This area that does not contribute to the wall losses should be considered in the initial calculation to eliminate the guess work otherwise required afterwards in accounting for this fact. Therefore,

No.1

$Q_B = (As)(U_{BS})(\Delta t) + (Ar)(U_{Br})(\Delta t)$

Q_B = (3519)(2.42)(100) + (804)(2.2)(100) = 1,028,478 Btu/hr.

No.2

$Q_B = (As - Ap)(U_{Bs})(\Delta t) + (Ar)(U_{Br})(\Delta t)$

Q_B = (3519 - Ap)(2.42)(100) + (804)(2.2)(100)

Q_B = 1,028,478 Btu/hr. - 242 Ap

No.3

$Q_I = (As + Ar)(U_I)(\Delta t)$

Q_I = 3519 + (804)(0.14)(100) = 60,522 Btu/hr.

No.4

$Q_I = (As+Ar-Ap)(U_I)(\Delta t)$ = (3519 + 804 - Ap)(0.14)(100)

Q_I = 60,522 Btu/hr. - 14 Ap

CALCULATION OF THE PLATECOIL SURFACE AREA:

The PLATECOIL surface area for the above four conditions is obtained by the formula

$$A = \frac{Q}{(U)(\Delta t)} = \text{sq. ft.}$$

Ui (inside tank), from Fig. 78-1, line 5 = 20, using mid range, under design conditions and natural convection. (See discussion following the table.)

Uo (for PLATECOIL clamped to outside of tank) from Fig. 78-1 = 15 (middle range for heating viscous products, using heat transfer mastic, line 20). Refer also to item 7 of the discussion on pg. 79.

Δt = 250°F (Steam temp.) - 100°F (holding temp.) = 150°F

No. 1 $\quad Ap = \dfrac{1{,}028{,}478}{(20)(150)}$ = 342.8 sq. ft.

No. 2 $\quad Ap = \dfrac{1.028{,}478 - 242\ Ap}{(15)(150)}$ = 412.7 sq. ft.

No. 3 $\quad Ap = \dfrac{60{,}522}{(20)(150)}$ = 20.2 sq. ft.

No. 4 $\quad Ap = \dfrac{60.522 - 14\ Ap}{(15)(150)}$ = 26.7 sq. ft.

Selecting PLATECOIL Sizes:

No. 1

For internal heating, Style 70 PLATECOIL would be appropriate. Considering size

22" x 131" with 45.8 sq. ft. area $\dfrac{342.8}{45.8}$ = 7.48 or 8

PLATECOIL. For temperature uniformity and piping economy, it would be desirable to install four banks of two PLATECOIL each, spaced at 90 degree intervals.

No. 2

For attachment to outside surface of tank, single embossed PLATECOIL are generally used, rolled to fit outer diameter of the tank. Since only the companion plate side (flat side) of the PLATECOIL is in contact with the tank, only the companion plate area is considered when selecting the PLATECOIL sizes. A general formula can be set up for determining the needed total width (W) of PLATECOIL for completely ringing the storage tank. This is,

$$W = \frac{Ap}{\text{Tank circumference in feet}}$$

Therefore,

$$W = \frac{413 \text{ sq. ft.}}{(\pi)(32 \text{ ft.})} = 4.11 \text{ ft.} = 49 \text{ in.}$$

Two 26" wide PLATECOIL will provide the necessary total width and coverage. The length of each PLATECOIL can be selected arbitrarily; however, this length should be fairly long for economic reasons. A general rule here is to divide the circumference in inches by a whole number which will result in a length of PLATECOIL equal to or slightly less than a standard length. Allowance of approximately 1" between each PLATECOIL should be made for expansion and pulling the PLATECOIL tight against the tank wall. Thus,

$$\text{Length of PLATECOIL} = \frac{\text{Circumference in inches}}{\text{whole number}} - 1"$$

In this case, Length of PLATECOIL =

$$\frac{(\pi)(32)12}{10} - 1" = 119.6"$$

DETAILED HEATING CALCULATIONS (CONT'D)

Therefore, 10 PLATECOIL 119" long will form a complete circumferential ring.

To check if this PLATECOIL arrangement provides enough heating surface, refer to page 12.

From this 20 x 21.2 sq. ft. = 424 sq. ft. Style 70E or 80E *Multi-Zone* PLATECOIL would usually be selected for applications of this type. In conclusion, the PLATECOIL selection would be 20 Style 70E or 80E single embossed *Multi-Zone* PLATECOIL 26" x 119", length rolled to fit the tank. Note that nominal sizes are used when ordering or describing PLATECOIL widths.

No. 3

The requirement of 20.2 sq. ft. of heating surface can readily be supplied by one Style 70 PLATECOIL 22" x 71," which has 24.8 sq. ft. surface area (refer to page 12).

However, one PLATECOIL in a tank of this size would not supply uniform heat distribution. It would be more logical to use several PLATECOIL spaced apart and located near the tank wall. Theoretically, several smaller PLATECOIL equaling the total area requirement could be used, but through experience it has been found that more area should be used to give better heat distribution because the area required cannot be economically dispersed throughout the entire tank. Four Style 70 PLATECOIL 12" x 71" would be a better selection in this case for more uniform heat distribution.

No. 4

In this instance, 26.7 sq. ft. of heating surface is required. As in No. 3, experience dictates that more area should be used to obtain good heat distributon. Usually, it is desirable under these conditions to completely ring the tank with 12" wide PLATECOIL.

Thus, the suggested arrangement would be 10 Style 70E or 80E single embossed *Multi-Zone* PLATECOIL 12" x 119," length rolled to fit the tank.

GENERAL NOTE: A convenient method of installing clamp-on PLATECOIL is by use of mounting lugs, see page 24. It is also desirable to use a good heat transfer mastic for maximum efficiency. See page 46.

SPRAY WASHER APPLICATIONS FOR METAL FINISHING

Many metal working operations involve spray cleaning, surface treatment such as phosphatizing, or rinsing. These operations are ususally conducted in industrial spray washers which may consist of from one to eight stages, each stage normally having a solution storage tank, canopy to enclose the spray chamber, circulating pump protected by screens, spray piping and nozzles, PLATECOIL for heating the solution, ventilation and belt or monorail conveyor to carry the work. The entrance and exit ends of the canopy have openings, known as silhouettes, conforming as nearly as practical to the shape of the parts being processed. Exhaust ventilation ducts are provided to keep the hot vapors within the canopy from spreading into the surrounding area.

Selection of PLATECOIL for the various heated stages of the spray washer is usually controlled by the operating heat requirements rather than the heat-up requirements. Operating heat requirements include the following:

1. Heat to raise work load to operating temperature.
2. Heat lost to exhaust ventilation air,
   (a) Air entering silhouettes and heated
   (b) Evaporative cooling effect of moisture
3. Heat lost through tank and canopy walls.
4. Heat to raise temperature of make-up water.

Calculating the operating heat requirements by the above steps entails much information which ordinarily is not readily available. Therefore, an estimated temperature drop due to spraying, to include all these losses, is commonly used. The following table, based on wide experience, shows the approximate factors applicable to this type of installation.

Operating temperatures of the spray stages are important factors in heat losses. Much lower evaporation losses will occur at operating temperatures of 120°F to 140°F than at 180°F to 200°F, with other losses also somewhat smaller.

Many spray washers include stages for phosphatizing or other solutions which tend to cause scale accumulation on the PLATECOIL surface. In calculating PLATECOIL surface area for these conditions it is desirable to reduce the applicable U value by 25 to 50% to ensure reasonable service life before descaling is required.

For efficient solution heating, it is important to locate the PLATECOIL in a manner to obtain the maximum velocity across the surface as the solution moves towards the pump suction screen. Size and shape of the tank and the canopy will control the length and arrangement of PLATECOIL to best accomplish this result. The tank is normally larger than the canopy or spray chamber, usually with an extension on one side in which the pump screens and suction box are located. In many cases, PLATECOIL can be located in this tank extension, especially on larger machines and in stages such as phosphatizing where access for cleaning may be desirable.

SPRAY WASHER APPLICATIONS FOR METAL FINISHING (CONT'D.)

Temperature Drop Due To Spraying

Fig. 73-1

	For 160 - 190°F Operating Temperature	For 120 - 155°F Operating Temperature	For 160 - 190°F Operating Temperature	For 120 - 155°F Operating Temperature
	Hoods 6' H x 3' W or Smaller		Hoods Larger than 6' H x 3'W	
First and last stages	6°F to 10°F drop	3°F to 7°F drop	8°F to 12°F drop	4°F to 8°F drop
Intermediate stages	4°F to 8°F drop	3°F to 6°F drop	4°F to 10°F drop	3°F to 6°F drop
Single stage (two silhouettes)	8°F to 15°F drop	5°F to 9°F drop	10°F to 15°F drop	6°F to 10°F drop

Example:
The first stage of a spray washer, using an alkali solution, has a spray rate of 250 gpm. The solution operating temperature is 180°F using steam at 50 psig. The tank is 4' x 10' x 3' deep with 2 1/2' solution depth. Before spraying can start the solution must be heated from 60°F to 180°F in 1 hr. The canopy is average size, about 5' high by 2' wide. What PLATECOIL area is required?

1. The PLATECOIL area for tank heat-up should first be determined.

   (a) Liquid volume = 4 x 10 x 2.5 x 7.5 = 750 gal., (Sp. gr. = 1).

   (b) Using 50 psig, Fig. 80-1, the required PLATECOIL area is about 31 sq. ft., or a 22" x 95" PLATECOIL will supply the necessary heating capacity.

2. Since operating heat requirements normally dictate the required heating surface, the requirements should be determined as previously discussed.

   (a) This being the first stage, a temperature drop of 9°F appears logical for 180°F operating temperature. (Fig. 73-1)

$$Q=\left(\frac{250\text{ gal.}}{\text{min.}}\right)\left(\frac{60\text{ min.}}{\text{hr.}}\right)\left(\frac{8.33\text{ lbs.}}{\text{gal.}}\right)(1)(9°F)\left(\frac{1\text{ Btu}}{\text{lb. F}}\right)=1{,}124{,}550\text{ Btu/hr.}$$

   (b) Calculate PLATECOIL area by equation (2), pg. 65.

$$A = \frac{Q}{(U)(\Delta t_L)}$$

   Select U = 175 from Fig. 78-1 based on reasonable solution velocity and average surface fouling.

   Δt_L may be considered as the arithmetic mean temperature since the temperature change is small.

   Solution temperature = 180°F.

   Return spray temperature = 171°F.

   Mean temperature = 175.5°F.

   Δt = 298°F (steam temp.) - 175.5°F = 122.5°F

$$A = \frac{1{,}124{,}550}{175 \times 122.5} = 52.5 \text{ sq. ft. approx.}$$

The second calculation shows that the operating requirements are greater than the requirements for tank heat-up. PLATECOIL area of 52.5 sq. ft. should be supplied. Two Style 90D carbon steel 22" x 83" will adequately supply the requirements.

EFFECT OF AIR MOVEMENT ON HEATING REQUIREMENTS FOR OPEN TANKS

The velocity of air over the surface of an open tank containing a water base solution, may have a controlling influence on the installed heating capacity to maintain a specified temperature. In the case of plating and other solutions giving off dangerous fumes, the air velocity may be relatively high; 10 to 20 ft. per second. Fig. 86-3 gives the heat loss in Btu/sq. ft./hr. from water surface at various water temperatures and air velocities with air temperature at 60°F.

Example:
In the example, page 70, assume an air velocity of 10 fps over the water surface instead of still air, other conditions the same as stated.

Referring to Fig. 86-3, the surface heat loss at 200°F is 14,600 Btu/hr., therefore

Heat loss from water surface =
(14,600) (48 sq. ft.) = 700,800 Btu/hr.
Heat loss from tank walls = 46,100 Btu/hr.
Heat absorbed by work = 27,600 Btu/hr.
774,500 Btu/hr.

$$A = \frac{Q}{(U)(\Delta t_L)} = \frac{774{,}500}{(160)(50°F)} = 96.8 \text{ sq. ft.}$$

This area now exceeds the 68.6 sq. ft. needed for even a 1 hr heat-up (provided the exhaust was off during heat-up). The example with a 200°F temperature and a 10 fps exhaust velocity is high but does show that exhaust air velocity must be considered.

PLATECOIL FOR COOLING APPLICATIONS

GENERAL COOLING CALCULATIONS

Determining the amount of PLATECOIL surface area necessary to cool water base solutions in an open tank, when water is utilized as the coolant, can be easily accomplished using the charts and examples.

Fig. 74-1

HOLDING TEMPERATURE IN PLATING SOLUTIONS, °F				
Watts Removed Per Sq. Ft.	**GPM/Sq. Ft. Cooling Water**	**Cooling Water Inlet Temp.**	**Solution Holding Temperature**	**Btu/hr. Removed Per Sq. Ft.**
1140	.4	50	100	3900
1730	.6	50	120	5900
2320	.8	50	140	7900
850	.3	60	100	2900
1440	.5	60	120	4900
2020	.7	60	140	6900
410	.2	70	100	1400
1140	.4	70	120	3900
1730	.6	70	140	5900

NOTE: The above table is based on a U value of 100 Btu/hr. sq. ft. °F for an agitated watery solution and a cooling water temperature rise of approximately 20°F through the PLATECOIL. Generally city water pressure will supply adequate cooling water for a Style 60 or 50 PLATECOIL up to about 30 sq. ft. For tanks requiring more than 30 sq. ft. of cooling surface, several smaller PLATECOIL may be desirable. Page 84 gives more complete pressure drop data.

HOW TO USE THE TABLE (FIG. 74-1)

Example:

Maximum current input into a 4'x 6'x 4' liquid level Cyanide Copper plating bath is 30,000 watts. Determine the size of PLATECOIL required to hold 120°F operating temperature using 60°F cooling water.

Solution:

1. Entering the table at 60°F cooling water and 120°F solution temperature, a PLATECOIL capacity of 4900 Btu/hr. sq. ft. or 1440 Watts/sq. ft. is noted.
2. Divide input by PLATECOIL capacity to obtain the required PLATECOIL area.

$$A = \frac{30{,}000}{1440} = \frac{20.8 \text{ sq. ft.}}{\text{PLATECOIL Area}}$$

3. Select the appropriate PLATECOIL size from the area table Fig. 12-1. A 22" x 59" PLATECOIL will do the job, utilizing (20.8)(.5) = 10.4 gpm cooling water.

DETAILED COOLING CALCULATIONS

When applications require the calculation of precise amounts of PLATECOIL surface area the following examples will indicate the procedures which should be utilized.

COOLING WITH WATER

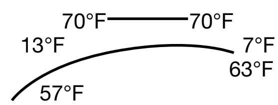
Example:

An anodizing application uses a plastic lined tank 30' x 4' x 7' deep, containing a 15% sulfuric acid solution air agitated, which is to be maintained at 70°F during operation. The anodizing is accomplished by means of an electrical input of 4000 amps at 24 volts, direct current. Cooling water is available at an average temperature of 57°F. Determine number and size of PLATECOIL to supply the requirements.

The heat which has to be dissipated is supplied by the electrical input, or 4000 x 24 = 96,000 watts.

Heat input, Q = 96,000 x 3.413 Btu/whr = 327,648 Btu/hr. Assume that all of the heat input has to be removed in order to maintain the specified 70°F.

Fig. 74-2



In order to obtain the temperature conditions shown by Fig. 74-2, it is necessary to assume the temperature rise of the water circulating through the PLATECOIL. For small temperature differences between initial cooling water and the solution, in this case 13°F, experience indicates about one-half this difference will be picked up by the water. Assuming a 6°F rise, the final water temperature becomes 63°F and temperature differences of 13°F and 7°F are obtained, from which Δt_L is determined as 9.5°F per Fig 82.1.

$$\text{PLATECOIL area, } A = \frac{Q \text{ (Formula 2)}}{(U)(\Delta t_L)}$$

U = 100 (Fig. 78-1). Air agitation produced some solution movement over the PLATECOIL Δt_L = 9.5°F (Fig. 82-1).

$$\text{Area} = \frac{327{,}648}{(100)(9.5)} = 349.9 \text{ sq. ft.}$$

For cooling applications, *Serpentine* type PLATECOIL are normally used. In the deep tank of this application, it is desirable to install the PLATECOIL vertically, therefore, the maximum practical length is 71". A Style 60D PLATECOIL 22" x 71 " provides 24.8 sq. ft.

$$\frac{349.9}{24.8} = 13.9 \text{ or } 14 \text{ PLATECOIL}$$

To find the cooling water required,

$$\frac{\text{Btu liberated/hr.}}{\text{Temp. rise x sp. ht. of coolant}} = \text{lb. of coolant hr.}$$

$$\frac{327{,}648}{(6°F)(1)} = 54{,}608 \text{ lbs./hr.}$$

$$\frac{54{,}608}{(8.33 \text{ lb./gal.})(60 \text{ min.})} = 109.3 \text{ gpm, total water rate}$$

For most efficient operation, the PLATECOIL should be connected in parallel.

The flow rate per PLATECOIL is, $\frac{109.3}{14}$ = 7.8 gpm.

DETAILED COOLING CALCULATIONS (CONT'D.)

By reference to Fig. 84-1, the pressure drop across each PLATECOIL is found to be approximately 6.5 psi. This drop is not excessive and may be considered satisfactory for this application.

If, in similar problems, a pressure drop considerably above 10 psi is obtained, it may be necessary to adjust the number and size of the PLATECOIL to give a pressure drop satisfactory for the specific application.

In anodizing applications involving sulfuric acid solutions, Tranter type 316L stainless steel PLATECOIL are giving satisfactory service provided the solution temperature is not permitted to rise much above 70°F, during idle periods as well as during operation. PLATECOIL life is further increased by connecting them as the cathode of the electrical circuit. Advantage is thereby taken of "cathodic protection" and reduces the need for additional cathode area in the form of lead or stainless sheets.

NOTE: Current carrying bars are desirable if the load exceeds 850 watts/sq. ft. of PLATECOIL, one side only.

COOLING WITH REFRIGERANTS

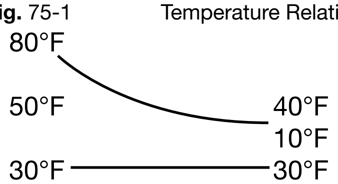
Example:

Determine the number of PLATECOIL and refrigerating requirements to cool sherry wine from 80°F to 40°F at the rate of 4 gpm, using direct expansion R-12. A tank 4' x 2' x 2 1/2' deep is available for installing the PLATECOIL and through which the wine will flow.

While it is desirable to have as large a temperature differential as possible between the chilled liquid and the refrigerant, there is danger of water content freezing out onto the PLATECOIL if the refrigerant temperature is too low. In this case the refrigerant temperature should not be lower than about 30°F, not only to prevent freeze out but also for good efficiency of compressor operation.

The temperature relations applying to this problem are shown in Fig. 75-1.

Fig. 75-1 Temperature Relationships



By referring to Fig. 90-3 it is noted that the R-12 pressure within the PLATECOIL (suction pressure) should be controlled to approximately 28.5 psig.

The average physical properties of wines, Fig. 96-1, are sp. ht. = 0.9 and sp. gr. = 1.03.

Heat extracted per hour is:

$$Q = \left(4\ \frac{\text{gal.}}{\text{min.}}\right)\left(\frac{60\ \text{min.}}{\text{hr.}}\right)\left(\frac{8.33\ \text{lb.}}{\text{gal.}}\right)(1.03)\left(\frac{.9\ \text{Btu}}{\text{lb. F}}\right)(80°\text{F} - 40°\text{F}) = 74{,}130$$

Total PLATECOIL area, by equation (2) pg. 65 where:

U = 35 (Fig. 76-1, similar to water)
Δt_L = 25 (from Fig. 80-1)

$$\text{is: } A = \frac{774{,}130}{(35)(25)} = 84.7 \text{ sq. ft.}$$

Serpentine type PLATECOIL are preferable for refrigeration applications as they provide positive refrigerant distribution and are free from the possibility of short circuiting. In sizing *Serpentine* PLATECOIL for refrigeration service, it is necessary to choose a size that will result in a reasonable refrigerant pressure drop. In this case, 7 or 8 Style 50 PLATECOIL, 22" x 35" will provide the calculated cooling surface and can be installed readily in the tank. Once a size is selected, the refrigeration capacity must be checked from a pressure drop standpoint.

Refrigeration capacity required:

$$\frac{774{,}130}{8} = 9{,}266 \text{ Btu/hr. per PLATECOIL}$$

Referring to Fig. 90-1, page 90, a Style 50 or 60, 22" x 143", has an allowable maximum refrigerating loading of 14,750 Btu/hr. for R-12 at 30°F with the PLATECOIL immersed in a watery solution. The capacity factor of a 22" x 35" is 3.3, so that the maximum allowable loading for this size is 3.3 x 14,750 = 48,675 Btu/hr. Since the actual loading is only 9,266 Btu/hr., there will be no pressure drop problem with the 22" x 35" Style 50D PLATECOIL selected above. It is important to realize that the capacities in Fig. 90-1 relate to pressure drop only and in no way replace the calculations involving

$$A = \frac{Q}{(U)(\Delta t_L)}$$

In some cases it may be necessary to revise the initial PLATECOIL selection so that a larger number of smaller PLATECOIL can be used in order to avoid excessive pressure drop.

It is always good policy to cooperate closely with the refrigeration contractor when PLATECOIL are to be used in the refrigeration system. Refer to page 62 for additional comments on PLATECOIL for refrigeration.

PLATECOIL FOR ENERGY RECOVERY APPLICATIONS

HEAT RECOVERY FROM WASTE LIQUIDS

PLATECOIL finds wide use in a variety of steam-to-liquid and liquid-to-liquid heat recovery applications, because of its design versatility and heat transfer capability. The amount of heat transfer surface necessary to provide efficient, money-saving energy recovery is provided in the following example:

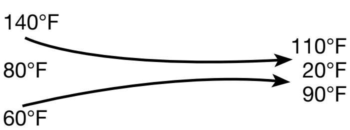
Example:

Waste dye liquor is discharged at an average rate of 3000 gph = 50 gpm. Avg. temp. = 140°F. Work week, 55 hr. City water for make-up available at 60°F and 60 psig. Local boiler plant produces steam at $5.00/1000 lb. Desired, the estimated economics of heat recovery for heating make-up water.

Two types of heat exchanger systems are considered: (1) co-current flow and (2) counter flow.

1. Co-Current Flow - For the temperatures involved, a 20°F min. end temperature differential between the discharge and make-up water is considered practical. The respective temperature curves are shown in Fig. 76-1, and the 50 gpm of make-up water will be heated from 60°F to 90°F.

Fig. 76-1 Temperature Relationships for Co-Current Flow



sp. gr. = 1
sp. ht. = 1 Btu/lb. - °F
Δt_L (from Fig. 82-1) = 43
Q = (3000)(8.33)(1)(1) (140°F - 110°F) = 749,700 Btu/hr.
U = 75 (using *Serpentine* type PLATECOIL Fig. 83-1, consider minimum of fouling and reasonable water velocity)

$$A = \frac{749{,}700}{75 \times 43} = 232.5 \text{ sq. ft.}$$

For this type of application *Serpentine* construction should be selected. The PLATECOIL should be connected in parallel and installed in a sump or other container. In determining the number of PLATECOIL to use, both size and pressure drop per PLATECOIL should be considered. Six Style 50D or 60D PLATECOIL 18" x 131" will supply the required surface area. The flow rate in each PLATECOIL is 50/6 = 8.33 gpm. By referring to page 84, the pressure drop through each PLATECOIL is found to be approximately 10 psi which is entirely satisfactory for this application.

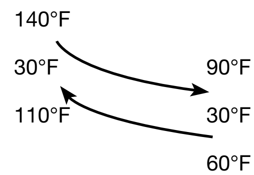
If the alternative for heating the make-up water is by use of live steam, the cost by this method would be:

$$\frac{(750{,}000)(\$5.00)(55 \text{ hr./wk.})(50 \text{ wk./yr.})}{(1000)(1000 \text{ Btu avg./lb.})} = \$10{,}312.50 \text{ approx./yr.}$$

The amortization period is dependent upon cost of installation and whether mild steel or stainless steel PLATECOIL are selected.

2. Counter Flow - A 30°F Δt is commonly used, particularly for textile waste heat recovery. Closer Δt's, of course, can be used. The respective temperature curves are shown in Fig. 76-2.

Fig. 76-2 Temperature Relationships for Counter Flow



Δt in this case is 30°F
U = 75 (as in previous example)
Q = (3000)(8.33)(140°F - 90°F) = 1,249,500 Btu/hr.

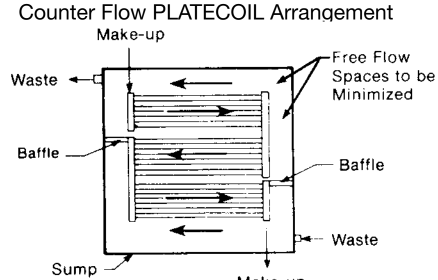
$$A = \frac{1{,}249{,}500}{75 \times 30} = 555.3 \text{ sq. ft.}$$

In counter flow operation, an arrangement of PLATECOIL similar to Fig. 76-3 has proven effective in service. The sketch shows 3 banks connected in series, each bank consisting of 7 PLATECOIL installed in parallel. By balancing PLATECOIL size against reasonable pressure drop, it is found that in this instance 21 Style 60D PLATECOIL 18" x 95" will supply the required surface area. A flow rate of 50 gpm is passing through the system, therefore, the flow rate per PLATECOIL in each band is:

$$\frac{50}{7} = 7.14 \text{ gpm}$$

Reference to page 84 shows the pressure drop to be approximately 5.5 psi per PLATECOIL. In the installation, three banks are connected in series giving a total pressure drop of 5.5 x 3 = 16.5 psi. This is a reasonable value, considering that city water is available at 60 psig.

Fig. 76-3 Counter Flow PLATECOIL Arrangement



Economics, by ratio =

$$(\$6{,}187.50)\left(\frac{1{,}249{,}500}{749{,}700}\right) = \$10{,}312.50 \text{ approx./yr.}$$

IMPORTANT POINTS TO REMEMBER

CONDITIONS AFFECTING TEMPERATURE RISE OR DROP FOR LIQUIDS FLOWING THROUGH PLATECOIL

In most calculations involving liquid heat transfer media flowing through PLATECOIL, the inlet temperature is given and the outlet temperature must be assumed. This matter is discussed briefly in the example of a cooling problem on page 74. Further, Fig. 88-3 shows temperature drop test data with High Temperature Hot Water (HTHW) flowing through PLATECOIL.

To summarize, general guides may be set forth as follows:

1. For any conditions, the temperature rise (or drop) may be taken as 1/2 the difference between the heating or cooling media inlet temperature and the product outlet temperature.

2. Fig. 88-3 shows that 100°F temperature drops with HTHW are practical as assumptions.

3. When using header type PLATECOIL, do not expect quite as much temperature change through the PLATECOIL as with *Serpentine.*

4. When Δt's are small, final approach temperature may be assumed within as little as 2°F of each other. Do not expect them to meet.

5. If temperatures must cross, be sure to design for counter flow and figure Δt_L accordingly.

6. In some cases an available flow rate will be given. From this figure the necessary temperature drop to transfer Btu load can be determined. This will also serve as a check to determine whether or not the available flow rate is adequate.

NOTE: These comments cover temperature rise or drop assumptions only. Pressure drop must also be checked from flow rates required.

The above conditions were considered in the design of the PLATECOIL shown in the photos.

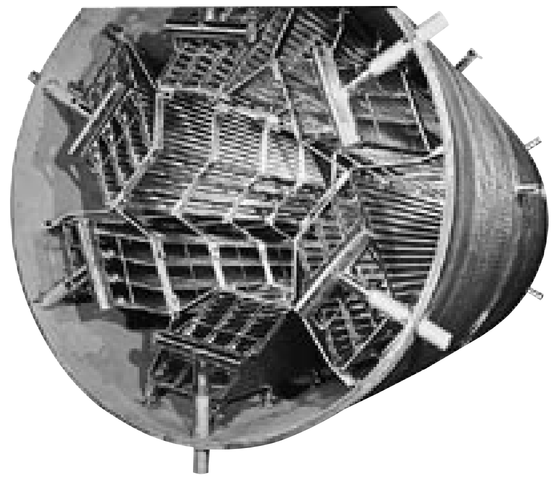


Fig. 77-1
PLATECOIL units for heat transfer surface in agitated vessels and reactors.

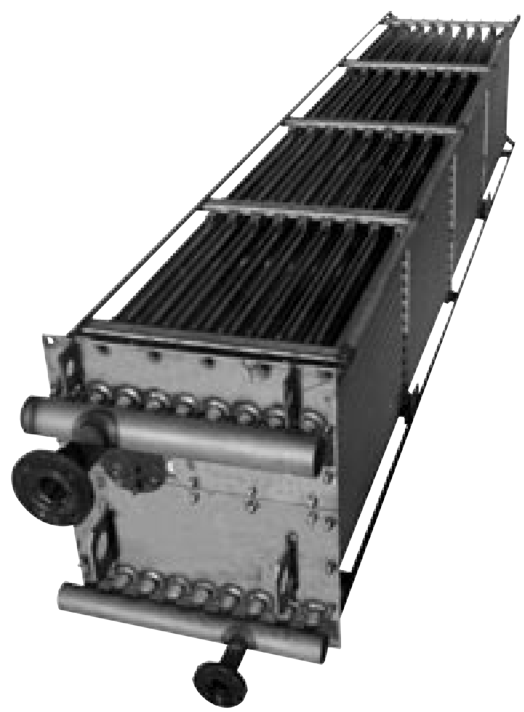


Fig. 77-2
PLATECOIL bank for heat recovery.

Platecoil Heat Transfer Design Data

AVERAGE OVERALL HEAT TRANSFER COEFFICIENTS U= Btu/hr. sq. ft. °F (For Immersed or as Integral Vessel Jackets)

Fig. 78-1

HEATING APPLICATIONS		PLATECOIL STYLE	CLEAN SURFACE COEFFICIENTS		DESIGN COEFFICIENTS Considering Usual Fouling in this Service	
HOT SIDE	**COLD SIDE**		**Nat. Convect.**	**Forc. Convect.**	**Nat. Convect.**	**Forc. Convect.**
1. Steam	Watery solution	90-80-70	250-500	300-550	125-225	150-275
2. Steam	Light oils	90-80-70	50-70	110-140	40-45	60-110
3. Steam	Medium lube oil	90-80-70	40-60	100-130	25-40	50-100
4. Steam	Bunker C or #6 fuel oil	90-80-70	20-40	70-90	10-30	60-80
5. Steam	Tar or asphalt	90-80-70	15-35	50-70	15-25	40-60
6. Steam	Molten sulphur	90-80-70	35-45	60-80	4-15	50-70
7. Steam	Molten paraffin	90-80-70	35-45	45-55	25-35	40-50
8. Steam	Air or gases	90-80-70	2-4*	5 10*	I-3*	4-8
9. Steam	Molasses or corn syrup	90-80-70	20-40	70-90	15-30	60-80
10. High temp. hot water	Watery solutions	60-50-40	80-100	100-225	70-100*	110-160*
11. High temp. ht. transfer oil	Tar or asphalt	60-50-40	12-30	45-65	10-20	30-50
12. Therminol	Tar or asphalt	60-50-40	15-30	50-60	12-20	30-50
COOLING APPLICATIONS						
COLD SIDE	HOT SIDE					
13. Water	Watery solution	60-50-40	70-100	90-160	50-80	80-140
14. Water	Quench oil	60-50-40	10-15	25-45	7-10	15-25
15. Water	Medium lube oil	60-50-40	8-12	20-30	5-8	10-20
16. Water	Molasses or corn syrup	60-50-40	7-10	18-26	4-7	8-15
17. Water	Air or gases	60-50-40	2-4	5-10	1-3	4-8
18. Freon or ammonia (dir. expan.)	Water solution	60-50	35-45	60 - 90	20-35	40-60
19. Ammonia (flooded)	Watery solution	70-80	—	100-175	—	100-175
CLAMP-ON PLATECOIL •	**WATER AND SOLVENTS**		**VISCOUS PRODUCTS**		**AIR AND GASES****	
	Heating	**Cooling**	**Heating**	**Cooling**	**Heating**	**Cooling**
20. With heat transfer mastic	30-40	20-30	10-20	5-12	1-3	1 3
21. Without heat transfer mastic	15-25	10-20	6-12	3-8	1-3	1-3

* See curves on page 86 for more detailed data.
• Clamp-on PLATECOIL should be used only for holding conditions. DO NOT use for heat up or cool down except in moderate requirement situations and with calculated area doubled as a safety factor.
** For low velocity air or gas. At higher velocities U values will increase to about 50% of Fig. 88-2.

SELECTION OF OVERALL HEAT TRANSFER U VALUES

The discussion on the overall heat transfer coefficient, U, page 67, calls attention to a number of factors that influence the value to be assigned this coefficient for a specific application. Through extensive laboratory tests and accumulated field experience, a range of U values, applicable to PLATECOIL, has been established for a variety of typical applications, as presented in Fig. 78-1. The improved efficiency of the *Multi-Zone* PLATECOIL design results in a conservative basic U value for steam heated, watery solutions in open tanks of 150. This higher U value is used for the Quick Selection Chart on page 80 and is also discussed in the example on page 80. The example explains that this conservative U of 150 is such that wall and surface losses may be ignored for steam to water, open tank, one or two hour heat-up problems. This greatly simplifies calculation of these problems. When figuring longer heat-up periods, which require calculation of losses, then U of 160 is generally used. This is near the middle of the 125-225 range shown in line 1 for design coefficients, natural convection in Fig. 78-1.

The selection of a specific U value, within the range shown in the table for a given type of service, should be governed by one or more of the following factors:

SELECTION OF OVERALL HEAT TRANSFER U VALUES (CONT'D.)

1. The original clean surface of the PLATECOIL is not usually retained over extended service, therefore:

(a) "Clean Surface" coefficients should be used with caution and only when it is known that the type of solution involved does not cause corrosion or other types of fouling during use.

(b) "Design Coefficients" take into account normal fouling and other operating variables and introduce a reasonable factor of safety into the calculations. For liquids known to produce heavy fouling such as phosphatizing solutions, the low side of the coefficient range should be chosen.

2. The circulation rate, or velocity, of the solution being heated or cooled has a direct influence on heat tranfer and on the U value selected.

(a) Natural Convection: Steam pressure, location of PLATECOIL in the tank, viscosity and thermal conductivity of the liquid affect the rate at which the fluid will circulate by natural convection. The use of Tranter "quick change" hangers assures the proper PLATECOIL location with respect to the tank wall. In general, the greater the temperature difference between the heat transfer surface and the solution, whether for heating or for cooling, the greater will be the rate of circulation and a correspondingly higher U value may be used.

(b) Forced Convection: The rate at which the solution is circulated across the surface of the PLATECOIL has a direct influence on the U value selected. For high flow rates, higher values in the range of coefficients may be used.

3. Steam Pressure: For a given installation, the steam pressure used affects the rate of heat transfer. With higher steam pressures, U values in the upper range may be selected.

4. Viscosity: High viscosity liquids are more difficult to heat than those of low viscosity. As a result, U values in the lower range would be selected. The temperature at which a high viscosity liquid is held also affects the rate of heat transfer. As an example, a higher U value should be realized in holding Bunker C fuel oil at 150°F than when holding it at 80°F, due to its lower viscosity at the higher temperature.

5. Thermal conductivity (k) and specific heat: Generally, the higher the thermal conductivity and specific heat of the solution, the better the heat transfer, with corresponding effect on the U value selected.

6. In selecting U values, special consideration should be given to solutions that have the capacity to produce heavy scale or other fouling, or that have unusually high viscosities. Attention has previously been called to phosphatizing solutions. Corn syrup presents a case of high viscosity. On page 96 it will be observed that the viscosity of corn syrup increases rapidly as its temperature decreases. If the problem were to cool this material from 160°F to 40°F, using tap water as the coolant, it would be found that as the temperature decreases a viscous film collects on the PLATECOIL surface, appreciably reducing its effective heat transfer. To compensate for this situation, a U value in the low range should be selected. Maintaining a high liquid velocity over the cooling surface, by agitation or recirculation, will somewhat correct the above situation as well as greatly reduce the cooling time.

7. Clamp-on PLATECOIL general U values are given in line 20 and 21 of Fig. 78-1. Tests have shown that regardless of the heat tranfer conditions 40 is about the maximum U that can be obtained with clamp-on. See page 46 for further comments.

8. When steam pressures of less than approximately 15 psig entering the PLATECOIL are likely with steam to watery solutions, it is desirable to hold the PLATECOIL size to a maximum of approximately 50 sq. ft.

9. In installations using plastic or lead covered PLATECOIL, the applicable U value should be multiplied by a factor of 0.75. This applies also to clamp-on on glass lined vessels.

If due consideration is given to the factors mentioned, a representative U value can be selected for the various applications listed in Fig. 78-1. For solutions not listed, an approximate U value can be assigned if the density, viscosity, specific heat and thermal conductivity of the solution are known. By referring to a material in Fig. 78-1 having somewhat comparable physical properties, the U values there specified may be used with resonable accuracy.

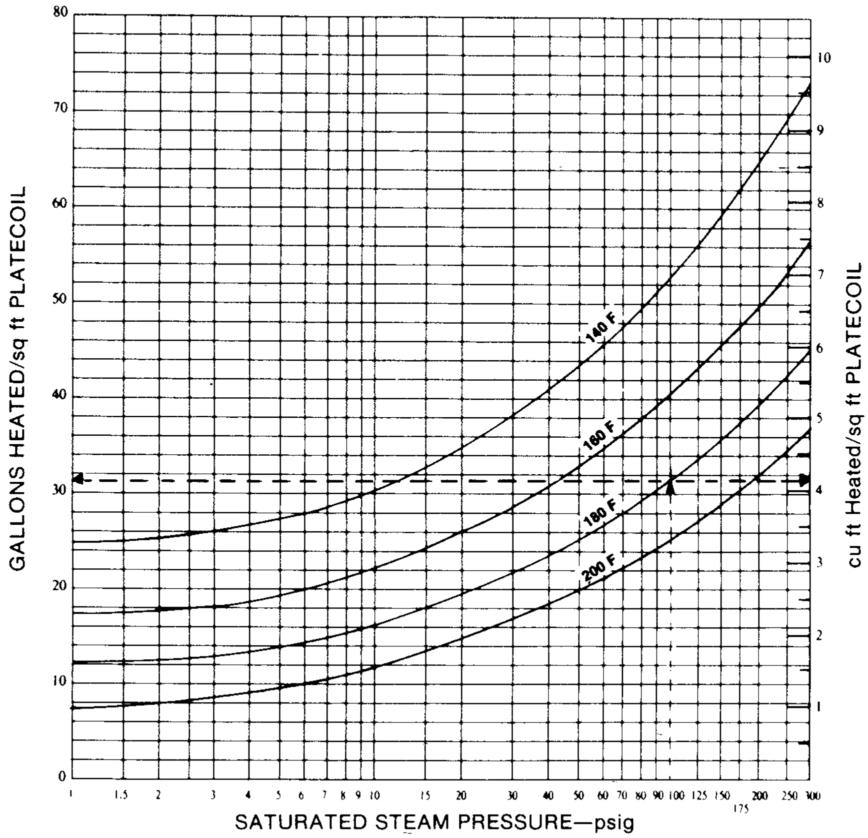
QUICK SELECTION CHARTS

The charts on this page and page 81 are based on U = 150 Btu/hr. sq. ft. °F

Fig. 80-1

Quantity of Solution Heated Per sq. ft. vs. Steam Pressure

BASED ON ONE HOUR HEAT UP TIME (FROM 60°F)



EXAMPLES: ILLUSTRATING THE USE OF THE QUICK SELECTION CHARTS

Determine the total sq. ft. of PLATECOIL needed to heat a watery solution from 60°F to 180°F in one hour with steam at 100 psig. The tank measures 10'x 5'x 5' and the solution depth is 4'. Also, determine pounds of steam condensed.

1. Calculate solution volume: V = 10'x 5'x 4' = cu. ft. (This is equivalent to 200 x 7.5 gal./cu. ft. = 1500 gallons.)

2. Enter the bottom of Fig. 80-1 at the line for 100 psig steam pressure. Follow it vertically to the curve for 180°F operating temperature. From this intersection, move horizontally to the left and read: 31.8 gal. heated per sq. ft. of PLATECOIL, or move right and read 4.24 cu. ft. heated per sq. ft. of PLATECOIL.

3. Divide result of step (1) by result of step (2) to obtain

$$\text{PLATECOIL AREA} = \frac{200}{4.24} \text{ or } \frac{1500}{31.8} = 47.2 \text{ sq. ft.}$$

4. Select the appropriate size style 90 PLATECOIL from Fig. 12-1 page 12. Either a 26" x 119" or a 29" x 107" PLATECOIL will do the job.

5. To find pounds of steam condensed for trap sizing and boiler load, enter the bottom of Fig. 81-1 at 100 psig, move upward to the curve for 180°F, then left read 33.8 lb. condensate per hour per sq. ft. of PLATECOIL. Multiply by 47.2 sq. ft. to obtain 1595 lb. condensate per hour. For conditions not covered by Fig. 81-1, simply divide the Btu/hr. load by the latent heat of vaporization for steam found in Fig. 89-1.

6. To find Btu per hour for determining PLATECOIL rating, enter bottom of Fig. 81-2 at 100 psig, move upward to the curve for 180°F, then left to read 31,800 Btu per hour per sq. ft. of PLATECOIL. Multiply by 47.2 sq.ft. to obtain a rating of 1,357,860 Btu per hour.

NOTE: These charts can be used for heat-up times other than one hour by:

(a) Multiplying the gallons or cu. ft. heated per sq. ft. figures by the ratio of the heat-up time. In the above example, for a 2-hour heat-up the gal. heated figure would be 63.6, the cubic feet heated figure would be 8.48, and the PLATECOIL area needed would be only 23.6 sq. ft.

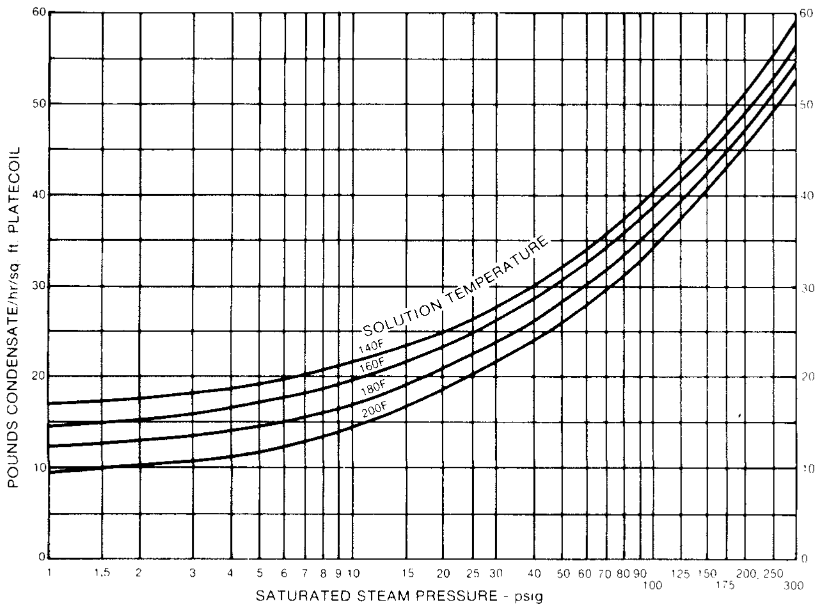
(b) Dividing the lb. condensate per hour (result of step 5) and Btu per hour (result of step 6) by the ratio of heat-up times. For a 2-hour heat-up the figures in the example would be 797.5 lb. condensate per hour and 678,930 Btu per hour.

This method should not be used for heat-up times longer than 2 hours. For such cases, use the method on page 70 under Precautions for Long Heat-Up

QUICK SELECTION CHARTS (cont'd.)

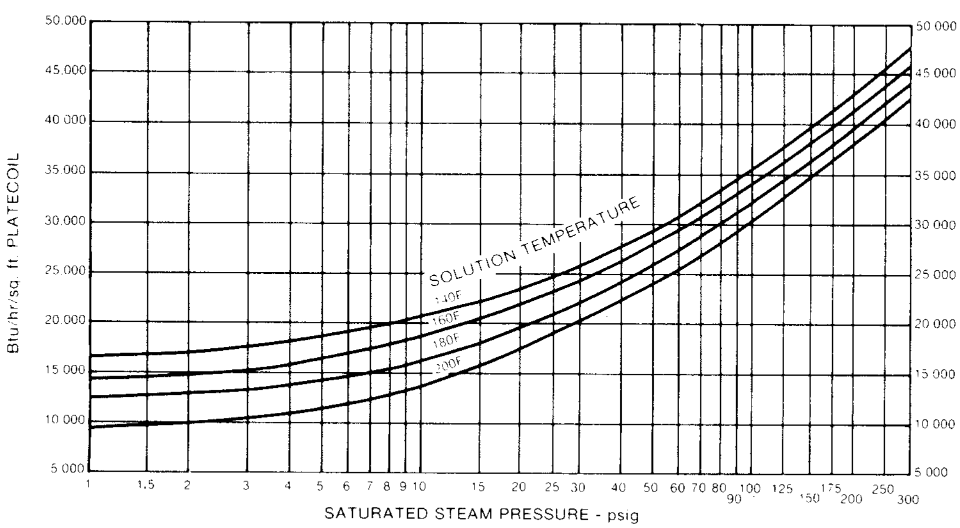
POUNDS CONDENSATE VERSUS STEAM PRESSURE

Fig. 81-1
For sizing temperature controls and traps and checking boiler load. See example on page 80.



BTU VS. STEAM PRESSURE

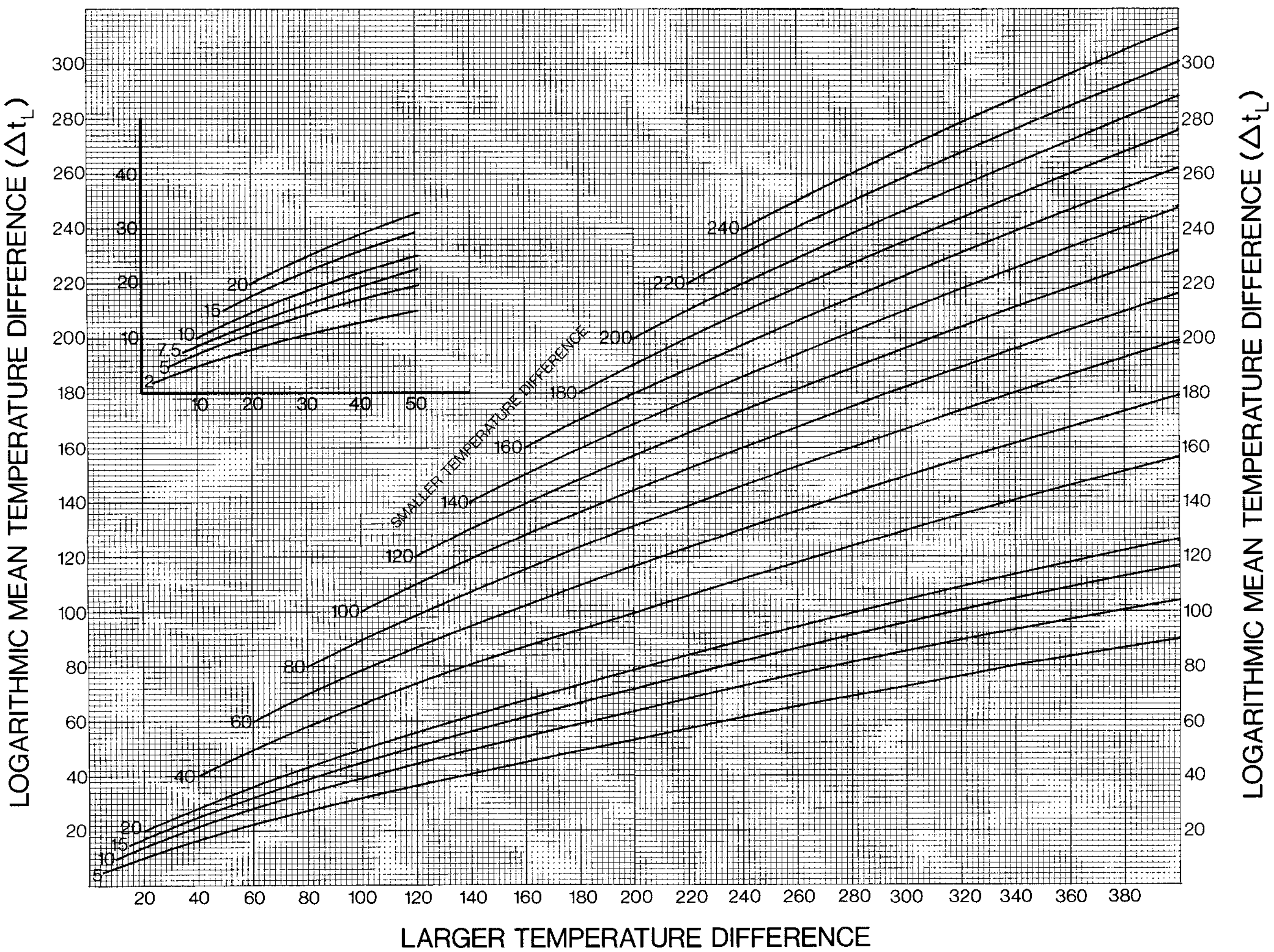
Fig. 81-2
For Btu/hr. capacity data.



LOGARITHMIC MEAN TEMPERATURE DIFFERENCE CHART

For heating or cooling applications

Fig. 82-1



Explanation

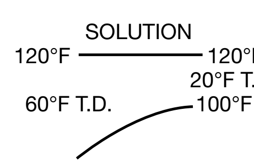
The work involved in calculating Δt_L by equation (5), page 68, is greatly reduced by the use of the above chart.

The application where water at 60°F is used to hold the temperature of a plating solution at 120°F, the water is raised to 100°F while passing through the PLATECOIL. For heat transfer calculations, it is necessary to determine the Δt_L. If the terminal temperature conditions are represented by two curves, as in Figure 82-2, the larger and smaller temperature differences are readily obtained. Applying these temperature differences to the above chart, the Δt_L is quickly obtained.

NOTE: This chart is applicable for degrees Fahrenheit or degrees Centigrade.

Solution: Enter the graph at the larger temperature difference of 60°F on the base line and rise vertically to intersect the line which represents the smaller temperature difference, 20°F. This intersect, when read on the vertical scale (either the left or right side) gives the Δt_L or, in this case, 36°F.

Fig. 82-2



FLUIDS IN MOTION

PRESSURE DROP VS. FLOW RATE

When a fluid flows through a pipe, or other enclosure, either of two general types of motion may occur. (1) If the fluid particles flow in paths parallel to the axis of the pipe, without radial components, the flow is called laminar, viscous or stream lined. This condition exists only at low velocities and, for best heat transfer, is to be avoided if possible. (2) The most important flow condition from the standpoint of good heat transfer, is when radial components exist together with the fluid motion parallel to the pipe axis and is known as turbulent flow.

An important property that affects the movement of fluids is viscosity. The VISCOSITY (μ) of a fluid is the measure of its resistance to flow. The unit of absolute viscosity is the "poise" which is equal to 1 gram/(cm.)(sec.). However, the unit most commonly used is the "centipoise" (0.01 poise), which happens to be the viscosity of water at approximately 70°F. In the English system, viscosity is frequently expressed as lb./(ft.)(hr.) which equals centipoises times 2.42.

Measurements by industrial viscometers take into account the density (sp. gr.) of the liquid involved. Such measurements are designated as kinematic viscosity, which is absolute viscosity of a fluid divided by its density at the temperature under consideration. The metric units of kinematic viscosity corresponding to poises and centipoises are stokes and centistokes. Other commonly used kinematic units, particularly in the petroleum industry, are: Seconds Saybolt Universal (SSU): Seconds Saybolt Furol (SSF); and Seconds Redwood. Figure 92-1 provides data for converting from one system to another in kinematic units. The viscosity of all liquids decreases with increase in temperature while for gases the reverse is true. It is, therefore, necessary to state the temperature at which a given viscosity applies.

In considering pressure drop through a PLATECOIL, both viscosity of the liquid as well as rate of flow, have to be taken into consideration. The curve, Fig. 84-1 and the table in Fig. 84-2, can be used to calculate pressure drop vs. flow rate for standard size PLATECOIL using 70°F water. Pressure drop for PLATECOIL sizes not shown can readily be obtained by extrapolation. For liquids having viscosities other than water at 70°F, the curves, Fig. 85-1 should be used. The given viscosity must be converted to pounds per foot hour before using these curves. NOTE: The pressure drops shown on all curves are nominal. Actual pressure drops may vary dependent upon gauge and style.

Example:

In a PLATECOIL application, a Style 60 PLATECOIL 22" x 119" is installed. Water flows through the PLATECOIL at 10 gpm.

(1) What is the pressure drop when the water temperature is 70°F?

(2) What is the pressure drop when the water temperature is 160°F?

(1) Page 84 gives the pressure drops for water at 70°F. In this case it is found to be approximately 13 psig.

(2) At 160°F, both the density and viscosity of water are lower than at 70°F and for accurate results the pressure drop, ΔP, can be calculated from the curves, Fig. 85-1. In the abscissa factor $p \frac{(gpm)}{\mu}$ where

$$p = 62.4 \text{ x} .977(^1) = 60.9 \text{ lb./cu. ft.}$$
$$\mu = 0.4(^2) \times 2.42 = .968 \text{ lb./(ft.)(hr.)}$$

$$\frac{60.9 \times 10}{.968} = 629$$

To find the corresponding pressure drop for 160°F water, the point 629 is located on the 22" x 119" line and projected to the left ordinate which, in this case, is approximately

$$0.11 = \frac{\Delta P}{(gpm)^2}$$
$$\text{then } \Delta P = (.11)(10)^2 = 11 \text{ psig}$$

This illustrates the effects of density and viscosity on pressure drop. Fig 85-1 can be used to determine pressure drop for any fluid flowing through Style 60 PLATECOIL provided the physical properties are available.

(1) Density of water at 160°F, Chem. Engr. Handbook, 3rd Ed., pg. 175, Table 46.

(2) Page 96 or Chem. Engr. Handbook, 3rd Ed., pg. 374, Table 7.

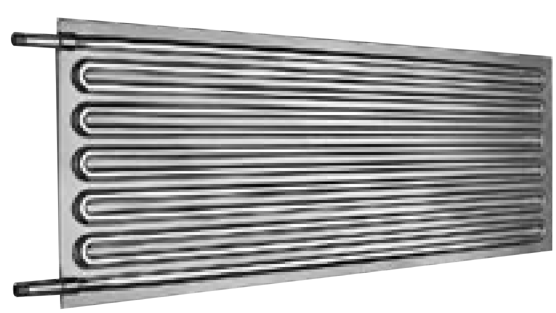
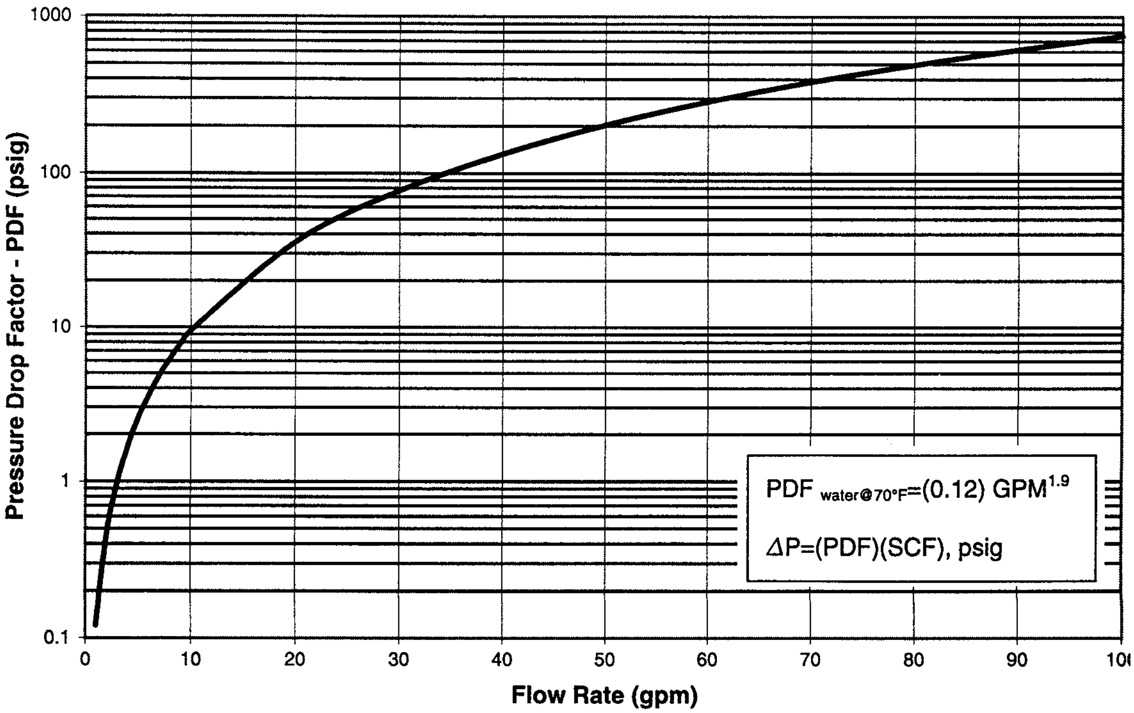


Fig. 83-1
Style 60D PLATECOIL as discussed in the above example.

PLATECOIL PRESSURE DROP VS. FLOW RATE FOR WATER AT 70°F FOR 3/4" PASS DOUBLE EMBOSSED PLATECOIL

Fig. 84-1



Size Correction Factors - SCF

Fig. 84-2

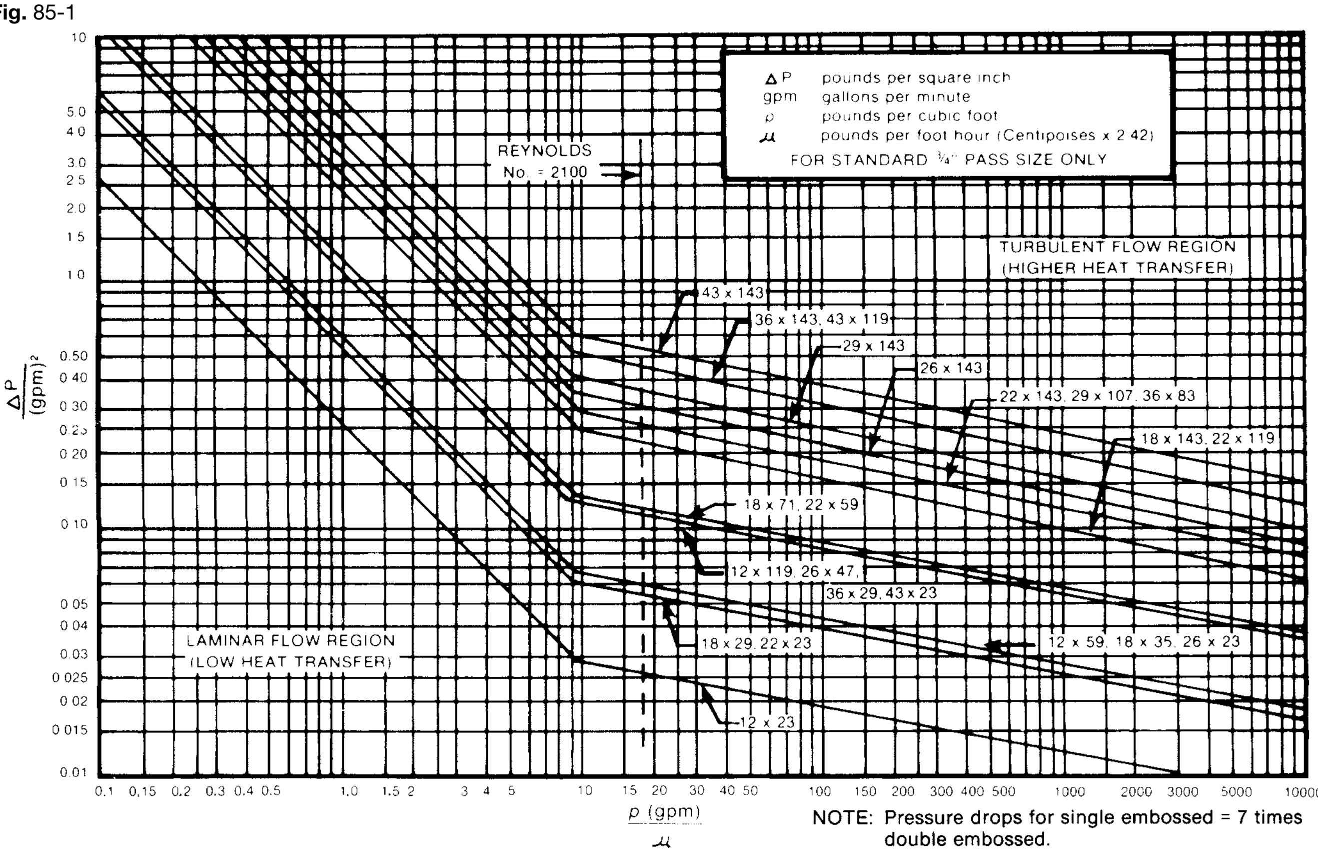
Size (in.)	90/70	80	60/50	Size (in.)	90/70	80	60/50	Size (in.)	90/70	80	60/50
12x23	0.12	0.06	0.3	22x71	0.17	0.04	1.1	29x119	0.21	0.04	2.0
12x29	0.13	0.06	0.4	22x83	0.18	0.04	1.1	29x131	0.23	0.04	2.2
12x35	0.13	0.06	0.4	22x95	0.19	0.04	1.3	29x143	0.24	0.04	2.3
12x47	0.14	0.06	0.5	22x107	0.20	0.04	1.4	36x23	0.15	0.06	0.9
12x59	0.16	0.06	0.5	22x119	0.22	0.04	1.5	36x29	0.16	0.07	1.0
12x71	0.17	0.06	0.6	22x131	0.23	0.04	1.6	36x35	0.12	0.02	1.1
12x83	0.18	0.06	0.6	22x143	0.24	0.05	1.8	36x47	0.14	0.02	1.3
12x95	0.19	0.06	0.7	26x23	0.13	0.06	0.6	36x59	0.15	0.02	1.5
12x107	0.21	0.06	0.7	26x29	0.13	0.04	0.7	36x71	0.16	0.03	1.7
12x119	0.22	0.06	0.8	26x35	0.13	0.04	0.8	36x83	0.17	0.03	1.9
12x131	0.23	0.06	0.9	26x47	0.14	0.04	1.0	36x95	0.19	0.03	2.1
12x143	0.25	0.06	0.9	26x59	0.15	0.04	1.1	36x107	0.20	0.03	2.3
18x23	0.13	0.05	0.5	26x71	0.16	0.04	1.2	36x119	0.21	0.03	2.5
18x29	0.13	0.05	0.6	26x83	0.18	0.04	1.4	36x131	0.22	0.03	2.7
18x35	0.13	0.05	0.6	26x95	0.19	0.04	1.5	36x143	0.24	0.03	2.9
18x47	0.14	0.05	0.6	26x107	0.20	0.04	1.6	43x23	0.15	0.06	1.1
18x59	0.15	0.05	0.7	26x119	0.22	0.04	1.8	43x29	0.16	0.07	1.2
18x71	0.17	0.05	0.8	26x131	0.23	0.04	1.9	43x35	0.12	0.02	1.3
18x83	0.18	0.05	1.0	26x143	0.24	0.04	2.1	43x47	0.13	0.02	1.5
18x95	0.19	0.05	1.1	29x23	0.14	0.06	0.7	43x59	0.15	0.02	1.8
18x107	0.21	0.05	1.1	29x29	0.13	0.03	0.8	43x71	0.16	0.02	2.0
18x119	0.22	0.05	1.2	29x35	0.13	0.03	0.9	43x83	0.17	0.02	2.3
18x131	0.23	0.05	1.3	29x47	0.14	0.03	1.1	43x95	0.18	0.02	2.5
18x143	0.24	0.05	1.5	29x59	0.15	0.03	1.2	43x107	0.20	0.02	2.8
22x23	0.11	0.04	0.6	29x71	9.16	0.03	1.4	43x119	0.21	0.02	3.0
22x29	0.12	0.04	0.6	29x83	0.18	0.03	1.5	43x131	0.22	0.02	3.2
22x35	0.13	0.04	0.6	29x95	0.19	0.03	1.7	43x143	0.23	0.02	3.5
22x47	0.14	0.04	0.8	29x107	0.20	0.03	1.9				
22x59	0.15	0.04	0.9								

For single embossed, multiply above chart by 7.
Shaded boxes indicate 320 headers.

FLOW RATE VS. PRESSURE DROP FOR VISCOUS FLUIDS FOR STYLE 60D AND STYLE 50D 3/4" PASS SIZE PLATECOIL

THIS CURVE SUPPLEMENTS THE CURVES ON PAGE 84, SEE EXAMPLE ON PAGE 82.

Fig. 85-1



NOTE: Pressure drops for single embossed = 7 times double embossed.

PRESSURE DROP DATA FOR STYLE 30D LARGE PASS *SERPENTINE* PLATECOIL

FOR WATER, OR EQUIVALENT, AT 60°F.

Style 30 PLATECOIL.
Details are on page 20 and 21.

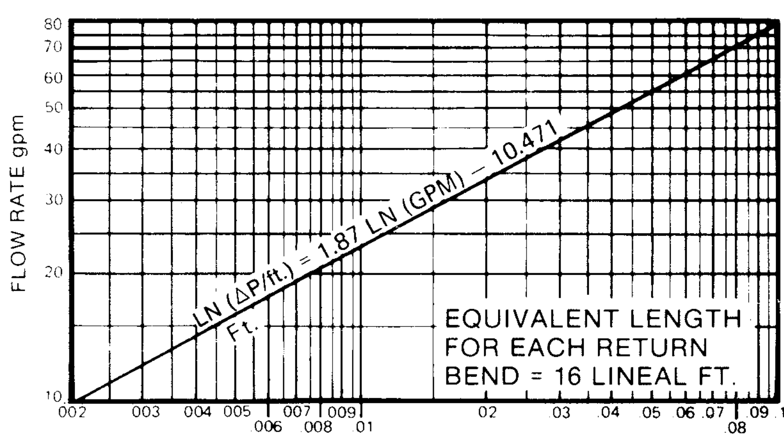


Fig. 85-2
Note: See Fig. 87-1 for Flow Rate vs. Velocity.
Pressure drop for single embossed = 7 x double embossed.

HEAT LOSS DATA

HEAT LOSS FOR STORAGE TANKS AND PRODUCT CORRECTION FACTORS

Heat loss expressed as U (BTU/hr. sq. ft.°F)
Δt = Product temperature minus air temperature.
Fig. 86-1

Surface Condition	Still Air	10 mph	15 mph	20 mph	25 mph	30 mph
	General Range of Δt = 60°F					
(*) Uninsulated	1.8	4.1	4.7	5.2	5.7	6.1
1" Insulation	0.18	0.20	0.20	0.21	0.21	0.21
1 1/2" Insulation	0.13	0.14	0.14	0.14	0.14	0.14
2" Insulation	0.10	0.11	0.11	0.11	0.11	0.11
	General Range of Δt = 100°F					
(*) Uninsulated	2.1	4.4	5.1	5.7	6.1	6.5
1" Insulation	0.18	0.20	0.20	0.21	0.21	0.21
1 1/2" Insulation	0.13	0.14	0.14	0.14	0.14	0.14
2" Insulation	0.10	0.11	0.11	0.11	0.11	0.11
	General Range of Δt = 200°F					
(*) Uninsulated	2.7	5.1	5.7	6.4	6.8	7.4
1" Insulation	0.19	0.21	0.21	0.21	0.22	0.22
1 1/2" Insulation	0.13	0.15	0.15	0.15	0.15	0.15
2" Insulation	0.11	0.11	0.11	0.11	0.11	0.11

NOTES:
A k value of 0.23 was used in calculating U for insulated tanks. The example, page 70, illustrates a typical application of U values in solving storage tank heating problems.
Calculated from data in Oil and Gas Journal's "The Refiner's Notebook," No. 125, by Prof. W. L. Nelson.

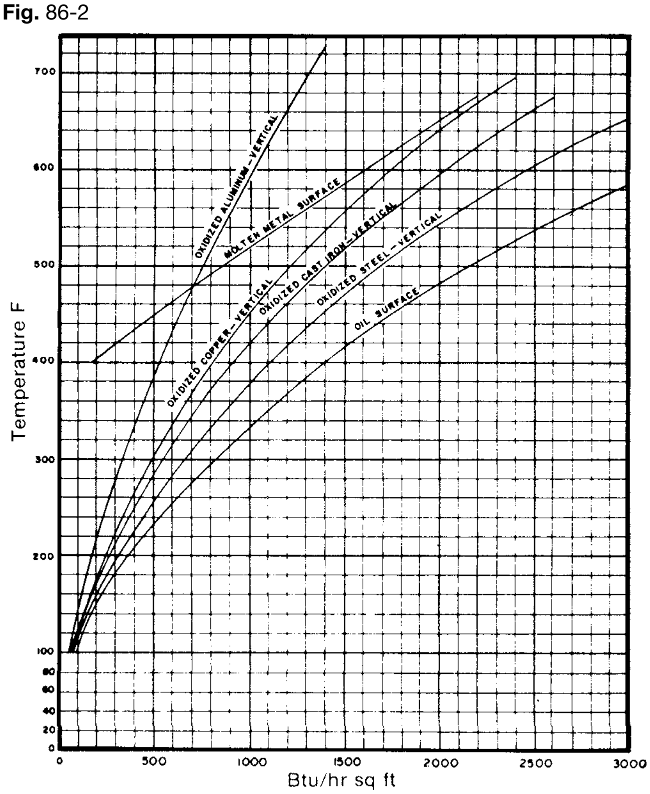
(*) Product correction factors. Apply to uninsulated U values only.

Product	Approximate Product Temp.		
	75°F	150°F	250°F
Watery solutions	1.00	1.00	1.00
Gasoline, Kerosene, etc.	0.90	0.90	0.90
Light oils	0.80	0.85	0.90
Medium oils	0.70	0.75	0.80
Heavy oils	0.60	0.65	0.70
Asphalts, Tars, etc.	0.50	0.55	0.60
Gases or Vapor spaces	0.50	0.50	0.50

U values as listed for insulated tanks, apply to all products without correction.

HEAT LOSS FROM SMOOTH SURFACES

Fig. 86-2



Total heat loss rates based on 72°F ambient temperature and still air.

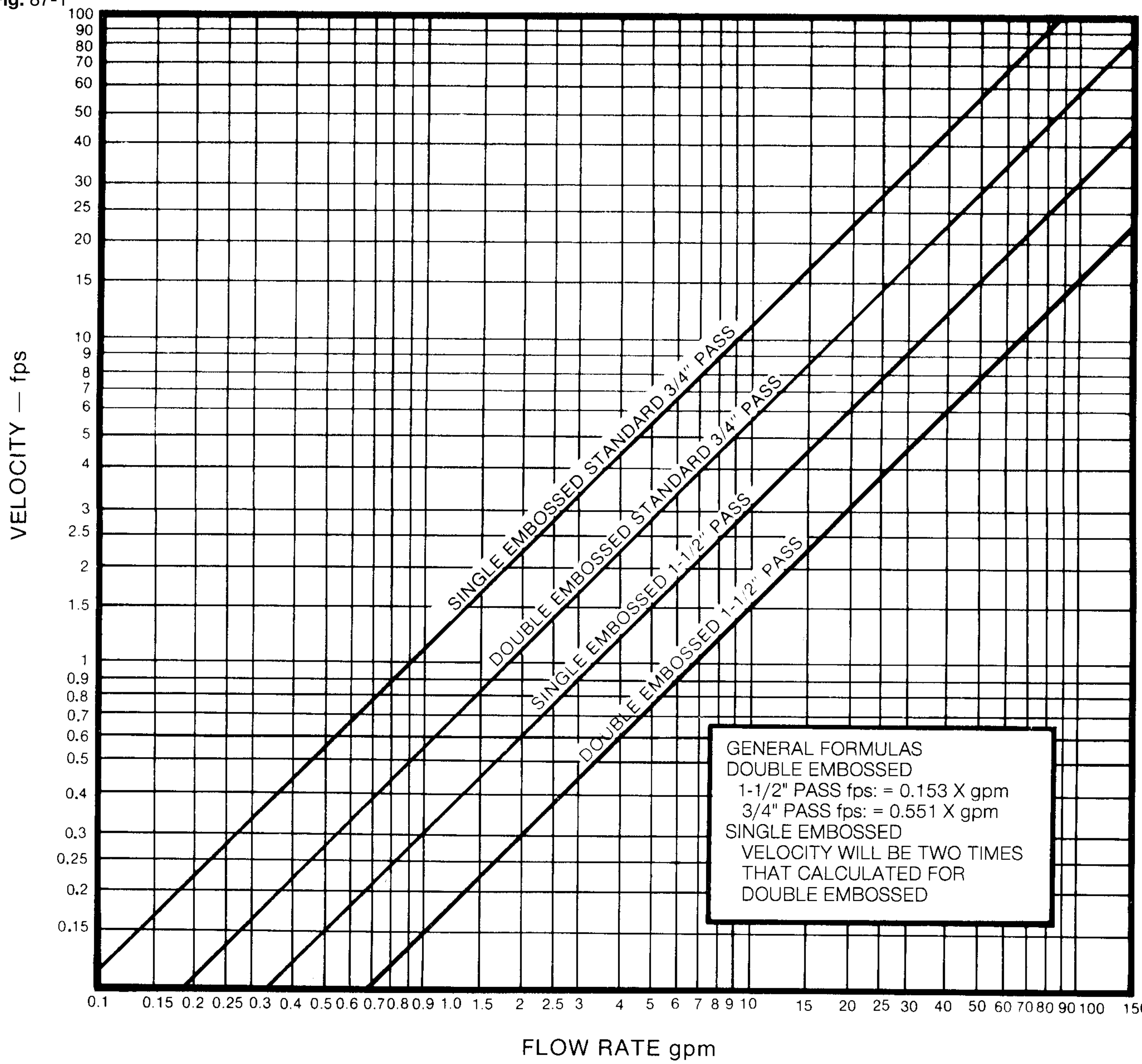
HEAT LOSS FROM WATER SURFACE AT VARIOUS WATER TEMPERATURES AND AIR VELOCITIES

Fig. 86-3 Air Temperatures, 60°F. Relative Humidity, 70%

	AIR VELOCITY - FEET PER SECOND							
Water Temp °F	0	0.5	1	2	5	10	20	50
	HEAT LOSS — Btu/hr. sq. ft.							
60	7	18	21	26	34	56	95	180
70	33	52	60	78	105	170	270	580
80	78	110	125	150	210	315	510	1050
90	130	180	210	240	330	490	780	1600
100	205	270	320	350	480	710	1150	2300
110	290	370	420	480	670	1000	1600	3300
120	400	500	570	660	930	1350	2200	4400
130	550	660	750	890	1240	1800	3000	6000
140	710	870	970	1150	1600	2400	4000	8000
150	950	1130	1260	1510	2100	3200	5300	10500
160	1230	1450	1600	2000	2700	4050	6900	13700
170	1600	1900	2100	2600	3700	5200	9100	18500
180	2050	2600	2900	3550	5000	7200	12500	25000
190	2600	3550	4000	4950	6900	10300	17500	35000
200	3300	5200	5700	7000	9760	14600	25600	50000
210	4300	7200	8100	10000	14000	21000	36600	72000

FLOW RATE vs. VELOCITY Through PLATECOIL Passes

Fig. 87-1



For more detailed calculations involving fluid flow and heat transfer the following data are presented. They apply to styles 50, 60, 70, and 90, i.e., 0.582 and 0.291 sq. in. pass cross sections for double and single embossed, respectively.

Fig. 87-2

	Double Embossed	Single Embossed
Wetted perimeter	3.3030 in.	2.9952 in.
Hydraulic radius	0.0146 ft.	0.0081 ft.
Hydraulic diameter	0.0584 ft.	0.0322 ft.

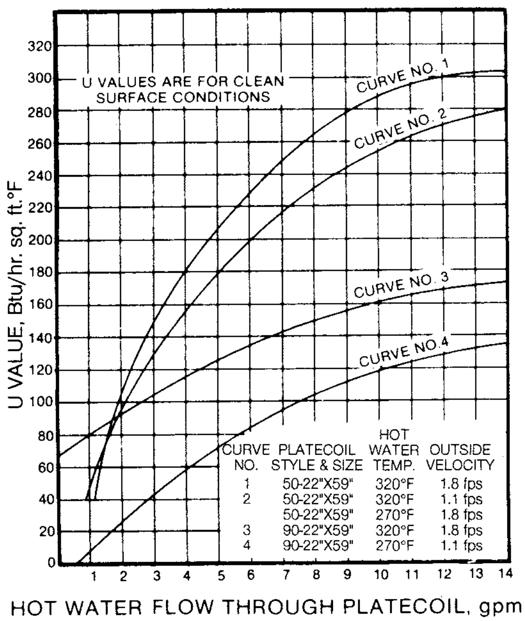
HIGH TEMPERATURE HOT WATER DATA

The curves shown on this page are the result of heat transfer tests. This data supplements page 78 and is useful for applications involving high temperature hot water and for heating air.

HIGH TEMPERATURE HOT WATER (HTHW)

Effect of water flow rate and temp. on U value - for heating water flowing at unifom velocity over outside of PLATECOIL.

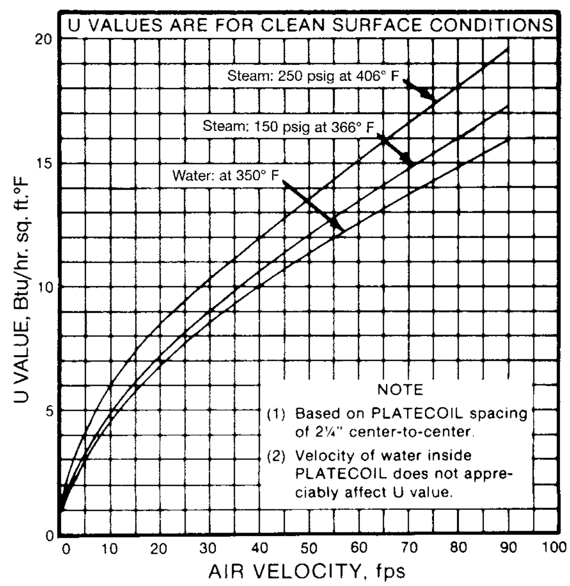
Fig. 88-1
U Value vs. Velocity



U VALUES FOR HEATING AIR

Heating air with steam and high temp. hot water - variation of U value with air velocity.

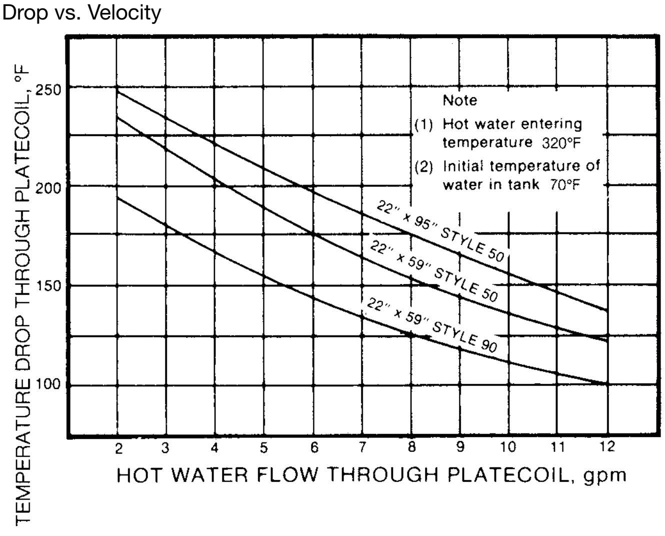
Fig. 88-2
U Value vs. Velocity



HIGH TEMPERATURE HOT WATER U VALUES AND TEMPERATURE DROP DATA

High temperature hot water. Temp. drop of hot water flowing through PLATECOIL vs. flow rate.

Fig. 88-3
Temperature Drop vs. Velocity



Thermodynamic Properties of Saturated Steam

Fig. 89-1 To facilitate trap calculaton, values in this table are shown in nearest even digits.

GAUGE PRESSURE PSIG	TEMPERATURE (°F)	Btu/lb.			SPECIFIC VOLUME cu. ft./lb. sat. vapor
		Heat of Liquid	Latent Heat of Evaporation	Total Heat of Steam	
28 (Vacuum, In Hg)	101	68	1037	1105	339.0
26	126	93	1023	1116	177.0
24	141	109	1014	1122	121.0
22	152	120	1007	1127	92.0
20	162	130	1001	1131	75.0
18	169	137	997	1134	63.0
16	176	144	993	1137	55.0
14	182	150	989	1139	48.0
12	187	155	986	1141	43.0
10	192	160	983	1143	39.0
8	197	165	980	1145	36.0
6	201	169	977	1146	33.0
4	205	173	975	1148	31.0
2	209	177	972	1149	29.0
0	212	180	970	1150	27.0
1	216	183	968	1151	25.0
2	219	187	965	1152	24.0
3	222	190	964	1154	22.5
4	224	193	962	1155	21.0
5	227	195	961	1156	20.0
6	230	198	959	1157	19.5
7	232	201	957	1158	18.5
8	235	203	956	1159	18.0
9	237	206	954	1160	17.0
10	240	208	952	1160	16.5
15	250	218	945	1163	14.0
20	259	227	940	1167	12.0
25	267	236	934	1170	10.5
30	274	243	929	1172	9.5
35	281	250	924	1174	8.5
40	287	256	920	1176	8.0
45	292	262	915	1177	7.0
50	298	267	912	1179	6.7
55	303	272	908	1180	6.2
60	307	277	905	1182	5.8
65	312	282	901	1183	5.5
70	316	286	898	1184	5.2
75	320	290	895	1185	4.9
80	324	294	892	1186	4.7
85	328	298	889	1187	4.4
90	331	302	886	1188	4.2
95	335	306	883	1189	4.0
100	338	309	881	1190	3.9
110	344	316	876	1192	3.6
120	350	322	871	1193	3.3
125	353	325	868	1193	3.2
130	356	328	866	1194	3.1
140	361	334	861	1195	2.9
150	366	339	857	1196	2.7
160	371	344	853	1197	2.6
170	375	348	849	1197	2.5
180	380	353	845	1198	2.3
190	384	358	841	1199	2.2
200	388	362	837	1199	2.1
220	395	370	830	1200	2.0
240	403	378	823	1201	1.8
250	406	381	820	1201	1.75
260	409	385	817	1202	1.7
280	416	392	811	1203	1.6
300	422	399	805	1204	1.5
350	436	414	790	1204	1.3
400	448	428	776	1204	1.1
450	460	441	764	1205	1.0
500	470	453	751	1204	0.90
600	489	475	728	1203	0.75

Steam Pipe Capacities

Fig. 89-2 For 30 psig and 150 psig Steam Systems capacity in pounds per hour (using sch. 40 iron pipe)

Std. Pipe Size (in.)	30 psig System			150 psig System		
	Drop In Pressure - Lb./100 Ft. Length					
	1/4 Lb.	1/2 Lb.	1 Lb.	1/4 Lb.	1/2 Lb.	1 Lb.
3/4	22	31	45	41	58	82
1	46	63	89	82	117	165
1 1/4	100	141	199	185	262	370
1 1/2	154	219	309	287	407	575
2	313	444	627	583	825	1170
2 1/2	516	730	1030	959	1360	1920
3	940	1330	1880	1750	2480	3500
3 1/2	1410	2000	2830	2630	3720	5250
4	2000	2830	4000	3720	5260	7430
5	3640	5230	7390	6880	9730	13800
6	6030	8590	12100	11300	16000	22600
8	12600	17900	25300	23500	33200	47000

From: Heating, Ventilating, Air Conditioning Guide 1958, P. 544.
Note: While the pressure drop to use depends on individual circumstances, a drop of 1/2 lb. will usually be satisfactory.

REFRIGERATION DATA

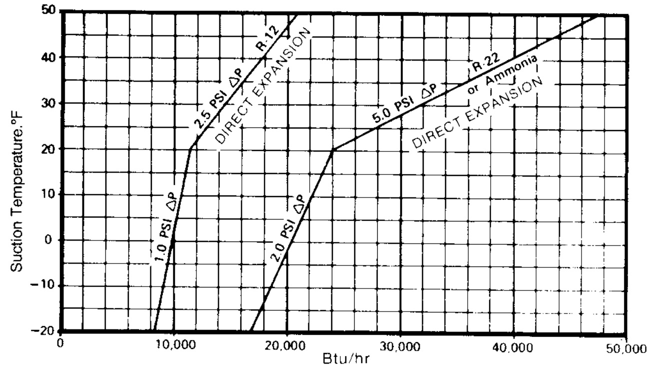
ALLOWABLE MAXIMUM REFRIGERATION LOADINGS

For One Style 60 - 22” x 143” PLATECOIL - Double Embossed (3/4” Pass).

Combinations of temp. and Btu/hr. to the left of the curves are acceptable from a pressure drop standpoint. For PLATECOIL sizes different from 22” x 143”, multiply the Btu/hr. by the factors in Fig. 90-2.

(Do not use this chart to replace $A = \frac{Q}{(U)(\Delta t)}$ Calculation.)

Fig. 90-1



Size Factors for Refrigeration Loading

Fig. 90-2 Capacities for single embossed PLATECOIL will be 1/7th of those for double embossed.

Size (in.)	Factor	Size (in.)	Factor	Size (in.)	Factor	Size (in.)	Factor	Size (in.)	Factor	Size (in.)	Factor	Size (in.)	Factor
43 x 143	0.5	36 x 143	0.6	29 x 143	0.7	26 x 143	0.8	22 x 143	1.0	18 x 143	1.2	12 x 143	2.0
43 x 131	0.5	36 x 131	0.6	29 x 131	0.8	26 x 131	0.9	22 x 131	1.1	18 x 131	1.3	12 x 131	2.2
43 x 119	0.6	36 x 119	0.7	29 x 119	0.9	26 x 119	1.0	22 x 119	1.2	18 x 119	1.4	12 x 119	2.4
43 x 107	0,6	36 x 107	0.8	29 x 107	1.0	26 x107	1.1	22 x 107	1.3	18 x 107	1.6	12 x 107	2.6
43 x 95	0.7	36 x 95	0.9	29 x 95	1.1	26 x 95	1.2	22 x 95	1.5	18 x 95	1.8	12 x 95	2.9
43 x 83	0.8	36 x 83	1.0	29 x 83	1.2	26 x 83	1.4	22 x 83	1.6	18 x 83	2.0	12 x 83	3.3
43 x 71	0.9	36 x 71	1.1	29 x 71	1.4	26 x 71	1.6	22 x 71	1.9	18 x 71	2.0	12 x 71	3.8
43 x 59	1.1	36 x 59	1.3	29 x 59	1.6	26 x 59	1.8	22 x 59	2.2	18 x 59	2.6	12 x 59	4.4
43 x 47	1.3	36 x 47	1.6	29 x 47	1.9	26 x 47	2.2	22 x 47	2.6	18 x 47	3.2	12 x 47	5.4
43 x 35	1.6	36 x 35	1.9	29 x 35	2.4	26 x 35	2.8	22 x 35	3.3	18 x 35	4.0	12 x 35	6.8
43 x 29	1.8	36 x 29	2.2	29 x 29	2.8	26 x 29	3.2	22 x 29	3.7	18 x 29	4.3	12 x 29	7.8
43 x 23	2.1	36 x 23	2.6	29 x 23	3.2	26 x 23	3.7	22 x 23	4.4	18 x 23	5.3	12 x 23	9.2

Temperature Pressure Chart - Various Refrigerants

Fig 90-3 Figures outside shaded area in inches of mercury, in shaded area in psig. (1 Ton) of Refrigeration = 12,000 Btu.

F	C	R-12	R-502	Ammonia	R-22	F	C	R-12	R-502	Ammonia	R-22
-100	-73.3	27.0		27.4	25.1	0		9.2	31.2	15.7	24.2
-95	-70.6	26.4		26.8	24.1	5	-17.8	11.8	36.2	19.6	28.4
-90	-67.8	25.7		26.1	23.0	10	-15.0	14.7	41.1	23.8	33.0
-85	-65.0	25.0		25.3	21.7	15	-12.2	17.7	46.6	28.4	37.7
-80	-62.2	24.1	17.1	24.3	20.2	20	-9.4	21.1	52.4	33.5	43.3
-75	-59.4	23.0	15.0	23.2	18.5	25	-6.7	24.6	58.8	39.0	49.0
-70	-56.7	21.8	12.6	21.9	16.6	30	-3.9	28.5	65.4	45.0	55.3
-65	-53.9	20.5	10.0	20.4	14.4	32	-1.1	30.1	—	47.6	58.0
-60	-51.1	19.0	7.0	18.6	11.9	35	0	32.6	72.6	51.0	62.0
-55	-48.3	17.3	3.7	16.6	9.1	40	1.7	37.0	80.2	58.6	69.0
-50	-45.6	15.4	0.0	14.3	6.0	45	4.4	41.7	88.4	66.3	77.0
-45	-42.8	13.3	2.1	11.7	2.6	50	7.2	48.7	96.9	74.5	84.7
-40	-40.0	11.0	4.3	8.7	0.6	55	10.0	52.0	106.1	83.4	93.2
-35	-37.2	8.3	6.7	5.4	2.7	60	12.8	57.7	115.6	92.9	102.5
-30	-34.4	5.5	9.4	1.6	5.0	65	15.6	63.7	125.9	103.1	112.0
-25	-31.7	2.3	12.4	1.3	7.5	70	18.7	70.1	.136.6	114.1	122.5
-20	-28.9	0.6	15.5	3.6	10.3	75	21.1	76.9	148.1	125.8	133.8
-15	-26.0	2.5	19.0	6.2	13.3	80	23.9	84.1	159.9	138.3	145.0
-10	-23.2	4.5	22.8	9.0	16.6	85	26.7	91.7	172.6	151.7	158.0
-5	-20.5	6.8	26.9	12.2	20.3	86	29.4	93.2	-	154.5	160.4
						90	30.0	99.6	185.8	165.9	170.1
							32.2				

Technical Reference Data

PROPERTIES OF VARIOUS HEAT TRANSFER MEDIA

Fig. 91 -1

Medium	Temperature Range	Normally used as	Temp. F	Den. lb./ cu. ft. Liq.	Sp. ht. Btu/lb.F	k/ft.	Vis. CP Liq.	Vapor Press. psia	MP F	BP F
PARATHERM HE	150 to 600F	Liquid	150	53.0	0.511	0.0750	11.0			
			400	46.4	0.650	0.0688	0.58			
			600	41.1	0.760	0.0640	0.15	0.87		
SYLTHERM XLT	-100 to +500F	Liquid	-100	57.8	0.336	0.0651	12.6		-135	
			200	48.4	0.438	0.0588	0.60	1.2		
			500	35.2	0.541	0.0526	0.20	75.8		
THERMINOL 55	0 to 575F	Liquid	100	54.8	0.472	0.0784	25.4	0.010		
			300	50.1	0.572	0.0724	1.69	0.193		
			500	45.5	0.670	0.0661	0.58	1.93		
MINERAL OIL (Mobiltherm Light)	-15 to +460F	Liquid	50 200 400	61.4 58.2 54.0	0.412 0.483 0.578	0.0685 0.0675 0.0632	10.8 1.6 0.57	 0.044 4.4		
ETHYLENE GLYCOL (Aqueous Solution - 20% By Weight)	20 - 210F	Liquid	20 100 200	64.2 63.5 61.3	0.828 0.875 0.926	0.295 0.305 0.324	4.77 1.17 0.46		17	215
ETHYLENE GLYCOL (Aqueous Solution - 60% By Weight)	-70 to +225F	Liquid	50 100 200	67.5 66.4 64.0	0.641 0.687 0.777	0.225 0.221 0.214	8.7 3.32 0.90		-74	230
ETHYLENE GLYCOL (100% By Weight)	15 - 380F	Liquid	50 150 300	70.0 68.9 63.4	0.555 0.646 0.772	0.172 0.148 0.111	34 4.6 1.1	 0.035 3.0	9	387

MP - Melting Point CP - Centipoise k - Thermal Conductivity, Btu/sq. ft. BP - Boiling Point

FRICTION LOSS IN PIPE FITTINGS IN TERMS OF EQUIVALENT FEET OF STRAIGHT PIPE

This data may be applied to any liquid or gas

Fig. 91-2

Nominal Pipe Size D. Std. Wt.	Actual Inside Dia. (in.)	Gate Valve FULL OPEN	45 Elbow	Long-swee-Elbow or Run of Std. Tee	Std. Elbow or Run of Tee Reduced 1/2	Std. Tee through Side Outlet	Close Return Bend	Swing Check Valve FULL OPEN	Angle Valve FULL OPEN	Globe Valve FULL OPEN	Equivalent Resistance of Standard Weight Welding Elbows Length of Straight Pipe (ft.) 1*			
											90 Degree Elbows		45 Degree Elbows	
											Short Radius R/D = 1	Long Radius R/D = 1 1/2	Short Radius R/D = 1	Long Radius R/D = 1 1/2
Resistance factor		.19	.42	.6	.9	1.8	2.2	2.3	5.	10.				
1/2	.622	.35	.78	1.11	1.7	3.3	4.1	4.3	9.3	18.6	+	0.68	+	0.44
3/4	.824	.44	.97	1.4	2.1	4.2	5.1	5.3	11.5	23.1	+	0.91	+	0.58
1	1.049	.56	1.23	1.8	2.6	5.3	6.5	6.8	14.7	29.4	1.6	1.15	1.01	0.74
1 1/4	1.380	.74	1.6	2.3	3.5	7.0	8.5	8.9	19.3	38.6	2.1	1.5	1.33	0.98
1 1/2	1.610*	.86	1.9	2.7	4.1	8. 1	9.9	10.4	22.6	45.2	2.4	1.8	1.6	1.14
2	2.067	1.10	2.4	3.5	5.2	10.4	12.8	13.4	29	58	3.1	2.3	2.0	1.5
2 1/2	2.469	1.32	2.9	4.2	6.2	12.4	15.2	15.9	35	69	3.7	2.7	2.4	1.7
3	3.068	1.6	3.6	5.2	7.7	15.5	18.9	19.8	43	86	4.7	3.4	3.0	2.2
4	4.026	2.1	4.7	6.8	10.2	20.3	24.8	26.0	57	113	6.1	4.4	3.9	2.9
5	5.047	2.7	5.9	8.5	12.7	25.4	31	33	71	142	7.7	5.6	4.9	3.6
6	6.065	3.2	7.1	10.2	15.3	31	37	39	85	170	9.2	6.7	5.9	4.3
7	7.024	3.7	8.3	11.8	17.7	35	43	45	98	197	++	++	++	++
8	7.981	4.3	9.4	13.4	20.2	40	49	52	112	224	12.1	8.8	7.7	5.7
10	10.020	5.3	11.8	16.9	25.3	51	62	65	141	281	15.2	11.0	9.7	7.1
12	12.000	6.4	14.1	20.2	30	61	74	77	168	336	18.2	13.2	11.6	8.5
14		7.5	16.5	23.5	35	71	86	96			20.1	14.6	12.8	9.4
16		8.5	18.8	26.9	40	81	99	104			23.1	16.8	14.7	10.8
18		9.6	21.2	30	45	91	111	116			26.2	19.0	16.7	12.2
20		10.7	23.5	34	50	101	123	129			29	21.2	18.6	13.6
24		12.8	28.2	40	61	121	148	155			35	25.6	22.5	16.5
30		16.0	35.3	50	76	151	185	193			44	32	28.3	20.7
36		19.2	42.4	61	91	181	222	232			53	39	34	25.0
42		22.4	49.4	71	106	212	259	271			63	45	40	29.2
48		25.6	57.6	81	121	242	296	310			72	52	46	33

Data on fittings based on information published by Crane Co.
* For 180 degree bend multiply values for 90 degree bend by 1.34.
Data are based on Fanning coefficient of 0.006 as taken from Chart No. 18 of Catalog 211 of Tube Turns. Inc.
\+ Short Radius elbows R/DN = l not made in this size and weight.
\++ Not made in this size.

PHYSICAL PROPERTIES

Viscosity Conversion Table

The following table will give a comparison of various viscosity ratings so that if the viscosity is given in terms other than Saybolt Universal, it can be translated quickly by following horizontally to the Saybolt Universal column.

Fig. 92-1

Seconds Saybolt Universal ssu	Kinematic Viscosity Centistokes *	Seconds Saybolt Fural ssf	Seconds Redwood 1 (Standard)	Seconds Redwood 2 (Admiralty)	Degrees Engler	Degrees Barbey	Seconds Saybolt Universal ssu	Kinematic Viscosity Centistokes *	Seconds Saybolt Fural ssf	Seconds Redwood 1 (Standard)	Seconds Redwood 2 (Admiralty)	Degrees Engler	Degrees Barbey
31	1.00		29.0		1.00	6200.0	700	154	71.1	592	64.6	20.45	40.30
35	2.56		32.1		1.16	2420.0	800	176	81.0	677	73.8	23.35	35.20
40	4.30		36.2	5.10	1.31	1440.0	900	198	91.0	762	83.0	26.30	31.30
50	7.40		44.3	5.83	1.58	838.0	1000	220	100.7	896	92.1	29.20	28.20
60	10.30		52.3	6.77	1.88	618.0	1500	330	150.0	1270	138.2	43.80	18.70
70	13.10	12.95	60.9	7.60	2.17	483.0	2000	440	200.0	1690	184.2	58.40	14.10
80	15.70	13.70	69.2	8.44	2.45	404.0	2500	550	250.0	2120	230.0	73.00	11.30
90	18.20	14.44	77.6	9.30	2.73	348.0	3000	660	300.0	2540	276.0	87.60	9.40
100	20.60	15.24	85.6	10.12	3.02	307.0	4000	880	400.0	3380	368.0	117.00	7.05
150	32.10	19.30	128.0	14.48	4.48	195.0	5000	1100	500.0	4230	461.0	146.00	5.64
200	43.20	23.50	170.0	18.90	5.92	144.0	6000	1320	600.0	5080	553.0	175.00	4.70
250	54.00	28.00	212.0	23.45	7.35	114.0	7000	1540	700.0	5920	645.0	204.50	4.03
300	65.00	32.50	254.0	28.00	8.79	95.0	8000	1760	800.0	6770	737.0	233.50	3.52
400	87.60	41.90	338.0	37.10	11.70	70.8	9000	1980	900.0	7620	829.0	263.00	3.13
500	110.00	51.60	423.0	46.20	14.60	56.4	10000	2200	1000.0	8460	921.0	292.00	2.82
600	132.00	61.40	508.0	55.40	17.50	47.0	15000	3300	1500.0	13700		438.00	2.50
							20000	4400	2000.0	18400		584.00	1.40

$$\text{*Kinematic Viscosity (in centistokes)} = \frac{\text{Absolute Viscosity (in centipoises)}}{\text{Specific Gravity}}$$

Relation of A.P.I. Hydrometer Scale to Specific Gravity

Fig. 92-2

Degrees API	Specific Gravity	Degrees API	Specific Gravity	Degrees API	Specific Gravity	Degrees API	Specific Gravity	Degrees API	Specific Gravity	Degrees API	Specific Gravity	Degrees API	Specific Gravity
10	1.0000	25	.9042	40	.8251	55	.7587	70	.7022	85	.6536	140	.521
11	.9930	26	.8984	41	.8203	56	.7547	71	.6987	86	.6506	145	.512
12	.9861	27	.8927	42	.8156	57	.7507	72	.6953	87	.6476	150	.503
13	.9792	28	.8871	43	.8109	58	.7467	73	.6919	88	.6446	160	.486
14	.9725	29	.8816	44	.8063	59	.7428	74	.6886	89	.6417	170	.469
15	.9659	30	.8762	45	.8017	60	.7389	75	.6852	90	.639	180	.454
16	.9593	31	.8708	46	.7972	61	.7351	76	.6819	95	.625		
17	.9529	32	.8654	47	.7927	62	.7313	77	.6787	100	.611		
18	.9465	33	.8602	48	.7883	63	.7275	78	.6754	105	.598		
19	.9402	34	.8550	49	.7839	64	.7238	79	.6722	110	.586		
20	.9340	35	.8498	50	.7796	65	.7201	80	.6690	115	.574		
21	.9279	36	.8448	51	.7753	66	.7165	81	.6659	120	.563		
22	.9218	37	.8398	52	.7711	67	.7128	82	.6628	125	.552		
23	.9159	38	.8348	53	.7669	68	.7093	83	.6597	130	.541		
24	.9100	39	.8299	54	.7628	69	.7057	84	.6566	135	.531		

TERMS USED TO EXPRESS SPECIFIC GRAVITY EQUIVALENTS AND TO CONVERT TO SPECIFIC GRAVITY

Specific Gravity (sp. gr.) of liquids and solids is the density compared to water at 39.2°F and of gases, density compared with air at 32°F and 14.7 lb. per sq. in. absolute.

Degrees Baume (°Bé), arbitrary calibration of hydrometer for liquids.

Degrees API (°API) arbitrary calibration used by petroleum industry for liquids lighter than water.

Degrees Brix (also called Fisher), arbitrary graduation so graduated that 1° Brix = I% sugar in solution.

Degrees Twaddell (°Tw), arbitrary calibration used for certain liquids heavier than water.

TO CONVERT TO SPECIFIC GRAVITY-

	Liquids lighter than water		Liquids heavier than water
SP. gr. =	$\frac{140}{°Bé + 130}$	=	$\frac{145}{145 - °Bé}$
SP. gr. =	$\frac{141.5}{°API + 131.5}$		
SP. gr. =	$\frac{400}{°Brix + 400}$		
SP. gr. =			$\frac{°Tw + 200}{200}$

For density conversion tables see Chemical Engineer's Handbook, 3rd ed., p. 38.

TEMPERATURE CONVERSION - Centigrade vs. Fahrenheit

Fig. 93-1

0 to 100						100 to 1000						1000 to 2000						2000 to 3000					
C	*	F	C	*	F	C	*	F	C	*	F	C	*	F	C	*	F	C	*	F	C	*	F
-17.8	0	32.0	10.0	50	122.0	38	100	212	260	500	932	538	1000	1832	816	1500	2732	1093	2000	3632	1371	2500	4532
-17.2	1	33.8	10.6	51	123.8	43	110	230	266	510	950	543	1010	1850	821	1510	2750	1099	2010	3650	1377	2510	4550
-16.7	2	35.6	11.1	52	125.6	49	120	248	271	520	968	549	1020	1868	827	1520	2768	1104	2020	3668	1382	2520	4568
-16.1	3	37.4	11.7	53	127.4	54	130	266	277	530	986	554	1030	1886	832	1530	2786	1110	2030	3686	1388	2530	4586
-15.5	4	39.2	12.2	54	129.2	60	140	284	282	540	1004	560	1040	1904	838	1540	2804	1116	2040	3704	1393	2540	4604
-15.0	5	41.0	12.8	55	131.0	66	150	302	288	550	1022	566	1050	1922	843	1550	2822	1121	2050	3722	1399	2550	4622
-14.4	6	42.8	13.3	56	132.8	71	160	320	293	560	1040	571	1060	1940	849	1560	2840	1127	2060	3740	1404	2560	4640
-13.9	7	44.6	13.9	57	134.6	77	170	338	299	570	1058	577	1070	1958	854	1570	2858	1132	2070	3758	1410	2570	4658
-13.3	8	46.4	14.4	58	136.4	82	180	356	304	580	1076	582	1080	1976	860	1580	2876	1138	2080	3776	1416	2580	4676
-12.8	9	48.2	15.0	59	138.2	88	190	374	310	590	1094	588	1090	1994	866	1590	2894	1143	2090	3794	1421	2590	4694
-12.2	10	50 0	15.6	60	140.0	93	200	392	316	600	1112	593	1100	2012	871	1600	2912	1149	2100	3812	1427	2600	4712
-11.7	11	51.8	16.1	61	141.8	99	210	410	321	610	1130	599	1110	2030	877	1610	2930	1154	2110	3830	1432	2610	4730
-11.1	12	53.6	16.7	62	143.6	100	212	413	327	620	1148	604	1120	2048	882	1620	2948	1160	2120	3848	1438	2620	4748
-10.5	13	55.4	17.2	63	145.4	104	220	428	332	630	1166	610	1130	2066	888	1630	2966	1166	2130	3866	1443	2630	4766
-10.0	14	57.2	17.8	64	147.2	110	230	446	338	640	1184	616	1140	2084	893	1640	2984	1171	2140	3884	1449	2640	4784
-9.44	15	59.0	18.3	65	149.0	116	240	464	343	650	1202	621	1150	2102	899	1650	3002	1177	2150	3902	1454	2650	4802
-8.89	16	60.8	18.9	66	150.8	121	250	482	349	660	1220	627	1160	2120	904	1660	3020	1182	2160	3920	1460	2660	4820
-8.33	17	62.6	19.4	67	152.6	127	260	500	354	670	1238	632	1170	2138	910	1670	3038	1188	2170	3938	1466	2670	4838
-7.78	18	64 4	20.0	68	154.4	132	270	518	360	680	1256	638	1180	2156	916	1680	3056	1193	2180	3956	1471	2680	4856
-7.22	19	66.2	20.6	69	156.2	138	280	536	366	690	1274	643	1190	2174	921	1690	3074	1199	2190	3974	1477	2690	4874
-6.67	20	68.0	21.1	70	158.0	143	290	554	371	700	1292	649	1200	2192	927	1700	3092	1204	2200	3992	1482	2700	4892
-6.11	21	69.8	21.7	71	159.8	149	300	572	377	710	1310	654	1210	2210	932	1710	3110	1210	2210	4010	1488	2710	4910
-5.56	22	71.6	22.2	72	161.6	154	310	590	382	720	1328	660	1220	2228	938	1720	3128	1216	2220	4028	1493	2720	4928
-5.00	23	73.4	22.8	73	163.4	160	320	608	388	730	1346	666	1230	2246	943	1730	3146	1221	2230	4046	1499	2730	4946
-4.44	24	75.2	23.3	74	165.2	166	330	626	393	740	1364	671	1240	2264	949	1740	3164	1227	2240	4064	1504	2740	4964
-3.89	25	77.0	23.9	75	167.0	171	340	644	399	750	1382	677	1250	2282	954	1750	3182	1232	2250	4082	1510	2750	4982
-3.33	26	78.8	24.4	76	168.8	177	350	662	404	760	1400	682	1260	2300	960	1760	3200	1238	2260	4100	1516	2760	5000
-2.78	27	80.6	25.0	77	170.6	182	360	680	410	770	1418	688	1270	2318	966	1770	3218	1243	2270	4118	1521	2770	5018
-2.22	28	82.4	25.6	78	172.4	188	370	698	416	780	1436	693	1280	2336	971	1780	3236	1249	2280	4136	1527	2780	5036
-1.67	29	84.2	26.1	79	174.2	193	380	716	421	790	1454	699	1290	2354	977	1790	3254	1254	2290	4154	1532	2790	5054
-1.11	30	86.0	26.7	80	176.0	199	390	734	427	800	1472	704	1300	2372	982	1800	3272	1260	2300	4172	1538	2800	5072
-0.56	31	87.8	27.2	81	177.8	204	400	752	432	810	1490	710	1310	2390	988	1810	3290	1266	2310	4190	1543	2810	5090
0.00	32	89.6	27.8	82	179.6	210	410	770	438	820	1508	716	1320	2408	993	1820	3308	1271	2320	4208	1549	2820	5108
0.56	33	91.4	28.3	83	181.4	216	420	788	443	830	1526	721	1330	2426	999	1830	3326	1277	2330	4226	1554	2830	5126
1.11	34	93.2	28.9	84	183.2	221	430	806	449	840	1544	727	1340	2444	1004	1840	3344	1282	2340	4244	1560	2840	5144
1.67	35	95.0	29.4	85	185.0	227	440	824	454	850	1562	732	1350	2462	1010	1850	3362	1288	2350	4262	1566	2850	5162
2.22	36	96.8	30.0	86	186.8	232	450	842	460	860	1580	738	1360	2480	1016	1860	3380	1293	2360	4280	1571	2860	5180
2.78	37	98.6	30.6	87	188.6	238	460	860	466	870	1598	743	1370	2498	1021	1870	3398	1299	2370	4298	1577	2870	5198
3.33	38	100.4	31.1	88	190.4	243	470	878	471	880	1616	749	1380	2516	1027	1880	3416	1304	2380	4316	1582	2880	5216
3.89	39	102.2	31.7	89	192.2	249	480	896	477	890	1634	754	1390	2534	1032	1890	3434	1310	2390	4334	1588	2890	5234
4.44	40	104.0	32.2	90	194.0	254	490	914	482	900	1652	760	1400	2552	1038	1900	3452	1316	2400	4352	1593	2900	5252
5.00	41	105.8	32.8	91	195.8				488	910	1670	765	1410	2570	1043	1910	3470	1321	2410	4370	1599	2910	5270
5.56	42	107.6	33.3	92	197.6				493	920	1688	771	1420	2588	1049	1920	3488	1327	2420	4388	1604	2920	5288
6.11	43	109.4	33.9	93	199.4				499	930	1706	777	1430	2606	1054	1930	3506	1332	2430	4406	1610	2930	5306
6.67	44	111.2	34.4	94	201.2				504	940	1724	782	1440	2624	1060	1940	3524	1338	2440	4424	1616	2940	5324
7.22	45	113.0	35.0	95	203.0				510	950	1742	788	1450	2642	1066	1950	3542	1343	2450	4442	1621	2950	5342
7.78	46	114.8	35.6	96	204.8				516	960	1760	793	1460	2660	1071	1960	3560	1349	2460	4460	1627	2960	5360
8.33	47	116.6	36.1	97	206.6				521	970	1778	799	1470	2678	1077	1970	3578	1354	2470	4478	1632	2970	5378
8.89	48	118.4	36.7	98	208.4				527	980	1796	804	1480	2696	1082	1980	3596	1360	2480	4496	1638	2980	5396
9.44	49	120.2	37.2	99	210.2				532	990	1814	810	1490	2714	1088	1990	3614	1366	2490	4514	1643	2990	5414
			37.8	100	212.0				538	1000	1832				1093	2000	3632				1649	3000	5432

Note: - The numbers in column* refer to the temperature either in degrees Centigrade or Fahrenheit which it is desired to convert into the other scale . If converting from Fahrenheit degrees to Centigrade degrees, the equivalent temperature will be found in the left column, while if converting from degrees Centigrade to degrees Fahrenheit, the answer will be found in the column on the right.

INTERPOLATION FACTORS

C	*	F	C	*	F
0.56	1	1.8	3.33	6	10.8
1.11	2	3.6	3.89	7	12.6
1.67	3	5.4	4.44	8	14.4
2.22	4	7.2	5.00	9	16.2
2.78	5	9.0	5.56	10	18.0

Conversion Formulas:

$$\frac{c}{100} = \frac{F-32}{180} = \frac{\text{Kelvin} - 273.16}{100} = \frac{\text{Rankine} - 491.7}{180} = \frac{\text{Reaumur}}{80}$$

USEFUL CONVERSION FACTORS (SEE FIG. 94-1 FOR OTHER CONVERSIONS)

Weight, Area, Volume

1 cu. ft. water = 62.4 lb. @ 39.2°F
1 US gal. = 8.33 lb. water @ 39.2°F
1 US gal. = 231 cu. in. = 0.134 cu. ft. = 0.833 Imp. gal.
1 Imp. gal. = 277.4 cu. in. = 1.2 US gal.
1 lb. = 453.6 grams (g) = 0.454 kilograms (kg)
1 kg = 1000 g = 2.2 lb.
1 cu. ft. = 1728 cu. in. = 7.48 US gal. = 6.23 Imp. gal.
1 slug = 32.2 lb.
1 gal. = 0.13368 cu. ft.

Pressure and Flow

1 Atmosphere (atm) = 14.7 psia
1 lb./sq. in. = 2.04 in Hg @ 62°F = 2.31 ft. water @ 62°F
1 Bar = 14.5 lb./sq. in. = 100 kPa
psia = paig + 14.7
g/cm3 = sp. gr.
sp. gr. x 62.4 = lb./cu. ft.
1 gpm = 0.134 cu. ft./min.= 500 lb./hr. x sp. gr.
1 cu.ft./min. (cfm) = 444.8 gal./hr. (gph)
1 centipoise = 2.42 lb./ft. hr.
1 lb./ft. sec. = 1488 centipoises = 3600 lb./ft. hr.

Work and Power

1 hp = 0.745 kw = 42.4 Btu/min. = 2544 Btu/hr. = 33,000 ft. lb./min.
1 boiler hp (bhp) = 33,475 Btu/hr.
1 kw = 1000 watts (w) = 1.341 hp = 56.88 Btu/min. = 3413 Btu/hr.
1 kw hr. = 1000 w hr. = 3413 Btu
1 Btu = 0.029 kw hr. = 778 ft. lb. = 0.555 pcu (lb. C unit)

Temperature Scales

Kelvin temp. scale = C + 273.16
Rankine temp. scale = F + 459.7

Heat Transfer

1 Btu/hr. ft^2 °F = 0.0001355 g-cal./sec. cm^2 °C
1 g-cal./sec. cm^2 C = 7380 Btu/hr. ft^2 °F

Thermal Conductivity

1 Btu/hr. ft^2 °F/ft. = 0.00413 g-cal./sec. cm^2 °C/cm
1 g-cal./sec. cm^2 C/cm = 242 Btu/hr. ft2 °F/ft.

METRIC CONVERSION TABLES

(See Fig. 93-2 for other conversions)

Fig. 94-1

TO OBTAIN	MULTIPLY	BY
Atmospheres	Kg/sq. meter	0,000096784
Btu	Kg-cal.	3.9685
Btu/kw hr.	Kg.cal./kw hr.	3.9685
Btu/(hr.)(ft.)(deg F)	Cal./(sec.)(sm)(deg C)	241.9
Btu/(hr.)(sq. ft.)	Cal./(sec.)(sq. cm)	13273
Btu/(hr.)(sq. ft.)(deg F)	Kg-cal./(hr.)(sq. m)(deg C)	0.205
Btu/(hr.)(sq. ft.) (deg F per in)	Kg-cal./(hr.)(sq. m) (deg C per cm)	0.080639
Btu/lb.	Kg cal./kg	1.8
Btu/(lb.)(deg F)	Cal./(gram)(deg C)	1
Btu/sq. ft.	Kg-cal./sq. meter	0.36867
Cal./gram	Btu/lb.	0.55556
Cal/(sec.)(cm)(deg C)	Btu/(hr.)(ft)(deg F)	0.0041336
Cal/(sec.)(sq. cm)	Btu/(hr.)(sq. ft.)	0.000075341
Cal(sec.)(sq. cm)(deg C)	Btu/(hr.)(sq. ft.)(deg F)	0.0001355
Centimeters	Inches	2.54
Cm of Hg @ 0 deg C	Atmospheres	76
Cm of Hg @ 0 deg C	Ft.of H2O @ 39.2°F	2.242
Cm of Hg @ 0 deg C	In. of H2O @ 39.2°F	0.1868
Cm of Hg @ 0 deg C	Lb./sq. in.	5.1715
Cm of Hg @ 0 deg C	Lb./sq. ft.	0.035913
Cm/deg C	In./deg F	4.572
Cm/sec.	Ft. min.	0.508
Cm of H2O @ 39.2°F	Lb./sq. in.	70.31
Cu. cm	Cu. ft.	28317
Cu. cm	Gal. (USA, liq.)	3785.43
Cu. cm	Quarts (USA, liq.)	946.358
Cu. cm/sec.	Cu. ft./min.	472
Cu. ft.	Cu. meters	35.314
Cu. ft./min.	Cu. meters.sec.	2118.9
Cu. ft./lb.	Cu. meters/kg	16.02
Cu. ft./lb.	Liters/kg	0.01602
Cu. ft./sec.	Cu. meters/min.	0.5886
Cu. ft./sec.	Liters/min.	0.0005886
Cu. in.	Cu. centimeters	0.061023
Cu. in.	Liters	61.03
Cu. meters	Cu. ft.	0.028317
Cu. meters	Cu. yards	0.7646
Cu. meters	Gal. (USA, liq)	0.0037854
Cu. meters/hr.	Gal./min.	0.22712
Cu. meters/kg	Cu. ft./lb.	0.062428
Cu. meters/min.	Cu. ft./min.	0.02832
Cu. meters/min.	Cal./sec.	0.22712
Cu. yards	Cu. meters	1.3079
Feet	Meters	3.281
Ft. of H2O @ 39.2°F	Atmospheres	33,899
Ft. of H2O @ 39.2°F	Cm. of Hg @ 0 deg C	0.44604
Ft. of H2O @ 39.2°F	Kf/sq. meter	0.003281
Ft./min.	Cm/sec.	1.9685
Ft./min.	Km/hr.	54.68
Ft./sec.	Km/hr.	0.9113
Ft./sec	Meters/sec.	3.2808
Ft./(sec.)(sec.)	Km/(hr.)(sec.)	0.91133
Ft./(sec.)(sec.)	Meters/(sec.)(sec.)	3.2808
Ft./lb.	Kf-calories	3087.4
Ft. lb./min.	Kg cal./min.	3087.4
Gal. (USA, liq.)	Barrels (Petroleum USA)	42
Gal. (USA, liq.)	Cu. meters	264.173
Gal. (USA, liq.)	Liters	0.2642

TO OBTAIN	MULTIPLY	BY
Gal.(USA, liq.)/min.	Cu. meters hr.	4.4029
Gal.(USA, liq.)/sec.	Liters min.	0.0044028
Grams	Ounces (avoir)	28.35
Grams/cu. cm	Lb../cu ft.	0.016018
Inches	Centimeters	0.3937
Inches	Microns	0.00003937
Inches of Hg @ 32°F	Kg/sq. meter	0.0028959
Inches of Hg @ 32°F	In. of H2O @ 39.2°F	0.07355
Inches/deg F	Cm/deg C	0.21872
Joules	Btu	1054.8
Joules	Kg-meters	9.807
Kg	Pounds (avoir)	0.45359
Kg-cal.	Btu	0.252
Kg-cal./kg	Btu/lb.	0.5556
Kg-cal./kw hr.	Btu/kw hr.	0.252
Kg-cal./min.	Kw	14.33
Kg-cal./sq. meter	Btu/sq. ft.	2.712
Kg-meters	Btu	107.56
Kg/cu. meter	Lb./cu. ft.	16.018
Kg/(hr.)(meter)	Centipoises	3.6
Kg/liter	Lb./gal. (USA, liq.)	0.11983
Kg/sq. cm	Atmospheres	1.0332
Kg/sq. cm	Lb./sq. in	0.0703
Kg/sq. meter	In Hg @ 32°F	345.31
Kg/sq. meter	Lb./sq. ft.	4.8824
Km/hr.	Ft./min.	0.018288
Km/hr.	Miles/hr.	1.609
Kw/hr.	Btu	0.000293
Liters	Cu. ft.	28.316
Liters	Gal. (Imperial Liq.)	4.546
Liters/kg	Cu. ft./lb.	62.42621
Liters/min.	Gal. (USA, liq.)/min.	3.785
Liters/sec.	Gal./min.	0.063088
Meters	Feet	0.3048
Meters/min.	Ft./min.	0.3048
Meters/sec.	Ft./sec.	0.3048
Millimeters/gram	Cu. ft./lb.	62.42621
Millimeters	Microns	0.001
Mils	Inches	1000
Minutes	Radians	3437.75
Ounces (avoir)	Grains (avoir)	0.0022857
Ounces (avoir)	Grams	0.035274
Part/million	Gr./gal. (USA, liq.)	17.118
Pounds (avoir)	Grams	0.0022046
Pounds (avoir)	Kg	2.2046
Pounds/cu. ft.	Kg/cu. meter	0.062428
Pounds/cu. in.	Grams/cu. cm	0.036127
Pounds/ft.	Kg/meter	0.67197
Pounds/(hr.)(ft.)	Centipoises	2.42
Pounds/sq. inch	In Hg@32°F	0.491
Pounds/sq. inch	kg/sq. cm	14.223
Pounds/sq. ft.	Kg/sq. meter	0.20481
Pounds/sq. inch	Bar	14.5
Quarts (USA, liq.)	Liters	1.057
Sq. Centimeters	Sq. ft.	929
Sq. ft.	Sq. meters	10.764
Sq. meters	Sq. ft.	0.0929
Tons (metric)	Tons (short)	0.9072
Yards	Meters	1.0936

DIMENSIONS AND PROPERTIES OF STEEL PIPE AND TUBE

PIPE

Fig. 95-1

Nominal Pipe Size (NPS) (in.)	Outside Diameter (in.)	Schedule No. See Note 1	Wall Thick-ness	Inside Diameter (in.)	External Surface sq. ft. per ft. length	Weight Lbs. per ft.	Internal CSA See Note 2 sq. ft.	Working Pressure PSIA
1/8	0.41	40 (s)	0.068	0.269	0.106	0.244	0.00039	314
	0.41	80 (x)	0.095	0.215	0.106	0.314	0.00025	1084
1/4	0.54	40 (s)	0.088	0.364	0.141	0.424	0.00072	649
	0.54	80 (x)	0.119	0.302	0.141	0.535	0.00050	1353
3/8	0.68	40 (s)	0.091	0.493	0.177	0.567	0.00133	574
	0.68	80 (x)	0.126	0.423	0.177	0.738	0.00098	1191
1/2	0.84	40 (s)	0.109	0.622	0.220	0.850	0.00211	697
	0.84	80 (x)	0.147	0.546	0.220	1.00	0.00163	1266
	0.84	xx	0.294	0.252	0.220	1.71	0.00035	3824
3/4	1.05	40 (s)	0.113	0.824	0.275	1.13	0.00370	604
	1.05	80 (x)	0.154	0.742	0.275	1.47	0.00300	1078
	1.05	xx	0.308	0.434	0.275	2.44	0.00103	3134
1	1.315	40 (s)	0.133	1.049	0.344	1.68	0.00600	651
	1.315	80 (x)	0.179	0.957	0.344	2.17	0.00500	1083
	1.315	xx	0.358	0.599	0.344	3.66	0.00196	2963
1 1/4	1.66	40 (s)	0.140	1.380	0.435	2.27	0.01039	440
	1.66	80 (x)	0.191	1.278	0.435	3.00	0.00891	805
	1.66	xx	0.382	0.896	0.435	5.21	0.00438	2318
1 1/2	1.90	40 (s)	0.145	1.610	0.497	2.72	0.01414	417
	1.90	80 (x)	0.200	1.500	0.497	3.65	0.01227	756
	1.90	xx	0.400	1.100	0.497	6.41	0.00660	2122
2	2.375	40 (s)	0.154	2.067	0.622	3.65	0.02330	376
	2.375	80 (x)	0.218	1.939	0.622	5.02	0.02051	690
	2.375	xx	0.436	1.503	0.622	9.03	0.01232	1861
2 1/2	2.875	40 (s)	0.203	2.469	0.753	5.79	0.03325	505
	2.875	80 (x)	0.276	2.323	0.753	7.66	0.02943	806
	2.875	xx	0.552	1.771	0.753	13.70	0.01711	2048
3	3.50	40 (s)	0.216	3.068	0.916	7.57	0.05134	454
	3.50	80 (x)	0.300	2.900	0.916	10.30	0.04587	734
	3.50	xx	0.600	2.300	0.916	18.50	0.02885	1829
3 1/2	4.00	40 (s)	0.226	3.548	1.050	9.11	0.06866	425
	4.00	80 (x)	0.318	3.364	1.050	12.50	0.06172	692
	4.00	xx	0.636	2.728	1 050	22.90	004059	1699
4	4.50	40 (s)	0.237	4.026	1.180	10.80	0.08840	403
	4.50	80 (s)	0.337	3.826	1.180	14.90	0.07984	663
	4.50	xx	0.674	3.152	1.180	27.50	0.05419	1602
5	5.563	40 (s)	0.258	5.047	1.460	14.60	0.13898	498
	5.563	80 (x)	0.375	4.813	1.460	20.80	0.12635	825
	5.563	xx	0.750	4.063	1.460	38.60	0.09004	1951
6	6,625	40 (s)	0.280	6.065	1.730	18.00	0.20063	467
	6.625	80 (x)	0.432	5.761	1.730	28.60	0.18102	825
	6.625	xx	0.864	4.897	1.730	53.10	0.13079	1912
8	8.625	30 (s)	0.277	8.071	2.260	24.70	0.35529	351
	8.625	40 (s)	0.322	7.981	2.260	28.60	0.34741	431
	8.625	80 (x)	0.500	7.625	2.260	43.40	0.31711	753
	8.625	xx	0.875	6.875	2.260	72.40	0.25779	1460
10	10.75	(s)	0.279	10.19	2.810	31.20	0.56656	285
	10.75	30 (s)	0.307	10.14	2.810	34.20	0.56035	324
	10.75	40 (s)	0.365	10.02	2.810	40.50	0.54760	405
	10.75	60 (x)	0.500	9.750	2.810	54.70	0.51849	600
12	12.75	30 (s)	0.330	12.09	3.340	43.80	0.79722	299
	12.75	(s)	0.375	12.00	3.340	49.60	0.78540	352
	12.75	(x)	0.500	11.75	3.340	65.40	0.75301	503
14	14.00	30 (s)	0.375	13.25	3.670	54.60	0.95754	458
	14.00	(x)	0.500	13.00	3.670	72.10	0.92175	653
16	16.00	30 (s)	0.375	15.25	4.180	62.40	1.26843	400
	16.00	40 (x)	0.500	15.00	4.180	82.80	1.22718	570
18	18.00	(s)	0.375	17.25	4.710	70.60	1.62295	355
	18.00	(x)	0.500	17.00	4.710	93.50	1.57625	506
20	20.00	20 (s)	0.375	19.25	5.230	78.60	2.02110	319
	20.00	30 (s)	0.500	19.00	5.230	104.20	1.96895	454
24	24.00	20	0.375	23.25	6.290	94.60	2.94831	265
	24.00	(s)	0.500	23.00	6.290	125.50	2.88525	378

TUBE

Fig. 95-2

Outside Diameter (in.)	B.W.G. Gage	Wall Thickness (in.)	Inside Diameter (in.)	External Surface sq. ft. per ft. length	Weight Lbs. per ft.	Internal CSA See Note 2 sq. ft.
1/4	22	0028	0.194	0.0655	0.067	0.00021
	24	0.022	0.206	0.0655	0.054	0.00023
	26	0.018	0.214	0.0655	0.045	0.00025
3/8	18	0.049	0.277	0.0982	0.173	0.00042
	20	0.035	0.305	0.0982	0.139	0.00051
	22	0.028	0.319	0.0982	0.105	0.00056
	24	0.022	0.331	0.0982	0.083	0.00060
1/2	16	0.065	0.370	0.1309	0.3020	0.00075
	18	0.049	0.402	0.1309	0.2360	0.00088
	20	0.035	0.430	0.1309	0.1738	0.00101
	22	0.028	0.444	0.1309	0.1411	0.00108
	24	0.022	0.456	0.1309	0.1123	0.00113
9/16	21	0.032	0.498	0.1473	0,183	0.00135
5/8	10	0.134	0.357	0.1636	0.703	0.00070
	11	0.120	0.385	0.1636	0.647	0.00081
	12	0.109	0.407	0.1636	0.605	0.00090
	13	0.095	0.435	0.1636	0.540	0.00103
	14	0.083	0.458	0.1636	0.481	0.00114
	15	0.072	0.481	0.1636	0.430	0.00126
	16	0.065	0.495	0.1636	0.390	0.00135
	18	0.049	0.527.	0.1636	0.301	0.00151
	20	0.035	0.555	0.1636	0.220	0.00168
3/4	10	0.134	0.482	0.1963	0.882	0.00127
	11	0.120	0.510	0.1963	0.810	0.00142
	12	0.109	0.532	0.1963	0.750	0.00154
	13	0.095	0.560	0.1963	0.670	0.00171
	14	0.083	0.584	0.1963	0.591	0.00186
	15	0.072	0.606	0.1963	0.522	0.00200
	16	0.065	0.620	0.1963	0.480	0.00210
	17	0.058.	0.634	0.1963	0.429	0.00219
	18	0.049	0.652	0.1963	0.367	0.00232
	20	0.035	0.680	0.1963	0.267	0.00252
7/8	8	0.165	0.545	0.2297	1.251	0.00162
	10	0.134	0.607	0.2297	1.060	0.00201
	11	0.120	0.635	0.2297	0.968	0.00220
	14	0.083	0.709	0.2297	0.702	0.00274
	16	0.065	0.745	0.2297	0.562	0.00303
	18	0.049	0.777	0.2297	0.432	0.00329
	20	0.035	0.805	0.2297	0.314	0.00353
1	8	0.165	0.670	0.2618	1.471	0.00245
	10	0.134	0.732	0.2618	1.240	0.00292
	11	0.120	0.760	0.2618	1.130	0.00315
	12	0.109	0.782	0.2618	1.040	0.00334
	13	0.095	0.810	0.2618	0.920	0.00358
	14	0.083	0.834	0.2618	0.813	0.00379
	15	0.072	0.856	0.2618	0.714	0.00400
	16	0.065	0.870	0.2618	0.650	0.00413
	18	0.049	0.902	0.2618	0.500	0.00444
	20	0.035	0.930	0.2618	0.361	0.00472
1 1/4	7	0.180	0.890	0.3272	2.057	0.00432
	8	0.165	0.920	0.3272	1.912	0.00462
	10	0.134	0.982	0.3272	1.597	0.00526
	11	0.120	1.010	0.3272	1.450	0.00556
	12	0.109	1.032	0.3272	1.328	0.00581
	13	0.095	1.060	0.3272	1.172	0.00613
	14	0.083	1.084	0.3272	1 040	0.00641
	16	0.065	1.120	0.3272	0.823	0.00684
	17	0.058	1.134	0.3272	0.738	0.00701
	18	0.049	1.152	0.3272	0.629	0.00724
	20	0.035	1.180	0.3272	0.454	0.00759
1 1/2	10	0.134	1.232	0.3927	1.980	0.00828
	12	0.109	1.282	0.3927	1.640	0.00896
	14	0.083	1.334	0.3927	1.280	0.00971
	16	0.065	1.370	0.3927	0.996	0.01024
2	11	0.120	1.760	0.5236	2.450	0.01689
	13	0.095	1.810	0.5236	1.933	0.01787
2 1/2	9	0.148	2.200	0.0654	3.820	0.02640

Note 1: The letters “s”, “x” and “xx” in column of Schedule Numbers indicate Standard, Extra Strong and Double Strong Pipe, respectively.
Note 2: The values shown in sq. ft. for the Internal Area also represent the volume in cubic feet per foot of pipe length.

PHYSICAL PROPERTIES - LIQUIDS AND MISC.

Fig. 96-1

	mol wt.	sp. gr. 60-70°F	sp. ht. 60°F	mp F	bp F	LH	k	Viscosity centipoises				Viscosity SSU			
								4.4°C 40°F	26.7°C 80°F	49°C 120°F	71°C 160°F	4.4°C 40°F	26.7°C 80°F	49°C 120°F	71°C 160°F
Acids															
Acetic acid, 100%	60	1.05	.48	62	245	175*	.095	1.65	1.18	0.85	0.65				
Acetic acid, 10%		1.01	.96												
Fatty acid - oleic	282	0.89		13	547		.092								
Fatty acid, palmitic	256	0.853	.653	146	520	21.8	.083								
Fatty acid,stearic	284	0.847	.550	157	721	26.4	.078								
Hydrochloric acid 31.5% (muriatic)		1.15	.6	-57				2.5	1.85	1.42	1.1				
Hydrochloric acid 10% (muriatic)		1.05	.75												
Nitric acid, 95%		1.50	.5	44	187			1.45	1.05	.8	.61				
Nitric acid, 60%		1.37	.64	9.4				3.4	2.2	1.5	1.05				
Nitric acid, I0%		1.05	.9												
Phenol (carbolic acid)	94	1.07	.56	106	346	16.1	.18	14.5	7.3	3.9	2.1				
Phosphoric acid, 20%		1.11	.85												
Phosphoric acid 10%		1.05	.93												
Sulfuric acid, 110% (Fuming)			.27	92	342			82.0	41.0	22.0	12.2	280	100	55	
Sulfuric acid, 98%		1.84	.35	28.6	625	219*	.15	46.0	23.0	11.5	6.4	118	68	45	37
Sulfuric acid, 60%		1.50	.52	-70	282		.24	8.9	5.8	3.9	2.7				
Sulfuric acid, 20%		1.14	.84	8	218		.31	2.5	1.4	0.8	0.55				
Water solutions															
Brine - calcium chloride, 25%		1.23	.689	-21			.28	4.5	2.1	.95	0.52				
Brine - sodium chloride, 25%		1.19	.786	16	221		.24	3.3	2.1	1.3	.92				
Sea water, 3 5% saline		1.03	.94				.33		1.61						
Sodium Hydroxide, 50% (caustic soda)		1.53	.78		288		.38	250.0	77.0	26.0	9.5	950	240	84	46
Sodium Hydroxide, 30%		1.33	.84						9.6	4.5	2.5				
Water	18	1.0	1.0	32	212	144	.34	1.55	0.86	0.56	0.4				
Food Products**															
Dextrose, corn syrup 40 Baume		1.38	.572		225		.23	(Viscosity varies with Dextrose Equivalent)				170000	11000	1700	430
Dextrose. corn syrup 45 Baume		1.45	.514		237								2x10/6	120000	12000
Fish, fresh, avg.			.76			101									
Fruit, fresh, avg.			.88			120									
Honey			.34			30	.31		8000	500					
Ice		.9	.5			144									
Ice cream			.70			96									
Lard		.92	.64			22						10000	450	155	88
Maple syrup			.48			52									
Meat, fresh, avg.			.70			90									
Milk, 4%		.99	.97			124	.35	1.9	1.0	.64	.44				
Molasses, primary A		1.43	.6									35833	15000	7267	1799
Molasses, secondary B		1.45											70000	10000	
Molasses,. blackstrap (final) C		1.47											300000	25000	
Corn Starch 25 Baume		1.21										2673	1170	600	346
Sucrose, 60% sugar syrup		1.29	.74	10	218			156	41.0	14.0	7.0	500	150	68	
Sucrose, 40% sugar syrup		1.18	.66	25	214			120	5.0	2.5	1.6				
Sugar, cane & beet		1.66	.3			72									
Vegetables, fresh, avg.			.92			130									
Wines, table and dessert, avg.		1.03	.90	7 to 22			.30	2.1	1.2	.83	.61				
Petroleum Products															
Asphalt, RS-1, MS-1, SS-1. emulsion		1.0	.42						86	34	17		400	160	85
Asphalt, RC-0, MC-0, SC-0, cut back													950	340	150
Asphaft: RC-3, MC-3, SC-3, cut back													40000	7000	1600
Asphalt, RC-5, MC-5, SC-5, cut back													500000	45000	8000
Asphalt, 100-120 penetration		1.0											3500 AT 250F		
Asphalt, 40-50 penetration		1.01											8000 AT 250F		
Benzene	78	.844	.41	42	176	170*	0.087	.8	.62	.46	0.30				
Gasoline		.6	.53			140*	0.078	.7	.55	.44	0.35				
No. 1Fuel Oil (Kerosene)		.811	.47			110*	0.084	3.3	2.1	1.4	0.95	40	36		
No. 2 Fuel Oil, - PS100		.865	.44				0.08	4.6	2.6	1.6	1.15	43	36	33	32
No. 3 Fuel Oil, - PS200		.887	.43				0.078	15.0	7.0	4.0	2.9	84	52	41	37
No. 4 Fuel Oil		.901	.42				0.075	92.0	24.0	9.6	5.0	480	125	62	42
No 5 Fuel Oil, - PS300		.937	.41				0.072		390.0	75.0	25.0		1600	370	125
No. 6 Fuel Oil, - Bunker C, - PS400		.956	.40				0.070		1000.0	155	40.0		4500	680	180
Transformer oil, light		.898	.42				0.075	34.2	12.1	6.3	3.9	170	72	49	40
Transformer oil, medium		.91	.42					89.0	28.2	11.9	6.7	460	145	70	50
34 API Mid-continent crude		.855	.44				0.08	15	6.5	3.0	2.0	88	51	37	34
28 API gas oil		.887	.42				0.078	25	9.0	6.0	4.0	135	59	48	41
Quench and tempering oil		.91	.49				.085								
SAE - 5W (#8 machine lube oil)		.88	.45				.08	110	30	12	7	550	160	74	51
SAE - 10W (#10 machine lube oil)		.88	.42					170	50	22	11	1500	265	120	64
SAE - 20 (#20 machine lube oil)		.89						580	98	33	14	2900	500	170	80
SAE - 30 (#30 machine lube oil)		.89						1200	200	60	25	5000	870	260	110
SAE - 40		.90										8500	1400	380	150
SAE - 50		.90							400	100	45	23000	3600	720	225
Paraffin, melted		.9	.69	100-133	660-800	70	0.14								
Toluene	92	.862	.42	-139	231	157*	0.084	.75	.57	.45	.36				
Miscellaneous															
Acetone, 100%	58	.789	.514	-137	133	225*	.096	.04	.032	0.26	0.21				
Alcohol, ethyl 95%		,81	.6			370*	.11	2.0	1.3	.8	0.53				
Alcohol, methyl. 90%		.82	.65				.13	1.0	0.73	.53	0.43				
Ammonia, 100%	17	.77	1.1	-106	-27	589*	.29	0.14	0.1	0.08	0.06				
Ammonia, 26%		.905	1.0				.26	1.8	1.2						
Arocior		1.44	.28		650		0.057	2000	200	.32	10	20000	500	95	48844
Cotton seed oil		.95	.47				.1	35.3	33.3	31.3	29.4				
Creosote	(see coal tars)														
Dowtherm A	166	.995	.63	54	500	123	.08	4.5	3.2	2.15	1.42				
Dowtherm C	231	1.10	.35-.65	70-220	600		.08								
Ethylene glycol	62	1.11	.58	9.5	387	346*	.153	44.0	19.0	9.0	4.5	185	86	53	39
Glue, 2 parts water, I part dry glue		1.09	.89												
Glycerol, 100% (glycerin)	92	1.26	.58	62.5	554	340*	164		490.0	130.0	56.0	25000	3100	700	230
Glycerol, 50%		1.13	.80	-6.5			.24	11.0	5.4	2.8	1.5				
Linseed oil		.93	.44	-5.0	532			72	37	20	11				
Phthalic anhydride	148	1.53	.232	267	544	66									
Soybean oil		.92	.24-.33	3-14					45.0						
Sulfur, melted	32	1.8	.34	239	832										
Tricholorethylene	166	1.62	.215	-99	189	90	.070	.7	0.58	0.46	0.4				
Turpentine, spirits of	136	.86	.42	14	320	184*	.074	1.9	1.35	0.95	0.7				
Carbon tetrachloride	154	1.58	.21	-95	170	84*	.095	1.3	0.95	0.72	0.56				

* This figure is latent heat of vaporization.
** sp. ht. of food products are for above freezing.
Below freezing the values are approx. 60% of those given.

mol wt. - molecular weight
sp. ht. - Btu/lb. F
mp - melting point, F
bp - boiling point, F

LH - latent heat of fusion, Btu/lb.
k - thermal conductivity, Btu/sq. ft. hr. F/ft.

PHYSICAL PROPERTIES - Solids

Fig. 97-1

	Weight	sp. gr. @ 60°F	sp. ht. @ 60°F	k/ft.	mp
Aluminum	165	2.64	0.23	117	1216
Asbestos board	55	0.88	0.19	0.096	
Asphalt, solid	81	1.1 to 1.5	0.22 to 0.4	0.43	250
Brickwork & Masonry	112	1.6 to 2.0	0.22	0.4	
Calcium silicate	11	0.177		0.027	
Celatex	16			0.027	
Clay, dry	137 avg.	1.9 to 2.4	0.224	0.072	3160
Coal	90 avg.	1.2 to 1.8	0.26 to 0.37		
Coal tars	75 avg.	1.2	0.35 @ 40°C		
Coke, solid	75 avg.	1.0 to 1.4	0.265	3.4	
Copper	556	8.92	0.1	220	1981
Cork	15	0.25	0.48	0.025	
Cotton cloth	93	1.5	0.32	0.03	
Glass, pyrex	140	2.25	0.2	0.63	
Glass, wool	4.5	0.072	0.157	0.0225	
Ice	56	0.9	0.5	1.41	32
Lead	710	11.34	0.031	20	621
Leather	59 avg.	0.86 to 1.02	0.36	0.092	
Magnesia 85%	13	0.208	0.27	0.034	
Nickel	537	8.9	0.11	36	2651
Paper	58 avg.	0.7 to 1.15	0.45	0.075	
Paraffin	54 to 57	0.86 to 0.91	0.62	0.14	100 to 140
Rubber, vulcanized	69	1.1	0.415	0.1	
Sand	90 to 105	1.4 to 1.70	0.19	0.19	
Silk	97	1.25 to 1.35	0.33	0.03	
Steel, mild @ 70°F	490	7.9	0.11	26	2507
Steel, mild @ 1600°F			0.16	18	
Steel, stainless, 300 series	501	8.04	0.12	9.4	2550
Styrofoam	1.3 to 2.0			0.02	
Sulfur	125	2	0.203	0.1	230
Titanium (commercial)	282	4.5	0.13	11	3135
Woods, vary from	28 to 49	0.35 to 0.9	0.45 to 0.65	0.1	
Wool	82	1.32	0.325	0.02	
Zinc	440	7.05	0.095	65	787

Weight - lb./cu. ft.
k - Btu/hr. sq. ft. °F/ft.
mp - melting point in °F

PHYSICAL PROPERTIES - Gases

Fig. 97-2

		sp. ht.			K		Viscosity			Density
	mol. wt.	0°C 32°F	100°C 212°F	500°C 932°F	0°C 32°F	100°C 212°F	0°C 32°F	100°C 212°F	500°C 932°F	
Air	29	0.241	0.242	0.245	0.014	0.018	0.017	0.0213	0.035	0.0808
Ammonia	17	0.52	0.54		0.0128	0.0185	0.0094	0.013	0.027	0.0482
Benzene	78	0.22	0.325	0.56	0.005	0.0103	0.007	0.0095	0.0197	
Butane	58	0.375	0.455	0.81	0.0078	0.0135	0.008	0.011	0.02	0.1623
Carbon dioxide	44	0.2	0.21	0.26	0.0085	0.0133	0.0137	0.0178	0.0335	0.1235
Carbon monoxide	28	0.25	0.255	0.27	0.0135	0.015	0.0171	0.0215	0.0352	0.0781
Chlorine	71	0.114	0.118	0.124	0.0043		0.0128	0.017	0.034	0.2011
Ethane	30	0.4	0.5	0.84	0.0106	0.0175	0.0085	0.0113	0.022	0.0848
Ethylene	28	0.36	0.45	0.72	0.0101	0.0161	0.0095	0.0123	0.023	0.0783
Freon -12	121	0.14	0.16		0.0045	0.008	0.0118	0.0145		
Hydrogen	2	3.39	3.42	3.5	0.1	0.129	0.0084	0.0104	0.017	0.0056
Hydrogen sulfide	34	0.24	0.25	0.3	0.0076		0.0118	0.016	0.033	0.0961
Methane	16	0.53	0.6	0.92	0.0175		0.0102	0.0132	0.024	0.0448
Nitrogen	28	0.25	0.253	0.27	0.014	0.018	0.0167	0.021	0.036	0.0782
Oxygen	32	0.22	0.225	0.257	0.0142	0.0185	0.0192	0.024	0.039	0.0892
Propane	44	0.38	0.46	0.82	0.0087	0.0151	0.0077	0.01	0.0185	0.1252
Sulfur dioxide	64	0.15	0.162	0.194	0.005	0.0069	0.0115	0.015	0.028	0.1828
Water vapor (steam)	18		0.453	0.507		0.0137		0.0125	0.028	

mol. wt. - Molecular weight
Viscosity - in centipoises at 1 atm
sp. ht. - Btu/lb. °F
Density - lb./cu. ft. t 760 mm and 32°F
k - Thermal conductivity in Btu/hr. sq. ft. °F/ft.
For viscosities of other gases see Perry's Chemical Engineers' Handbook, Third Edition, Page 370

WEIGHT (DENSITY) OF AIR AT VARIOUS PRESSURES AND TEMPERATURES

Fig. 98-1

Temp. of Air Deg. Fahr.	GAUGE PRESSURE, IN POUNDS PER SQUARE INCH (Based on an Atmospheric Pressure of 14.7 Pounds per Square Inch Absolute at Sea Level)																				
	0	5	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	175	200	225	250	300
	WEIGHT (DENSITY), IN POUNDS PER CUBIC FOOT																				
-20	.0900	.1205	.1515	.2125	..2744	.3360	.3970	.4580	.5190	.5800	.6410	.702	.7635	.825	.886	.948	1.010	1.165	1.318	1.465	1.625	1.934
-10	.0882	.1184	.1485	.2090	.2685	.3283	.3880	.4478	.5076	.5674	.6272	.687	.747	.807	.868	.928	.989	1.139	1.288	1.438	1.588	1.890
0	.0864	.1160	.1455	.2040	.2630	.3215	.3800	.4385	.4970	.5555	.6140	.672	.731	.790	.849	.908	.968	1.114	1.260	1.406	1.553	1.850
10	.0846	.1136	.1425	.1995	.2568	.3145	.3720	.4292	.4863	.5433	.6006	.658	.716	.774	.832	.889	.947	1.090	1.233	1.376	1.520	1.810
20	.0828	.1112	.1395	.1955	.2516	.3071	.3645	.4205	.4770	.5330	.5890	.645	.701	.757	.813	.869	927	1.067	1.208	1.348	1.489	1.770
30	.0811	.1088	.1366	.1916	.2465	.3015	.3570	.4121	.4672	.5221	.5771	.632	.687	.742	.797	.852	.908	1.046	1.184	1.322	1.460	1.730
40	.0795	.1067	.1338	.1876	.2415	.2954	.3503	.4038	.4576	.5114	.5652	.619	.673	.727	.781	.835	.890	1.025	1.161	1.296	1.431	1.705
50	.0780	.1045	.1310	.1839	.2367	.2905	.3432	.3960	.4487	.5014	.5541	.607	.660	.713	.766	.819	.873	1.006	1.139	1.271	1.403	1.661
60	.0764	.1025	.1283	.1803	.2323	.2840	.3362	.3882	.4402	.4927	.5447	.596	.649	.700	.752.	804	.856	.988	1.116	1.245	1.376	1.638
70	.0750	.1005	.1260	.1770	.2280	.2791	.3302	.3808	.4316	.4824	.5332	.584	.635	.686	.737	.788	.839	.967	1.095	1.223	1.350	1.604
80	.0736	.0988	.1239	.1738	.2237	.2739	.3242	.3738	.4234	.4729	5224	.572	.622	.673	.723	.774	.824	.949	1.074	1.199	1 325	1.573
90	.0723	.0970	.1218	.1707	.2195	.2688	.3182	.3670	.4154	.4639	.5122	.561	.611	.660	.709	.759	.809	.932	1.054	1.177	1.300	1.546
100	.0710	.0954	.1197	.1676	.2155	.2638	.3122	.3602	.4079	.4555	.5033	.551	.599	.648	.696	.745	.794	.914	1.035	1.155	1.276	1.517
110	.0698	.0937	.1176	.1645	.2115	.2593	.3070	.3542	.4011	.4481	.4950	.542	.589	.637	.685	.732	.780	.899	1.017	1.135	1.254	1.491
120	.0686	.0921	.1155	.1618	.2080	.2549	.3018	.3481	.3944	.4403	.4866	.533	.579	.626	.673	.720	.767	.884	1.001	1.118	1.234	1.465
130	.0674	.0905	.1135	.1590	.2045	.2505	.2966	.3446	.3924	.4296	.4770	.524	.570	.616	.662	.708	.754	.869	.984	1.099	1.214	1.440
140	.0663	.0889	.1115	.1565	.2015	.2465	.2915	.3364	.3813	.4262	.4711	.516	.561	.606	.651	.696	.742	.855	.968	1.081	1.194	1.416
150	.0652	.0874	.1096	.1541	.1985	.2425	.2865	.3308	.3751	.4193	.4636	.508	.552	.596	.640	.685	.730	.841	.953	1.064	1.175	1.392
175	.0626	.0840	.1054	.1482	.1910	.2335	.2755	.3181	.3607	.4033	.4450	.488	.531	.573	.616	.658	.701	.808	.914	1.021	1.128	1.337
200	.0603	.0809	.1014	.1427	.1840	.2248	.2655	.3054	.3473	.3882	.4291	.470	.511	.552	.592	.633	.674	.776	.879	.982	1.084	1.287
225	.0581	.0779	.0976	.1373	.1770	.2163	.2555	.2949	.3344	.3738	.4129	.452	.491	.531	.570	.609	.649	.747	.846	.944	1.043	1.240
250	.0560	.0751	.0941	.1323	.1705	.2085	.2466	.2845	.3223	.3602	.3981	.436	.474	.513	.551	.589	.627	.722	.817	.912	1.007	1.197
275	.0541	.0726	.0910	.1278	.1645	.2011	.2378	.2745	.3111	.3478	.3844	.421	.458	.494	.531	.568	.605	.697	.789	.881	.972	1.155
300	.0523	.0707	.0881	.1237	.1592	.1945	.2300	.2654	.3008	.3362	.3716	.407	.442	.478	.513	.549	.585	.673	.762	.852	.940	1.118
350	.0491	.0658	.0825	.1160	.1495	.1828	.2160	.2492	.2824	.3156	.3488	.382	.415	.449	.482	.516	.549	.632	.715	.799	.883	1.048
400	.0463	.0621	.0779	.1090	.1405	.1720	.2035	.2348	.2661	.2974	.3287	.360	.391	.423	.454	.486	.517	.596	.674	.753	.831	.987
450	.0437	.0586	.0735	.1033	.1330	.1628	.1925	.2220	.2515	.2810	.3105	.340	.369	.399	.429	.458	.488	.562	.637	.711	.786	.934
500	.0414	.0555	.0696	.0978	.1260	.1540	.1820	.2100	.2380	.2660	.2940	.322	.351	.379	.407	.435	.463	.534	.604	.675	.746	.885
550	.0394	.0528	.0661	.0930	.1198	.1464	.1730	.1996	.2262	.2528	.2794	.306	.333	.359	.386	.413	.440	.507	.573	.641	.709	.841
600	.0376	.0504	.0631	.0885	.1140	.1395	.1650	.1904	.2158	.2412	.2668	.292	317	.343	.368	.393	.419	.483	.547	.611	.675	.801

Reprinted from “Compressed Air Data” Fifth Edition. Courtesy of Ingersoll-Rand Company.

CRYOGENIC PROPERTIES OF GASES

Fig. 98-2

Gas	He	Ne	A	Kr	Xe	H_2	CH_4	NH_3	N_2	O_2
Density, 32°F Atm. lb../cu. ft.	.01114	.0562	.1113	.234	.368	.00561	.0448	.0481	.0781	.0892
Boiling Point 1 Atm. °F	-.452.0	-.410.6	-302.4	-243.2	-162.6	-423.0	-258.7	-28.03	-320.4	-297.4
MeltingPoint 1 Atm. °F	26 Atm. -458.0	-415.7	-308.7	-250.8	-169.2	-434.6	-299.2	-107.9	-345.8	-361.1
Vapor Dens. at B.P. lb./cu.ft.	.999	.593	.368	.518	.606	.0830	.1124	.0556	.288	.296
Liquid Dens. at B.P. lb./cu. ft.	7.803	74.91	86.77	149.8	193.5	4.37	26.47	42.58	50.19	71.29
Vapor Pressure Solid at M.P. in mm. Hg.	<.02	323	516	549	612	54	70	45.2	96.4	2.0

GAS	He	Ne	A	Kr	Xe	H_2	CH_4	NH_3	N_2	O_2
Heat of Vapor. at B.P. Btu./lb.	<0.3	37.4	70.0	46.4	41.4	194.4	248.4	588.6	85.7	91.6
Heatof Fusion at M.P. Btu./lb.	<1.8	7.2	12.1	7.0	5.9	25.2	26.1	151 2	11.0	5.9
CP, 59°F 1 Atm. Btu/lb. °F	-292°F 1.25	Ap. .25	.125	Ap. .06	Ap. .04	3.39	.528	.523	.248	.218
Cp/Cv, 59° - 68°F 1 Atm.	-292°F 1.66	1.64	1.67	1.68	1.66	1.41	1.31	1.31	1.40	1.40
Critical Temp. °F	-450.2	-379.7	-188.5	-82.7	61.9	-399.8	-116.5	270.3	-232.8	-181.1
Critical Press. Atm.	2.26	26.8	48.0	54.2	58.2	12.8	45.8	111.5	33.5	50.1

PROPERTIES OF WATER

Fig. 98-3

Deg. F.	Specific Heat (Btu/ lb.°F)	Density lb./cu. ft.*	Absolute Viscosity lb./ft. hr.
32	1.01	62.42	4.33
40	1.01	62.42	3.75
50	1.00	62.38	3.17
60	1.00	62.34	2.71
70	1.00	62.27	2.37
80	1.00	62.17	2.08
90	1.00	62.11	1.85
100	1.00	61.99	1.65
110	1.00	61.84	1.49
120	1.00	61.73	1.36
130	1.00	61.54	1.24
140	1.00	61.39	1.14
150	1.00	61.20	1.04
160	1.00	61.01	0.97
170	1.00	60.79	0.90
180	1.00	60.57	0.84
190	1.00	60.35	0.79
200	1.00	60.13	0.74
220	1.01	59.63	0.65
240	1.01	59.10	0.59
260	1.02	58.51	0.53
280	1.02	57.94	0.48
300	1.03	57.31	0.45
350	1.04	55.59	0.38
400	1.07	53.65	0.33
450	1.10	51.55	0.29
500	1.13	49.02	0.26
550	1.20	45.92	0.23
600	1.36	42.37	0.21

PROPERTIES OF AIR

Fig. 98-4

Deg. F.	Specific Heat (Btu/lb.°F)	Density lb./cu. ft.	Absolute Visosity lb./ft. hr.
0	0.240	.0864	0.040
20	0.240	.0828	0.041
40	0.240	.0795	0.042
60	0.240	.0764	0.043
80	0.240	.0736	0.045
100	0.240	.0710	0.046
120	0.240	.0686	0.047
140	0.240	.0663	0.048
160	0.240	.0639	0.050
180	0.240	.0619	0.051
200	0.240	.0603	0.052
250	0.241	.0560	0.055
300	0.241	.0523	0.058
350	0.241	.0491	0.060
400	0.241	.0463	0.063
450	0.242	.0437	0.065
500	0.242	.0414	0.067
600	0.242	.0376	0.072
700	0.243	.0341	0.076
800	0.244	.0314	0.080
900	0.245	.0295	0.085
1000	0.246	.0275	0.089
1200	0.248	.0238	0.097

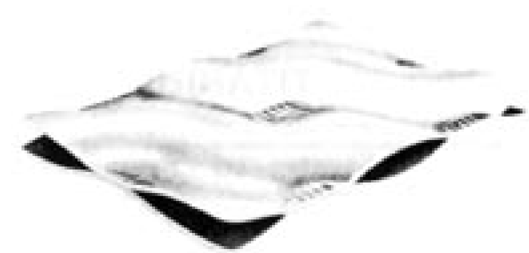
* Based on a pressure of one atmosphere and 32°F.

TITANIUM ECONOCOIL
...long service life
...outstanding heat transfer

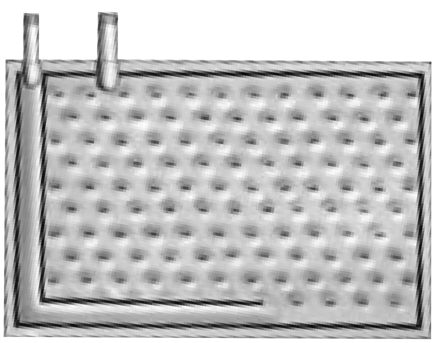
Titanium ECONOCOIL provides long service life in liquid-to-liquid or steam-to-liquid heat transfer applications where highly corrosive environments exist. This results from Titanium's built-in resistance to corrosion attack by harsh chemicals such as the chlorines, chlorides and mineral acids found in many process solutions.

Additionally, Titanium ECONOCOIL provides outstanding heat transfer. Its light gauge construction allows maximum thermal conductivity between the medium flowing through the unit and the corrosive material that is being heated or cooled. This feature, plus the low rate of corrosion deposit build-up on its external and internal surfaces, means Titanium ECONOCOIL maintains better levels of heat transfer than units constructed from heavy gauge, low corrosion resistant material.

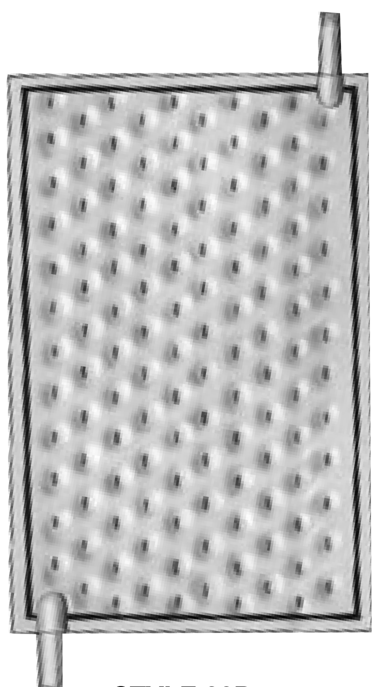
Available in an assortment of styles and sizes, Titanium ECONOCOIL offers a choice of header type or *Serpentine* flow patterns. Plain end tubing connections are furnished as standard. Threaded and other type fittings are available upon request. Optional designs include Titanium ECONOCOIL plates arranged in banks for applications requiring large heat transfer surface areas.



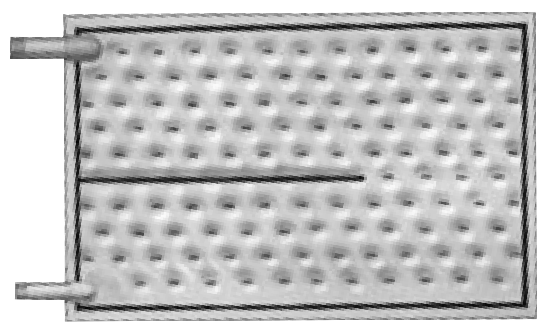
Titanium ECONOCOIL is produced in compliance with strict quality control standards. Each unit is hydrostatically pressure tested to assure structural integrity. Backed by Tranter's years of experience as a leading supplier of heat transfer products, Titanium ECONOCOIL is your assurance of performance excellence and maximum reliability. Contact your PLATECOIL/Titanium ECONOCOIL sales representative concerning your particular requirements.



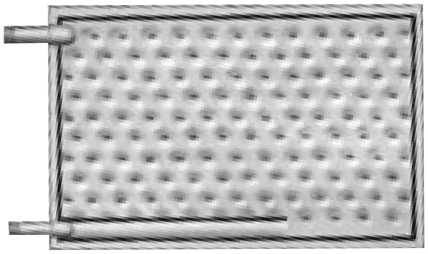
STYLE 90D



STYLE 80D



STYLE 60D



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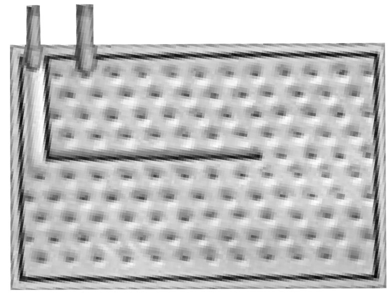


STYLE 50D

TITANIUM ECONOCOIL AREA/WEIGHT CHART

SQ. FT. SURFACE AREAS AND APPROXIMATE NET WEIGHTS IN LBS.													
Width (A Dim.)		Lengths (B Dimension)											
		23"	29"	35"	47"	59"	71"	83"	95"	107"	119"	131"	143"
12"	Sq Ft.	3.8	4.8	5.8	7.8	9.8	11.8	13.8	15.8	17.8	19.8	21.8	23.8
	Net Wt.	3	4	5	6	7	8	9	10	11	12	13	15
18"	Sq. Ft.	5.8	7.3	8.8	11.8	14.8	17.8	20.8	23.8	26.8	29.8	32.8	35.8
	Net Wt.	5	5	6	8	10	12	13	15	17	18	20	22
24"	Sq. Ft.	7.7	9.7	11.7	15.7	19.7	23.7	27.7	31.7	35.7	39.7	43.7	47.7
	Net Wt.	6	7	8	10	13	15	17	19	21	24	26	28
30"	Sq. Ft.	9.6	12.1	14.6	19.6	24.6	29.6	34.6	39.6	44.6	49.6	54.6	59.6
	Net Wt.	7	9	10	13	16	19	21	24	27	30	32	35
36"	Sq. Ft.	11.5	14.5	17.5	23.5	29.5	35.5	41.5	47.5	53.5	59.5	65.5	71.5
	Net Wt.	9	10	12	15	19	22	25	28	32	35	38	42
48"	Sq. Ft.	15.3	19.3	23.3	31.3	39.3	47.3	55.3	63.3	71.3	79.3	87.3	95.3
	Net Wt	11	13	15	20	24	28	33	37	42	46	50	55

SPECIFICATIONS

Working Pressure:
70 psig @ 350°F
Standard Material:
Titanium 0.0236", SB-265 (see note)
Standard Connections:
Plain end 0.035" Titanium Tubing. (Other fittings available)
Heat Transfer Rates

	Still	Agitated**
Steam to Water Solutions	175*	200*
Water to Watery Solutions	60*	100*

* These are typical heat transfer rates shown as U = Btu/hr. sq. ft.°F

** Special bracing may be required.

APPLICATIONS

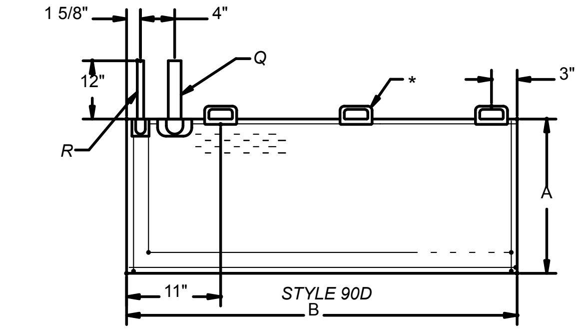
- Sulfate chrome plating solutions
- Chromic acid, 10% boiling
- Nickel plating solutions (not electroless nickel with fluorides)
- Inhibited sulfuric acid
- Inhibited hydrochloric acid
- Hypochlorites
- Seawater or salt brine
- Chlorinated hydrocarbons
- Chlorine gas (moist)

INSTALLATION

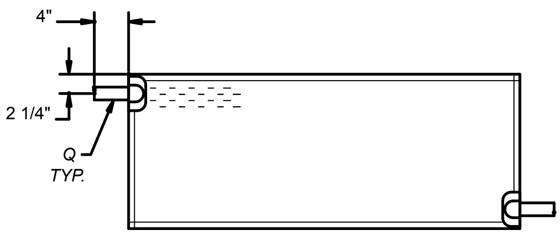
Titanium Hangers are available for easy open tank installation. Just bend the top of the hangers over the edge of the tank and support the ECONOCOIL from the hanger hooks. Three handles are provided on all ECONOCOIL 71" in length or longer. Hangers for these sizes should be ordered accordingly.

NOTE: Heavier guage material available for higher pressures and temperatures. Consult factory.

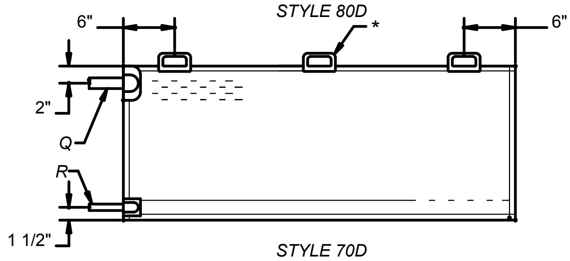
STANDARD STYLES AND CONNECTIONS



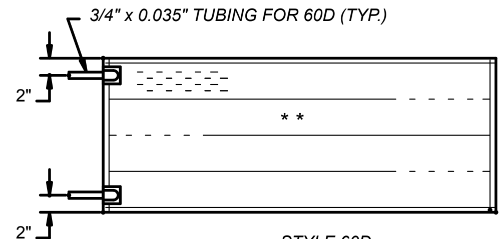
STYLE 90D



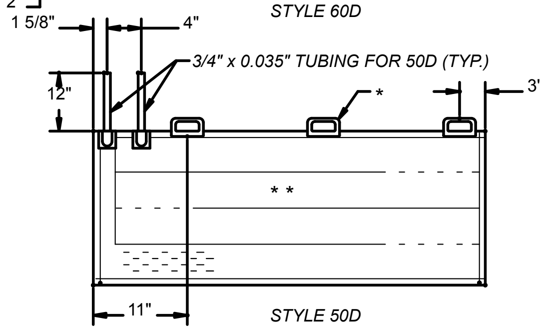
STYLE 80D



STYLE 70D



STYLE 60D



STYLE 50D

* 3 Handles required for lengths 71” & above. Handles equally spaced.
** 2 Zones on 12”, 18” & 24” Widths - Styles 50 & 60
Threaded Ends Available.
Handles on Styles 60 & 80 only if specified on order. (Locations same as Style 70.)

Connection Size Table

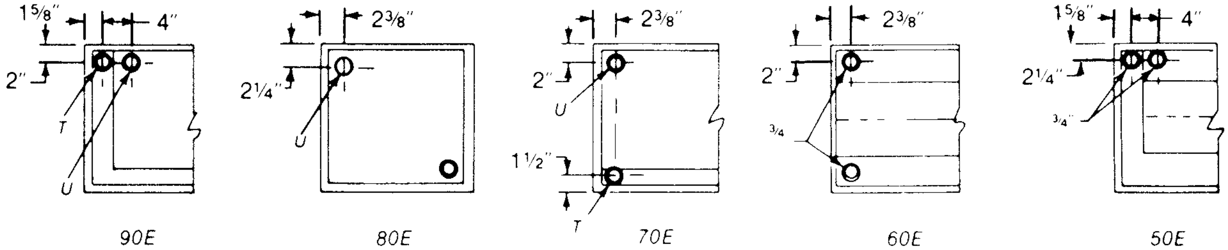
Dim. A. with Length B	0.035” Wall Tubing (Plain End)			
	Q	R	U	T
12”-All Lengths	‘1”	3/4”	1”	3/4”
18” & 24” Thru 47” Long	1”	3/4”	1”	3/4”
18 “ & 24 Over 47” Long	1 1/2”	3/4”	1 1/4”	3/4”
30”, 36”, 48” All Lengths	1 1/2”	1”	1 1/2”	1”

Dimension Table

WIDTHS “A” (IN.)					
12	18	24	30	36	48

LENGTHS “B” (IN.)					
23	29	35	47	59	71
83	95	107	119	131	143

Optional Connection Locations



E connections are 4" long as standard.

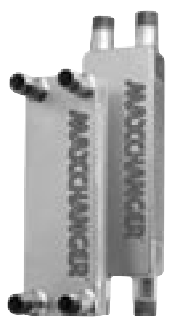
Other Tranter Plate Heat Exchanger Products

In addition to PLATECOIL, with its unique and prime heat transfer surface, Tranter can provide a number of other options to satisfy your heat transfer and performance needs.

SUPERCHANGER®
Plate & Frame

These versatile plate and frame type heat exchangers are highly efficient, flexible, compact, light-weight, and easy to clean. All units are custom designed by a computer rating system and available in a variety of plate materials and sizes. As a result, a SUPERCHANGER unit can be utilized in a variety of liquid-to-liquid and steam-to-liquid heat transfer applications.

With its ability to be tailored to meet exacting customer specifications, the SUPERCHANGER is an ideal heat exchanger for virtually any industrial process operation requiring efficient, economical heat transfer. The SUPERCHANGER plate and frame heat exchanger offers advantages over shell-and-tube units in virtually any industrial heat transfer application. They're particularly effective in recovering heat from waste liquids and in handling highly viscous and corrosive solutions. And they require only 10% to 50% of the space used by shell-and-tube heat exchangers.



MAXCHANGER®
All-Welded

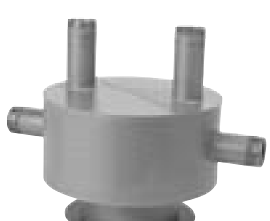
The MAXCHANGER all-welded plate heat exchanger offers higher performance, in less space, at lower cost. Because the unit is so compact, it occupies only 30 - 50% of space required for a shell-and-tube exchanger in the same application. Single and multiple pass designs are available to fit any application requirement.

Extremely high U values and low pressure drops are brought about by the unique geometry of the patented MAXCHANGER's variable interspaces. Channels formed between the specially dimpled, welded plates direct the two heat transfer media counter-currently through alternate paths to maximum efficiency and a close temperature approach capability of less then 2°F.

ULTRAMAX®
All-Welded

The ULTRAMAX all-welded plate heat exchanger is designed for "tough conditions" beyond the capabilities of gasketed exchangers. It incorporates plate and frame benefits without gaskets. Designed for use with liquids, gases or two-phase mixtures at extreme temperatures and pressures up to 1,000 psig, the ULTRAMAX unit works well with aggressive media, such as organic solvents, high pressure steam heaters and interchangers that are beyond the capability of a gasketed unit.

Working in the same way as a conventional plate and frame heat exchanger, the ULTRAMAX unit has alternating channels for hot and cold media, and true counter-current flow, unlike some competitive cross flow designed units. Counter-current flow offers full LMTD and allows closer temperature approaches.

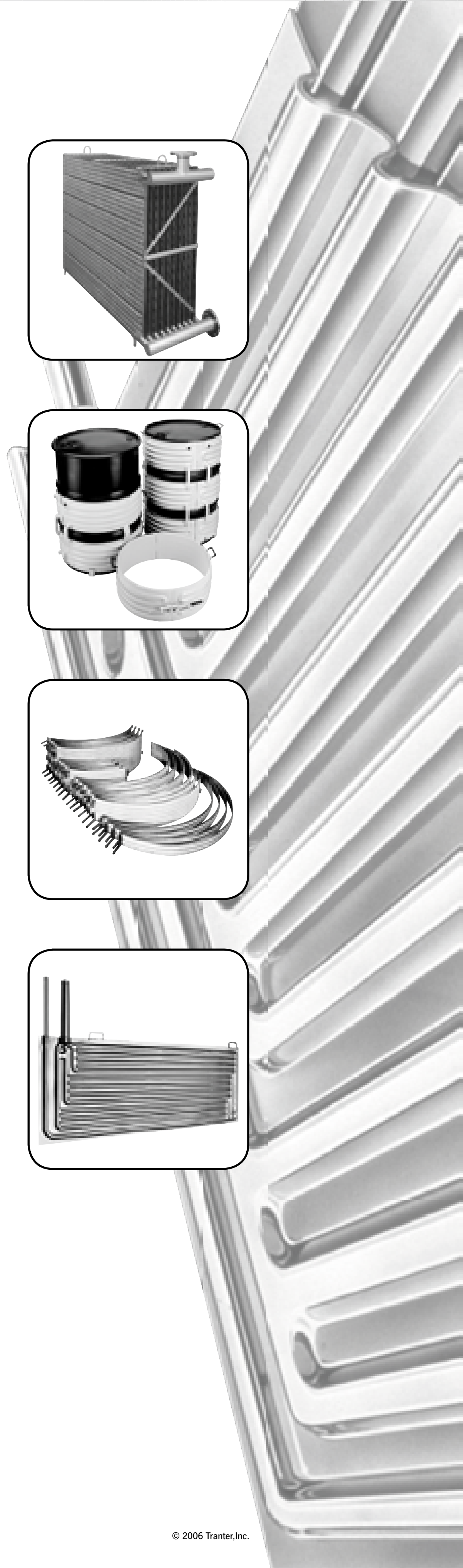


SUPERMAX®
All-Welded

The SUPERMAX all-welded plate heat exchanger provides the thermal efficiency and compactness of a plate and frame unit under conditions that would ordinarily call for a shell-and-tube unit. Designed for use with liquids, gases and two phase mixtures at pressures to 600 psig and at temperatures up to 1,000°F, the SUPERMAX unit works well with aggressive media, such as organic solvents, steam heaters and interchangers that are beyond the capability of a gasketed unit.

The unit features a plate side and a shell side, which offers high pressure ratings. It has alternating channels for hot and cold media, and can offer true counter-current or co-current flow. It can be fabricated from dissimilar metals when only one side will be exposed to corrosive conditions.

For more information write to Tranter, Inc., P.O. Box 2289, Wichita Falls, TX 76307. Or call a SUPERCHANGER technical specialist at (940) 723-7125.



PLATECOIL®

P R I M E

S U R F A C E

Also Manufactured in Great Britain by Tranter, Ltd.
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Also Manufactured in Japan by Nihon Parkerizing Co. Ltd.
Parker Ikegami Bldg., 3rd Floor :: 14-12 2-Chome, Nakaikegami
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TRANTER®
The heat transfer people

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