

# Heat Transfer

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## Heat Exchangers (HE)

Heat exchangers are used to transfer heat from one fluid to another fluid. In the terminology of chemical engineering, a fluid may be either a gas or a liquid. Therefore, when we say we are transferring heat from one fluid to another, we can mean either a gas-gas exchanger, a liquid-liquid exchanger or a gas-liquid exchanger.

Heat exchangers may be called by other names depending upon their specific purpose. If a process fluid is being cooled with water, the term cooler is often used. If a gaseous process fluid is cooled with water until it becomes a liquid, the term condenser is used. If a liquid process fluid is heated (usually with steam) until it turns into a gas, the term vaporizer is used. If a process fluid is heated (usually with steam) the term heater is used. If two process fluids exchange heat, the term heat exchanger is used.

The most common type of heat exchanger, and therefore, the kind described here, is the shell and tube heat exchanger. The shell and tube heat exchanger consists of a bundle of tubes. Each tube is usually 3/4 or 1" in outside diameter and 20 to 40 feet long. The tube bundle is held in a cylindrical shape by plates at either end called tube sheets. The tube bundle is placed inside a cylindrical shell. The design of the shell and tube heat exchanger is such that one fluid flows inside the tubes, while the other fluid flows over the outside of the tubes. Heat is transferred through the tube walls. The size of a heat exchanger is defined as the total outside surface area of the tube bundle.

Wide variety of materials: floating head, fixed tube sheet, U-tube exchangers, multiple shells/passes, TEMA Class B and other types.

### Description

Floating head shell of 48 INCHES [1200 MM] maximum and exchanger.

Applicable to any heat exchange application, but not normally used for clean and/or low temperature services where the fixed tube sheet exchanger is usually the more economic choice.

The floating head heat exchanger accommodates the differential thermal expansion of tube bundle and shell, and also allows the tube bundle to be completely removed from the shell. The floating head heat exchanger is consequentially specified for services where the shell size of the tube bundle is subject to fouling and services which involve large temperature differentials between shell side and tube side fluids.

**Surface Area:** Enter either heat transfer area or number of shells, tubes/shell and tube data.

**Number of Shells:** Enter either heat transfer area or number of shells, tube/shell and tube data.

**Tube Material:** Default: A 214 to 900 DEG F [482 DEG C], 304S for higher temperatures. See chapter 28 for tube materials.

**Tube Pressure - Gauge:** Default: \*150\* PSIG [\*1,000\* KPA]

**Tube Temperature:** Default: 400 DEG F [200 DEG C] for copper alloys; 650 DEG F [340 DEG C] other material

**Tube Outside Diam.:** 0.25 - 6.0 INCHES [6 - 150 MM]; Default: \*1.0\* INCHES [\*25\* MM]

**Shell Material:** Default: A285C to 900 DEG F [482 DEG C], SS304 for higher temperatures

**Shell Pressure - Gauge:** Default: 150 PSIG [1,000 KPA]

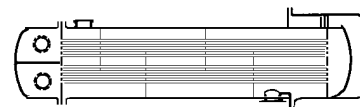
**Shell Temperature:** Default: 400 DEG F [200 DEG C] for copper alloys; 650 DEG F [340 DEG C] for other material

**Tube-Side Pipe Mat'l:** See Pipe Materials in Chapter 18.

**Shell-Side Pipe Mat'l:** See Pipe Materials in Chapter 18.

### Type

#### FLOAT-HEAD




Continued on next page

## Heat Exchangers (HE) - continued

Description	Type
<b>FLOAT-HEAD</b> - continued	
<b>No. of Tubes/Shell:</b> Enter either heat transfer area or number of shells, tubes/shell and tube data.	
<b>Extended Tube Length:</b> 8 - 60 FEET [2.5 - 18 M]; Default: *20* FEET [*6* M]	
<b>Tube Gauge:</b> Enter tube gauge or thickness, not both, including corrosion allowance; 1-24 BWG	
<b>Tube Thickness:</b> Enter tube gauge or thickness, not both, including corrosion allowance; 0.02 - 0.34 INCHES [0.6 - 8.6 MM]	
<b>Tube Corrosion All.:</b> Default: 0.0025 INCHES [0.06 MM] for CS, 0.0 for other materials	
<b>Tube Seal Type:</b> Default: *SEALW* EXPND - Expaned tube-to-tubesheet joints SEALW - Seal welded tube joints STRNW - Strength welded tube joints	
<b>Tube Pitch:</b> Default: 1.25 x tube outside diameter	
<b>Tube Pitch Symbol:</b> Default: *TRIANGULAR* DIAMOND - Diamond tube pitch SQUARE - Square tube pitch TRIANGLE - Triangular tube pitch	
<b>Shell Diameter:</b> Max: 192.0 INCHES [4,875.0 MM]	
<b>Shell Wall Thickness:</b> Shell thickness including corrosion allowance.	
<b>Shell Corrosion All.:</b> Default: 0.125 INCHES [3 MM] for CS, 0.0 for other materials.	
<b>Expansion Joint:</b> Default: *NO* NO - No expansion joint in shell YES - Expansion required in shell	
<b>Tube Sheet Material:</b> See TubeMaterials in Chapter 28.	
<b>Tubesheet Corr. All.:</b> Default: Lesser of 50 x tube corrosion allowance, or 0.25 INCHES [6 MM].	
<b>Channel Material:</b> Default: tubesheet material. See Tube Materials in Chapter 28.	
<b>Cladding Thickness:</b> Default: 0.125 INCHES [3 MM] if cladding material specified, otherwise 0.0.	
<b>Cladding Material:</b> See cladding material in Chapter 28.	
<b>Cladding Location:</b> Default: *SHELL* SHELL - Cladding on shell side only TUBE - Cladding on tube side only BOTH - Cladding on both shell and tube sides	
<b>No. of Tube Passes:</b> Default: *2*	
<b>No. of Shell Passes:</b> Default: *1*	
<b>Stress Relief:</b> Default: See Area Design Basis. CODE - Provide stress relief if code required YES - Provide stress relief NO - No stress relief required	
<b>Weld X-Ray %:</b> Max 100; Default: *20*	
<b>TEMA Type:</b> Default: BES for 1 shell pass, BFS for 2 shell passes.	
<b>Vendor Grade:</b> Default: *HIGH* STAND - Standard vendor HIGH - Specialty vendor - high grade/custom work	
<b>Regulation Type:</b> For Japanese country base only. Required government regulation and testing. Default: *NONE* NONE - No special regulations PV - Pressure vessel regulations HPG - High pressure gas regulations	

## Heat Exchangers (HE) - continued

Description	Type
<p>Fixed tube sheet shell and tube exchangers. TEMA type BEM fixed tube sheet.</p>	<p><b>FIXED-T-S</b></p>
<p>The fixed tube sheet shell and tube heat exchanger is applicable to trim cooler and other low temperature applications, as well as services where the shell side fluid is non-fouling, such as steam, dowtherm and gasses.</p>	
<p>A fixed tube sheet heat exchanger has its tube sheets fixed to both ends of the shell, with or without a shell expansion joint. Fixed tube sheet heat exchangers are more economical to fabricate than floating head heat exchangers, but unless an expansion joint is placed in the shell the difference in temperature between the shell and tubes must be small or the unequal thermal expansion of the shell and tube bundle will cause unacceptable mechanical stresses. The fixed tube sheet design also does not allow the tube bundle to be removed. Therefore, fixed tube sheet heat exchangers are limited to clean services and services where the dirt and scale on the outside surface of the tubes is easily cleaned by chemical means.</p>	
<p><b>Surface Area:</b> Enter either heat transfer area or number of shells, tubes/shell and tube data.</p> <p><b>Number of Shells:</b> Enter either heat transfer area or number of shells, tubes/shell and tube data.</p> <p><b>Tube Material:</b> Default: A 214 to 900 DEG F [482 DEG C], 304S for higher temperatures. See Chapter 28 for tube materials.</p> <p><b>Tube Pressure - Gauge:</b> Default: *150* PSIG [*1,000* KPA]</p> <p><b>Tube Temperature:</b> Default: 400 DEG F [200 DEG C] for copper alloys; other material: 640 DEG F [340 DEG C]</p> <p><b>Tube Outside Diam.:</b> 0.25 - 6.0 INCHES [6 - 150 MM]; Default: *1.0* INCHES [*25* MM]</p> <p><b>Shell Material:</b> Default: A285C to 900 DEG F [482 DEG C], SS304 for higher temperatures. See Chapter 28 for materials.</p> <p><b>Shell Pressure - Gauge:</b> Default: *150* PSIG [*1,000* KPA]</p> <p><b>Shell Temperature:</b> Default: 400 DEG F [200 DEG C] for copper alloys; *650* DEG F [*340* DEG C] for other materials.</p> <p><b>Tube-Side Pipe Mat'l:</b> See Chapter 18 for pipe materials.</p> <p><b>Shell-Side Pipe Mat'l:</b> See Chapter 18 for pipe materials.</p> <p><b>No. of Tubes/Shells:</b> Enter either heat transfer area or number of shells, tubes/shell and tube data.</p> <p><b>Extended Tube Length:</b> 8 - 60 FEET [2.5 - 18 M]; Default: *20* FEET [*6* M]</p> <p><b>Tube Gauge:</b> Enter tube gauge or thickness, not both, including corrosion allowance; 1 - 24 BWG</p> <p><b>Tube Thickness:</b> Enter tube gauge or thickness, not both, including corrosion allowance; 0.02 - 0.34 INCHES [0.6 - 8.6 MM]</p> <p><b>Tube Corrosion All.:</b> Default: 0.0025 INCHES [0.06 MM] for CS, 0.0 for other materials</p>	

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## Heat Exchangers (HE) - continued

Description	Type
<b>FIXED-T-S</b> - continued	
<p><b>Tube Seal Type:</b> Default: *SEALW*</p> <p>EXPND - Expaned tube-to-tubesheet joints  SEALW - Seal welded tube joints  STRNW - Strength welded tube joints</p> <p><b>Tube Pitch:</b> 1.25 x tube outside diameter</p> <p><b>Tube Pitch Symbol:</b> Default: *TRIANGLE*</p> <p>DIAMOND - Diamond tube pitch  SQUARE - Square tube pitch  TRIANGULAR - Triangular tube pitch</p> <p><b>Shell Diameter:</b> Max: 192.0 INCHES [4,875.0 MM]</p> <p><b>Shell Wall Thickness:</b> Shell thickness including corrosion allowance.</p> <p><b>Shell Corrosion All.:</b> Default: 0.125 INCHES [3 MM] for CS, 0.0 for other materials.</p> <p><b>Expansion Joint:</b> Default: *NO*</p> <p>NO - No expansion joint in shell  YES - Expansion joint required in shell</p> <p><b>Tube Sheet Material:</b> See Chapter 28 for tube materials.</p> <p><b>Tubesheet Corr. All.:</b> Default: lesser of 50 x tube corrosion allowance or 0.25 INCHES [6 MM].</p> <p><b>Channel Material:</b> Default: tubesheet material. See Chapter 28 for materials.</p> <p><b>Cladding Thickness:</b> Default: 0.125 INCHES [3 MM] if cladding material specified, otherwise 0.0.</p> <p><b>Cladding Material:</b> See Chapter 28 for material selection.</p> <p><b>Cladding Location:</b> Default: *SHELL*</p> <p>SHELL - Cladding on shell side only  TUBE - Cladding on tube side only  BOTH - Cladding on both shell and tube sides</p> <p><b>No. of Tube Passes:</b> Default: *1*</p> <p><b>No. of Shell Passes:</b> Default: *1*</p> <p><b>Stress Relief:</b> Default: See Area Design Basis.</p> <p>CODE - Provide stress relief if code requires  YES - Provide stress relief  NO - No stress relief required</p> <p><b>Weld X-Ray %:</b> Max: 100; Default: *20*</p> <p><b>TEMA Type:</b> Default: BEM for 1 shell pass, BFM for 2 shell passes.</p> <p><b>Vendor Grade:</b> Default: *HIGH*</p> <p>STAND - Standard vender  HIGH - Specialty vender - high grade/custom work</p> <p><b>Regulation Type:</b> Japanese country base only. Required government regulation and testing; Default: *NONE*</p> <p>NONE - No special regulations  PV - Pressure vessel regulations  HPG - High pressure gas regulations</p>	

## Heat Exchangers (HE) - continued

## Description

Air cooler with variety of plenum chambers, louver arrangements, fin types (or bare tubes), sizes, materials, free-standing or rack-mounted, multiple bays and multiple services within a single bay.

**Bare Tube Area:** Primary or single service. Total bare tube surface area for primary service. If the exchanger is a single service, then this is the total bare tube surface area.

**Tube Material:** Primary or single service; Default: \*A 179\*. See Chapter 28 for tube materials.

**Design Press. - Gauge:** Default: \*150\* PSIG [\*1,000\* KPA]

**Inlet Temperature:** Default: \*300\* DEG F [\*150\* DEG C]

**Tube Outside Diam.:** Default: \*1.0\* INCHES [\*25.0\* MM]

**Tube Thickness/BWG:** The wall thickness of tubing used for primary or single services, in inches or BWG rating. For grooved tubes, specify the thickness under the groove. Thickness may be entered as a positive signed value in decimal INCHES [MM] or as a negative signed integer value of BWG (-1 to -24 BWG). If no value is specified, the system calculates a value based on tube material, temperature and pressure of service, with minimum of 0.1080 INCHES [2.74 MM] per API 661 code.

**Header Corr. Allow.:** Default: 0.0, except CS: 0.125 INCHES [3 MM]

**Tube Length:** Range: 4 - 60 FEET [1.25 - 18.0 M]

**Bay Width:** Max: 30.0 [9.0 M]

**Height:** This is the leg height for air coolers at grade. Default: \*0.0\* (rack mounted)

**Number of Walkways:** Default: \*2\*

**Plenum Type Symbol:** Deault: \*TRNS\*

PANL - Panel shaped plenum

TRNS - Transition shaped

NONE - No plenum

**Louver Type Symbol:** Default: \*FACE\*

FACE - Face louvers only

SIDE - Side louvers only

BOTH - Face + side louvers

NONE - No louvers

**Fin Type Symbol:** Deault: L-footed if temperature below 400 DEG F [205 DEG C], esle embedded.

E - Embedded

L - L-foot tension wound

W - Wheel

X - Extracted

NONE - Bare tubes

**Fin Pitch:** Number of fin tubes per INCHE [per 25 MM], ignore if bar tube speciefied. Range: 6.0 - 20.0; Default: \*10.0\*

**Fin Material Symbol:** Ignore this field for bare tubes. Default: \*AL\*.

AL - Aluminum fins

CS - Carbon steel fins

CU - Copper fins

SS - Stainless steel fins

**Tube Fin Height:** Ignore this field for bare tubes; Range: 0.250 - 2.50 INCHES [10.0 - 65.0 MM]; Default: \*0.625\* INCHES [\*15\* MM]

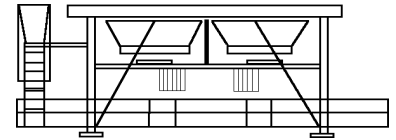
**No. of Tube Rows:** Max: 13

**Tube Pitch:** Default: \*2.25\* INCHES [55.0 MM]

**Number of Fans/Bay:** Range: 1-3

## Type

## AIR COOLER



## Heat Exchangers (HE) - continued

## Description

U-tube shell and tube exchangers. TEMA type BEU U-Tube.

U-tube shell and tube exchangers are normally used in those services where the tubeside fluid is non-fouling or where the deposits formed are easily removed with chemical cleaning. Since the tube bundle is removable, the fluid in the shell side can be fouling. Since the U-tube design eliminates one tube sheet, these exchangers are often used for high pressure applications.

As the name indicates, all the tubes are U-shaped. Consequentially, there is only one tube sheet. The tube side fluid enters one leg of the U-tube and exits from the other leg. The U-tubes are free to expand inside the exchanger shell; thus, a large temperature differences between shell side and tube side fluids can be handled. The U-tube bundle is usually removable for inspection and cleaning. The inside of the U-tubes are hard to clean because of the U-bend. U-tube heat exchangers are unsuitable for handling erosive fluids because the U-bends rapidly wear out.

**Surface Area:** Enter either heat transfer area or number of shells, tubes/shell and tube data.

**Number of Shells:** Enter either heat transfer area or number of shells, tubes/shell and tube data.

**Tube Material:** Default: \*A 214\* to 900 DEG F [482 DEG C], \*304S\* for higher temperatures. See Chapter 28 for tube data.

**Tube Pressure - Gauge:** Default: \*150\* PSIG [\*1,000\* KPA]

**Tube Temperature:** Default: \*400\* DEG F [\*200\* DEG C] for copper alloys; other material: \*650\* DEG F [\*340\* DEG C]

**Tube Outside Diam:** Range: 0.25 - 6.0 INCHES [6 - 150 MM]; Default: \*1.0\* INCHES [\*25\* MM]

**Shell Material:** Default: \*A285C\* to 900 DEG F [482 DEG C], SS304 for higher temperatures

**Shell Pressure - Gauge:** Default: \*150\* PSIG [\*1,000\* KPA]

**Shell Temperature:** Default: \*400\* DEG F [\*200\* DEG C] for copper alloys; \*650\* DEG F [\*340\* DEG C] other materials

**No. of Tubes/Shell:** Enter either heat transfer area or number of shells, tubes/shell and tube data.

**Extended Tube Length:** Range: 8 - 12 FEET [2.5 - 36 M]; Default: \*40\*Feet [\*12\* M]

**Tube Gauge:** Enter tube gauge or thickness, not both, including corrosion allowance. Range: 1-24 BWG

**Tube Thickness:** Enter tube gauge or thickness, not both, including corrosion allowance. Range:0.02 - 0.34 INCHES [0.6 - 8.6 MM]

**Tube Corrosion All.:** Default: \*0.0025\* INCHES [\*0.06\* MM] for CS, \*0.0\* for other materials.

**Tube Seal Type:** Default: \*SEALW\*

EXPD - Expaned tube-to tubesheet joints

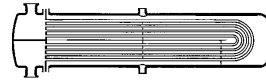
SEALW - Seal welded tube joints

STRNW - Strength welded tube joints

**Tube Pitch:** Default: 1.25 x tube outside diameter

## Type

## U-TUBE



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## Heat Exchangers (HE) - continued

Description	Type
U-TUBE - continued	
<b>Tube Pitch Symbol:</b> Default: *TRIANGULAR*	
DIAMOND - Diamond tube pitch	
SQUARE - Square tube pitch	
TRIANGULAR - Triangular tube pitch	
<b>Shell Diameter:</b> Max: 192 INCHES [4,875 MM]	
<b>Shell Wall Thickness:</b> Shell thickness including corrosion allowance.	
<b>Shell Corrosion All.:</b> Default: *0.125* INCHES [*3* MM] for CS, *0.0* for other materials	
<b>Expansion Joint:</b> Default: *NO*	
NO - No expansion joint in shell	
YES - Expansion joint required in shell	
<b>Tube Sheet Material:</b> See Chapter 28 for tube materials.	
<b>Tube Sheet Corr. All.:</b> Default: Lesser of 50 x tube corrosion allowance, or *0.25* INCHES [*6* MM]	
<b>Channel Material:</b> See Chapter 28 for materials.	
<b>Cladding Thickness:</b> Default: *0.125* INCHES [3 MM] if cladding material is specified; otherwise *0.0*	
<b>Cladding Material:</b> See Chapter 28 for cladding materials.	
<b>Cladding Location:</b> Default: *SHELL*	
SHELL - Cladding on shell side only	
TUBE - Cladding on tube side only	
BOTH - Cladding on both shell and tube sides	
<b>No. of Tube Passes:</b> Default: *2*	
<b>No. of Shell Passes:</b> Default: *1*	
<b>Stress Relief:</b> Default: See Project Design Basis.	
CODE - Provide stress relief if code requires	
YES - Provide stress relief	
NO - No stress relief required	
<b>Weld X-Ray %:</b> Max: 100; Default: *20*	
<b>TEMA Type:</b> *BEU* for 1 shell pass, *BFU* for 2 shell passes.	
<b>Vendor Grade:</b> Default: *HIGH*	
STAND - Standard vendor	
HIGH - Specialty vendor - high grade/custom work	
<b>Regulation Type:</b> Japanese country base only. Required government regulations and testing. Default: *NONE*.	
NONE - No special regulations	
PV - Pressure vessel regulations	
HPG - High pressure gas regulations	

Heat Exchangers (HE) - continued

Description

Pre-engineered (standard) U-tube exchanger for use as a sample cooler or other miscellaneous application.

**Surface Area:** Enter either heat transfer area or number of tubes and tube data. Range: 3.50 - 120.0 SF [0.33 - 11.0 M2]

**Tube Material:** Default: \*CA443\*

- |                             |                         |
|-----------------------------|-------------------------|
| A 179 - Seamless CS         | 304LW - 304L welded     |
| A 192 - Seamless CS         | 316W - 316 welded       |
| A 214 - Welded carbon steel | 316LW - 316L welded     |
| 304S - 304 seamless         | CA122 - Cu seamless     |
| 304LS - 304L seamless       | CA706 - Cu-Ni seamless  |
| 316S - 316 seamless         | CA715 - Cu-Ni seamless  |
| 316LS - 316L seamless       | CA443 - Admiralty brass |
| 304W - 304 welded           | CA444 - Admiralty brass |
|                             | CA445 - Admiralty brass |

**Tube Pressure - Gauge:** Default: \*150\* PSIG [\*1,000\* KPA]

**Tube Temperature:** Default: \*250\* DEG F [\*120\* DEG C]

**Tube Outside Diam:** Range: 0.5 - 1.5 INCHES [12.0 - 38.0 MM]; Default: \*0.75\* INCHES [\*19\* MM]

**Shell Material:** Default: \*A285C\*

- A285C - Carbon steel
- A 516 - A-516
- SS304 - SS304
- 304L - 304L
- SS316 - SS316
- 316L - 316L

**Shell Pressure - Gauge:** Default: \*150\* PSIG [\*1,000\* KPA]

**Shell Temperature:** Default: \*250\* DEG F [\*120\* DEG C]

**Number of Tubes:** Enter either heat transfer area or number of tubes and tube data.

**Extended Tube Length:** Enter either heat transfer area or number of tubes and tube data. Range: 4.00 - 16.0 FEET [1.20 - 4.80 M]

**Tube Gauge:** Enter tube gauge or thickness, not both, including corrosion allowance. Range: 16 - 20 BWG

**Tube Thickness:** Enter tube gauge or thickness, not both, including corrosion allowance; Range: 0.035 - 0.065 INCHES [0.900 - 1.65 MM]

**Tube Corrosion All.:** Default: \*0.0025\* INCHES [\*0.06\* MM] for CS, \*0.0\* for other materials

**Tube Pitch:** Default: \*.25 x tube outside diameter\*

**Tube Pitch Symbol:** Default: \*TRIANGULAR\*

- DIAMOND - Diamond tube pitch
- SQUARE - Square tube pitch
- TRIANGULAR - Triangular tube pitch

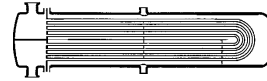
**Shell Diameter:** Range: 4.00 - 10.00 INCHES [102.0 - 254.0 MM]

**Shell Wall Thickness:** Shell thickness including corrosion allowance.

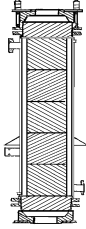


**Shell Corrosion All.:** Default: \*0.125\* INCHES [\*3\* MM] for CS, \*0.0\* for other materials

Type

PRE-ENGR



## Heat Exchangers (HE) - continued

Description	Type
<p>All-graphite heat exchanger.</p> <p><b>Mat'l of Construction:</b> Default: *GRAPH*</p> <p><b>Heat Transfer Area:</b> Range: 8 - 150 SF [1.0 - 13.5 M2]</p>	<p><b>CROSS BORE</b></p> 
<p>Graphite tube with carbon steel shell exchanger.</p> <p><b>Heat Transfer Area:</b> Range: 80 - 9,730 SF [7.5 - 870 M2]</p> <p><b>Tube Length:</b> Range: 6 - 20 FEET [2 - 6 M]</p>	<p><b>SHELL+TUBE</b></p> 
<p>Longitudinal finned double-pipe heat exchanger. Hairpin sections are connected in series or parallel.</p> <p><b>Material Selection:</b> Default:*CS*</p> <p>CS - Carbon steel SS - Stainless steel</p> <p><b>Heat Transfer Area:</b> Enter total heat transfer area (i.e., total extended surface or finned tubes.) Range: 70 - 10,000 SF [7 - 920 M2]</p> <p><b>Tube Length:</b> Range: 8 - 25 FEET [2.5 - 7.5 M]; Default: *20* FEET [*6* M]</p> <p><b>Number of Fins:</b> Range: 12 - 48; Default: *24*</p> <p><b>Design Press. - Gauge:</b> Max: 6,000 PSIG [40,000 KPA]</p> <p><b>No. of Tubes/Shell:</b> Default: *1*</p> <p>1 - 1 tube per shell 7 - 7 tubes per shell</p>	<p><b>FIN TUBE</b></p> 

Heat Exchangers (HE) - continued

**Description**

**Type**

Heating/cooling coil with spiral or serpentine coil of bare pipe, use as tank heater or column tray cooler to keep the contents of a tank from solidifying or becoming too viscous to pump.

This item is a steam coil. A steam coil is a long length of pipe that covers the bottom of a tank usually in a spiral or serpentine pattern. Steam is passed through the coil to heat the contents of the tank. If cooling water was passed through the coil instead of steam, this item would be a cooling coil.

This is normally a field fabricated item.

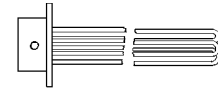
**Material Selection:** Default: \*CS\*

CS	- Carbon steel	316LP	- 316L
SS	- Stainless steel	321P	- SS321
A333C	- 3.5 Ni	CU	- Copper
A335C	- 1.25 Cr - .5 Mo - Si	NI	- Nickel
A335F	- 5 Cr - .5 Mo	MONEL	- Monel
304LP	- 304L	INCNL	- Inconel
316P	- SS316		

**Heat Transfer Area:** Range: 1 - 25,000 SF [0.1 - 2,300 M2]

**Pipe Diameter:** Range: 1 - 6 IN DIAM [25 - 150 MM DIAM]

**HEATER-STM**



Tank suction heater without tank.

**Mat'l of Construction:** Default: \*CS\*

**Heat Transfer Area:** Range: 135 - 4,000 SF [13 - 370 M2]

**SUC-HEATER**

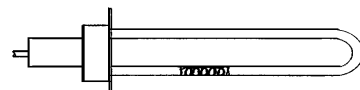
Electric immersion tank heater.

**Material Selection:** Default: \*CU\*


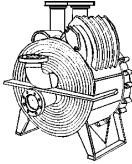
CU	- Copper
SS304	- SS304

**Power Output:** Range: 6 -200 KW

**HEATER-ELC**



## Heat Exchangers (HE) - continued

Description	Type
<p>Bare-tube double-pipe heat exchanger.</p> <p>Applicable to any heat transfer application where only a small amount of heat transfer surface area is required.</p> <p>This item is a hairpin heat exchanger. One or more finned or bare U-shaped tubes are supported concentrically inside a U-shaped shell.</p> <p><b>Material Selection:</b> Default: *CS*  CS - Carbon steel  SS - Stainless steel</p> <p><b>Heat Transfer Area:</b> 10 - 1,000 SF [1 - 90 M2]</p> <p><b>Tube Length:</b> Range: 8 - 25 FEET [2.5 - 7.5 M];  Default: *20* FEET [*6* M]</p> <p><b>No. of Tubes/Shell:</b> Default: *1*  1 - 1 tube per shell  7 - 7 tubes per shell</p> <p><b>Design Press. - Gauge:</b> Max: 6,000 PSIG [40,000 KPA]</p> <p><b>Design Temperature:</b> Max: 1,200 DEG F [645 DEG C]</p>	<p><b>JACKETED</b></p> 
<p>Spiral plate heat exchanger.</p> <p><b>Material Selection:</b> Default:*SS304*  SS304 - SS304  SS316 - SS316  TI - Titanium  HAST - Hastelloy</p> <p><b>Heat Transfer Area:</b> Range: 40 - 1,330 SF [4 - 123 M2]</p> <p><b>Tube Pressure - Gauge:</b> Range: 150 - 300 PSIG  [1,000 - 2,000 KPA]; Default: 150 PSIG [1,000 KPA]</p>	<p><b>SPIRAL PLT</b></p> 
<p>Rietz type thermascrew conveyor with motor and drive.</p> <p><b>Material Selection:</b> Default: *CS*  CS - Carbon steel  SS304 - SS304</p> <p><b>Heat Transfer Area:</b> 10 - 400 SF [1 - 37 M2]</p>	<p><b>ONE SCREW</b></p>
<p>Twin screw thermascrew conveyor with motor and drive.</p> <p><b>Material Selection:</b> Default: *CS*  CS - Carbon steel  SS304 - SS304</p> <p><b>Heat Transfer Area:</b> 10 - 400 SF [1 - 37 M2]</p>	<p><b>TWO SCREW</b></p>

Heat Exchangers (HE) - continued

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**Description**

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Waste heat boiler for generation of steam, hot gas or liquid heating medium.

A waste heat boiler is used to generate steam from heat that would otherwise be wasted. A waste heat boiler is essentially the convection section only of a normal water-tube gas or liquid boiler. The heating medium is a hot gas or liquid produced by exothermic chemical reactions, regeneration of cracking catalyst, etc.

**Mat'l of Construction:** Default: \*CS\*

**Heat Transfer Area:** Range: 1,300 - 10,000 SF [125 - 925 M2]

**Type**

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**WASTE HEAT**

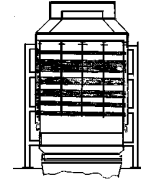


Plate and frame heat exchanger.

**PLAT+FRAM**

**Plate Material:** Default: \*SS304\*

SS304 - SS304

SS316 - SS316

S04L - 304L

S16L - 316L

HAST - Hastelloy

**Surface Area:** Range: 10 - 2,000 SF [1.0 - 185 M2]

**Number of Plates:** Max: 500

**Design Press. - Gauge:** Max: 350 PSIG [2,410 KPA];

Default: \*200\* PSIG [\*1,380\* KPA]

**Design Temperature:** Max: 400 DEG F [204 DEG C];

Default: \*200\* DEG F [\*93\* DEG C]

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## Reboilers (RB)

Reboilers are a special kind of shell and tube heat exchanger specifically designed to add heat to distillation columns. Liquid from the bottom of the distillation column flows over the reboiler tubes picking up heat from a hot fluid, such as steam, which is flowing inside the reboiler tubes. The liquid from the column is vaporized and returned to the column.

These are similar to the shell and tube heat exchanger, except that the shell is considerably larger than the tube inside. The design provides space for vapor-liquid disengagement so that only vapor is returned to the distillation column, not a vapor-liquid mixture.

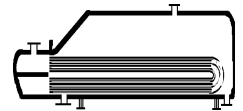
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### Description

### Type

Kettle reboilers with floating head.

**KETTLE**



Kettle reboilers are used when the hydrostatic head above the reboiler varies, when the operating pressure is in the high vacuum range or when there is a low percentage of volatiles (e.g., less than 5%) in the feed to the reboiler.

A “Kettle” reboiler is a shell and tube heat exchanger used to supply heat to a distillation column. Liquid from the bottom of the column enters the shell of the reboiler through nozzles in the underside of the shell. In order for liquid entering the shell side of the reboiler to get out it must overflow a weir at the end of the tube bundle. The weir is slightly taller than the tube bundle, thus, the reboiler tubes are always submerged. Part of the tower bottoms entering the reboiler vaporizes and returns to the tower via a vapor line called the riser. A large vapor space is provided above the tube bundle to allow for vapor liquid disengagement. The portion of entering liquid which is not vaporized overflows the weir and is removed from the reboiler. The “Kettle” reboiler is a floating head type exchanger.

**Surface Area:** Enter either heat transfer area or number of shells, tubes/shell and tube data.

**Number of Shells:** Enter either heat transfer area or number of shells, tubes/shell and tube data.

**Tube Material:** See Chapter 28 for tube materials.

Default: \*A 214\* to 800 DEG F [482 DEG C], \*304S\* for higher temperatures

**Tube Pressure - Gauge:** Default: \*150\* PSIG [\*1,000\* KPA]

**Tube Temperature:** Default: \*400\* DEG F [\*200 DEG C] for copper alloys; other material: \*650\* DEG F [\*340\* DEG C]

**Tube Outside Diam.:** Default: 0.25 - 6.0 INCHES [6 - 150 MM];

Default: \*1.0\* INCHES [\*25\* MM]

**Shell Material:** See Chapter 28 for materials.

Default: \*A285C\* to 900 DEG F [482 DEG C], \*SS304\* for higher temperatures

**Shell Pressure - Gauge:** Default: \*150\* PSIG [\*1,000\* KPA]

**Shell Temperature:** Default: \*400\* DEG F [\*200\* DEG C] for copper alloys; \*650\* DEG F [\*340\* DEG C] other material

**No. of Tubes/Shell:** Enter either heat transfer area or number of shells, tubes/shell and tube data.

**Extended Tube Length:** Range: 8 - 60 FEET [2.5 - 18 M];

Default: \*20\* FEET [\*6\* M]

Continued on next page

## Reboilers (RB) - continued

Description	Type
<b>KETTLE</b> - continued	
<p><b>Tube Gauge:</b> Enter tube gauge or thickness, not both, including corrosion allowance. Range: 1 - 24 BWG</p> <p><b>Tube Thickness:</b> Enter tube gauge or thickness, not both, including corrosion allowance. Range: 0.02 - 0.34 INCHES [0.6 - 8.6 MM]</p> <p><b>Tube Corrosion All.:</b> Default: *0.0025* INCHES [0.06 MM] for CS, *0.0* for other materials</p> <p><b>Tube Pitch:</b> Default: 1.25 x tube outside diameter</p> <p><b>Tube Pitch Symbol:</b> Default: *TRIANGULAR*</p> <p>DIAMOND - Diamond tube pitch  SQUARE - Square tube pitch  TRIANGULAR - Triangular tube pitch</p> <p><b>Shell Diameter:</b> Max: 192 INCHES [4,875 MM]; Default: *1.5 x port diameter*</p> <p><b>Shell Wall Thickness:</b> Shell wall thickness including corrosion allowance.</p> <p><b>Shell Corrosion All.:</b> Default: *0.125* INCHES [*3* MM] for CS, *0.0* for other materials.</p> <p><b>Tube Sheet Material:</b> See Chapter 28 for tube materials.</p> <p><b>Tubesheet Corr. All.:</b> Default: Lessor of 50 x tube corrosion allowance or 0.25 INCHES [6 MM].</p> <p><b>Cladding Thickness:</b> Default: 0.125 INCHES [3 MM] if cladding material is specified, otherwise 0.0.</p> <p><b>Cladding Material:</b> See Chapter 28 for cladding materials.</p> <p><b>Cladding Location:</b> Default: *SHELL*</p> <p>SHELL - Cladding on shell side only  TUBE - Cladding on tube side only  BOTH - Cladding on both shell and tube sides</p> <p><b>No. of Tube Passes:</b> Default: *2*</p> <p><b>Duty:</b> Default: 0.004 x surface area (SF); 0.01262 x surface area (M2).</p> <p><b>Percent Vaporization:</b> Max: 100; Default: *90*</p> <p><b>Sp. Gr. Tower Bottoms:</b> Default: *0.50*</p> <p><b>Mol Wgt Tower Bottom:</b> Default: *100*</p> <p><b>Heat of Vaporization:</b> Default: *150* BTU/LB [*350* KJ/KG]</p> <p><b>Stress Relief:</b> Default: See Area Design Basis</p> <p>CODE - Provide stress relief if code requires  YES - Provide stress relief  NO - No stress relief required</p> <p><b>TEMA Type:</b> Default: *BKT*</p>	



## Reboilers (RB) - continued

## Description

Kettle reboilers with u-tube.

The “u-tube” reboiler is identical to the “kettle” type reboiler except that there is a U-tube bundle in it instead of a floating head type tube bundle. The term kettle reboiler is derived from the fact that the bottoms from the distillation column accumulate in a pool (the height of the weir) in the reboiler and boil like liquid in a kettle. Therefore, both the “u-tube” and “kettle” reboilers are kettle type reboilers in the nomenclature of the chemical process industry.

**Surface Area:** Enter either heat transfer area or number of shells, tubes/shell and tube data.

**Number of Shells:** Enter either heat transfer area or number of shells, tubes/shell and tube data.

**Tube Material:** See Chapter 28 for tube materials.  
Default: \*A 214\* to 900 DEG F [482 DEG C], \*304S\* for higher temperatures.

**Tube Pressure - Gauge:** Default: \*150\* PSIG [\*1,000\* KPA]

**Tube Temperature:** Default: \*400\* DEG F [\*200\* DEG C] for copper alloys; other material: \*650\* DEG F [\*340\* DEG C]

**Tube Outside Diam.:** Range: 0.25 - 6.0 INCHES [6 - 150 MM];  
Default: \*1.0\* INCHES [\*25\* MM]

**Shell Material:** See Chapter 28 for materials.  
Default: \*A285C\* to 900 DEG F [482 DEG C], \*SS304\* for higher temperatures.

**Shell Pressure - Gauge:** Default: \*150\* PSIG [\*1,000\* KPA]

**Shell Temperature:** Default: \*400\* DEG F [\*200\* DEG C] for copper alloys; \*650\* DEG F [\*340\* DEG C] other material.

**Tube-Side Pipe Material:** See Chapter 18 for pipe materials.

**Shell-Side Pipe Material:** See Chapter 18 for pipe materials.

**No. of Tubes/Shell:** Enter either heat transfer area or number of shells, tubes/shell and tube data.

**Extended Tube Length:** Range: 8 - 120 FEET [2.5 - 36 M];  
Default: \*40\* FEET [\*12 M]

**Tube Gauge:** Enter tube gauge or thickness, not both, including corrosion allowance. Range: 1 - 24 BWG

**Tube Thickness:** Enter tube gauge or thickness, not both, including corrosion allowance. Range: 0.02 - 0.34 INCHES [0.6 - 8.6 MM].

**Tube Corrosion All.:** Default: \*0.0025\* INCHES [\*0.06\* MM] for CS, \*0.0\* for other materials.

**Tube Pitch:** Default: \*1.25 x tube outside diameter\*

**Tube Pitch Symbol:** Default: \*TRIANGULAR\*

DIAMOND - Diamond tube pitch

SQUARE - Square tube pitch

TRIANGULAR - Triangular tube pitch

**Shell Diameter:** Max: 192 INCHES [4,875 MM];

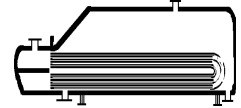
Default: \*1.5 x port diameter\*

**Shell Wall Thickness:** Shell thickness including corrosion allowance.

**Shell Corrosion All.:** Default: \*0.125\* INCHES [\*3\* MM] for CS, \*0.0\* for other materials.

## Type

U-TUBE



Continued on next page

Reboilers (RB) - continued

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**Description**

**Type**

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U-TUBE - continued

**Tubesheet Corr. All.:** See Chapter 28 for materials.

Default: Lesser of 50 x tube corrosion allowance, or  
0.25 INCHES [6 MM].

**Cladding Thickness:** See Chapter 28 for materials.

Default: \*0.125\* INCHES [\*3\* MM] if cladding material is  
specified; otherwise: \*0.0\*

**Cladding Location:** Default: \*SHELL\*

SHELL - Cladding on shell side only

TUBE - Cladding on tube side only

BOTH - Cladding on both shell and tube sides

**No. of Tube Passes:** \*2\*

**Duty:** Default: 0.004 x surface area (SF)

[0.01262 x surface are (M2)]

**Percent Vaporization:** Max: 100; Default: \*90\*

**Sp. Gr. Tower Bottoms:** \*0.5\*

**Mol Wgt Tower Bottom:** \*100\*

**Heat of Vaporization:** \*150\* BTU/LB [\*350\* KJ/KG]

**Stress Relief:** Default: See Area Design Basis

CODE - Provide stress relief if code requires

YES - Provide stress relief

NO - No stress relief required

**TEMA Type:** Default: \*BKU\*

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## Reboilers (RB) - continued

**Description****Type**

Horizontal or vertical thermosiphon reboilers.

**THERMOSIPH**

If a shell diameter is not specified, a value is calculated from the surface area, number of shells, tubes per shell, tube diameter, tube pitch, etc.

The thermosiphon reboiler is the most common reboiler used. However, the thermosiphon reboiler can not be used when the hydrostatic head above the reboiler varies, when the operating pressure is in the high vacuum range or when there is a low percentage of volatiles (e.g., less than 5%) in the feed to the reboiler.

The vertical thermosiphon reboiler, like the kettle reboiler, is a shell and tube heat exchanger used to supply heat to a distillation column. The thermosiphon reboiler operates in the following manner. Liquid from the bottom of the column or from a trapout tray flows into the bottom of the reboiler through a pipe called the downcomer. The column bottoms are partially vaporized in the reboiler and a two phase mixture is returned to the column through a pipe called the riser. The difference in density between the liquid in the downcomer and the two phase mixture in the reboiler and riser causes the tower bottoms to flow through the reboiler by natural circulation. Usually about 25% of the tower bottoms are vaporized in the thermosiphon reboiler. Thermosiphon reboilers are classified as either vertical or horizontal according to their erected position. The tower bottom enter the bottom head of the vertical thermosiphon, flow upward through the tubes and leave the top head. The heating fluid, usually steam, passes through the shell side. Vertical thermosiphons are available only as fixed tube-sheet exchangers.

The horizontal, fixed tube-sheet, thermosiphon reboiler differs from the vertical thermosiphon in that it is erected horizontally and the bottoms liquid from the distillation column flows through the shell side of the reboiler and the heat transfer fluid flows through the tubes.

**Thermosiphon Type:** Default: \*V-FXD\*

H-FLOT - Horizontal: float head

H-FXD - Horizontal: fixed tubesheet

H-UTUB - Horizontal: u-tube

V-FXD - Vertical: fixed tubesheet

**Surface Area:** Enter either heat transfer area or number of shells, tubes/shell and tube data.

**Number of Shells:** Enter either heat transfer area or number of shells, tubes/shell and tube data.

**Tube Material:** See Chapter 28 for materials.

Default: \*A 214\* to 900 DEG F [\*482\* DEG C],

\*304S\* for higher temperatures

**Tube Pressure - Gauge:** Default: \*150\* PSIG [\*1,000\* KPA]

**Tube Temperature:** Default: \*400\* DEG F [\*200\* DEG C] for copper alloys; other material: \*650\* DEG F [\*350\* DEG C].

Continued on next page

## Reboilers (RB) - continued

## Description

## Type

## THERMOSIPH - continued

**Tube Outside Diam.:** Range: 0.25 - 6.0 INCHES [6 - 150 MM];  
Default: \*1.0\* INCHES [\*25\* MM]

**Shell Material:** See Chapter 28 for materials.  
Default: \*A285C\* to 900 DEG F [482 DEG C],  
\*SS304\* for higher temperature

**Shell Pressure - Gauge:** Default: \*150\* PSIG [\*1,000\* KPA]

**Shell Temperature:** Default: \*400\* DEG F [\*200\* DEG C] for  
copper alloys; \*650\* DEG F [\*340\* DEG C] other material.

**Tube-Side Pipe Material:** See Chapter 18 for pipe materials.

**Shell-Side Pipe Material:** See Chapter 18 for pipe materials.

**No. of Tubes/Shell:** Enter either heat transfer area or number  
of shells, tubes/shell and tube data.

**Extended Tube Length:** 8 - 60 FEET [2.5 - 18 M];

Default: \*20\* FEET [\*6\* M]

**Tube Gauge:** Enter tube gauge or thickness, not both,  
including corrosion allowance. Range: 1 - 24 BWG

**Tube Thickness:** Enter tube gauge or thickness, not both,  
including corrosion allowance. Range: 0.02 to 0.34 INCHES  
[0.6 - 8.6 MM].

**Tube Corrosion All:** Default: 0.0025 INCHES [0.06 MM] for  
CS, 0.0 for other materials.

**Tube Pitch:** Default: \*1.25 x tube outside diameter\*

**Tube Pitch Symbol:** Default: \*TRIANGULAR\*

DIAMOND - Diamond tube pitch

SQUARE - Square tube pitch

TRIANGULAR - Triangular tube pitch

**Shell Diameter:** Max: 192.0 INCHES [4,875.0 MM]

**Shell Wall Thickness:** Shell thickness including corrosion  
allowance.

**Shell Corrosion All.:** Default: 0.125 INCHES [3 MM] for CS,  
0.0 for other materials.

**Tube Sheet Material:** See Chapter 28 for tube materials.

**Tubesheet Corr. All.:** Default: Lesser of 50 x tube corrosion  
allowance, or 0.25 INCHES [6 MM].

**Cladding Thickness:** Default: 0.125 INCHES [3 MM] if  
cladding material is specified, otherwise 0.0

**Cladding Material:** See Chapter 28 for materials.

**Cladding Location:** Default: \*SHELL\*

SHELL - Cladding on shell side only

TUBE - Cladding on tube side only

BOTH - Cladding on both shell and tube sides

**No. of Tube Passes:** Default: 1 pass per vertical fixed tube  
sheet type, 2 passes for all others.

**Duty:** Default: 0.004 x surface area (SF); 0.01262 x surface  
area (M2).

**Percent Vaporization:** Max: 100; Default: \*20\*

**Sp. Gr. Tower Bottoms:** Default: \*0.50\*

**Mol Wgt Tower Bottom:** Default: \*100\*

**Heat of Vaporization:** Default: \*150\*

**Stress Relief:** Default: See Area Design Basis

CODE - Provide stress relief if code requires

YES - Provide stress relief

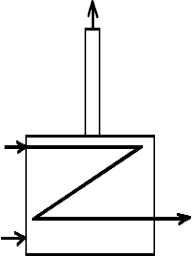
NO - No stress relief required

**TEMA Type:** Default: Based on the specified thermosiphon  
design symbol.

## Furnaces, Process Heaters (FU)

Furnaces are commonly used to heat a process fluid to a high temperature (600 - 1200°F). Furnaces are also called fired heaters or direct fired heaters because the source of heat is oil or gas fueled burners.

Furnaces are usually cylindrical (vertical heater) or rectangular (box heater) in shape. The burners may be located in the sides or floor of the furnace. The walls of the furnace are refractory (an insulating heat resistant material) lined. The furnace will have one or more smoke stacks. The process fluid being heated flows through horizontal tubes in a box furnace or vertical tubes in a vertical furnace. The amount of heat absorbed by the process fluid defines the size of the furnace. Use absorbed duty for calculations.

Description	Type
<p>A-frame process heater with sloping walls, radiant section along sides and roof of cabin, convection section in duct above roof of radiant section and vertical floor-mounted burners. For use as hot oil heater, pre-heater or cracking. Includes integral stacks.</p> <p><b>Material Selection:</b> See Chapter 28 for materials. Default: *CS*</p> <p><b>Duty:</b> Max: 500 MMBTU/H [145 MEGAW]</p> <p><b>Standard Flow Gas:</b> For liquid process fluid, enter liquid flow GPM [L/S] in place of gas flow.</p> <p><b>Process Type:</b> GAS - Gas process fluid LIQ - Liquid process fluid</p> <p><b>Design Press. - Gauge:</b> Max: 6,000 PSIG [41,000 KPA]; Default: *500* PSIG [*3,500* KPA]</p> <p><b>Design Temperature:</b> Max: 1,500 DEG F [815 DEG C]; Default: *750* DEG F [*400* DEG C]</p>	<p><b>HEATER</b></p> 
<p>Gas or oil fired for preheating, cracking; bridge walls separate radiant and convection sections; horizontal burners</p> <p>Box furnaces are the choice when a large amount of heat must be transferred to a process stream. Some specific applications are:</p> <ul style="list-style-type: none"> <li>• Pre-heating crude before it goes to the atmospheric or vacuum topping units</li> <li>• Heating for catalytic cracking</li> <li>• Providing heat for hydrocarbon cracking for ethylene</li> <li>• Providing heat for viscosity breaking.</li> </ul> <p>A box furnace is so named because the combustion chamber is box shaped. The radiant and convection sections of the box type furnace are separated by one or more walls called bridge walls. The box furnace is normally fired from end wall mounted burners; that is, the burners are mounted parallel to the floor and perpendicular to the tubes of the furnace. Box type furnaces are usually designed for large heat duty, typically above 170 MMBTU/HR. The burners may be fired with oil or gas. The box furnace can be used to provide heat input to several different process streams simultaneously.</p>	<p><b>BOX</b></p>

Continued on next page

Furnaces, Process Heaters (FU) - continued

Description

Type

BOX - continued

**Material Selection:** See Chapter 28 for materials. Default: \*CS\*  
**Duty:** Max: 500 MMBTU/H [145 MEGAW]  
**Standard Gas Flow:** For liquid process fluid, enter liquid flow in GPM [L/S] in place of gas flow.  
**Process Type:**  
 GAS - Gas process fluid  
 LIQ - Liquid process fluid  
**Design Press. - Gauge:** Max: 6,000 PSIG [41,000 KPA];  
 Default: \*500\* PSIG [\*3,500\* KPA]  
**Design Temperature:** Max: 1,500 DEG F [815 DEG C];  
 Default: \*750\* DEG F [\*400\* DEG C]

Pyrolysis.

**PYROLYSIS**

**Material Selection:** See Chapter 28 for materials. Default: \*CS\*  
**Duty:** Max: 500 MMBTU/H [145 MEGAW]  
**Standard Gas Flow:** For liquid process fluid, enter liquid flow in GPM [L/S] in place of gas flow.  
**Process Type:**  
 GAS - Gas process fluid  
 LIQ - Liquid process fluid  
**Design Press. - Gauge:** Max: 6,000 PSIG [41,000 KPA];  
 Default: \*500\* PSIG [\*3,500\* KPA]  
**Design Temperature:** Max: 1,500 DEG F [815 DEG C];  
 Default: \*750\* DEG F [\*400\* DEG C]

Box-type reformer without catalyst.

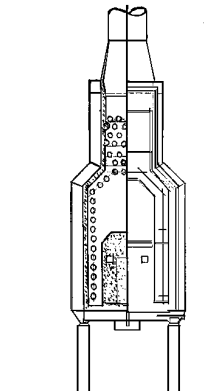
**REFORMER**

**Material Selection:** See Chapter 28 for materials. Default: \*CS\*  
**Duty:** Max: 500 MMBTU/H [145 MEGAW]  
**Standard Gas Flow:** For liquid process fluid, enter liquid flow in GPM [L/S] in place of gas flow.  
**Process Type:**  
 GAS - Gas process fluid  
 LIQ - Liquid process fluid  
**Design Press. - Gauge:** Max: 6,000 PSIG [41,000 KPA];  
 Default: \*500\* PSIG [\*3,500\* KPA]  
**Design Temperature:** Max: 1,500 DEG F [815 DEG C];  
 Default: \*750\* DEG F [\*400\* DEG C]

Gas or oil fired vertical cylindrical type for low heat duty range moderate temperature with long contact time.

**VERTICAL**

**Material Selection:** See Chapter 28 for materials. Default: \*CS\*  
**Duty:** Max: 500 MMBTU/H [145 MEGAW]  
**Standard Gas Flow:** For liquid process fluid, enter liquid flow in GPM [L/S] in place of gas flow.  
**Process Type:**  
 GAS - Gas process fluid  
 LIQ - Liquid process fluid  
**Design Press. - Gauge:** Max: 6,000 PSIG [41,000 KPA];  
 Default: \*500\* PSIG [\*3,500\* KPA]  
**Design Temperature:** Max: 1,500 DEG F [815 DEG C];  
 Default: \*750\* DEG F [\*400\* DEG C]





## ICARUS Supported TEMA Types

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### Shell and Tube Heat Exchangers

Front End Stationary Head Types	U-TUBE	FLOAT-HEAD	FIXED-T-S
	A, B, C	A, B, C	A, B, N
Shell Types	E, F, G, H, J, X	E, F, G, H, J, X	E, F, G, H, J, X
Rear End Head Types	U	P, S, T, W	L, M, N

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### Reboilers

Front End Stationary Head Types	U-TUBE	THERMOSIPH	KETTLE
	A, B, C	A, B, C, N	A, B, N
Shell Types	K,	E**, J*	K
Rear End Head Types	U	L, M, N, P*, S*, T* U*	T

TEMA CLASS B: Equipment cost includes shell, tube bundle, nozzles and saddles.  
 \* Horizontal only      \*\* Vertical only

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