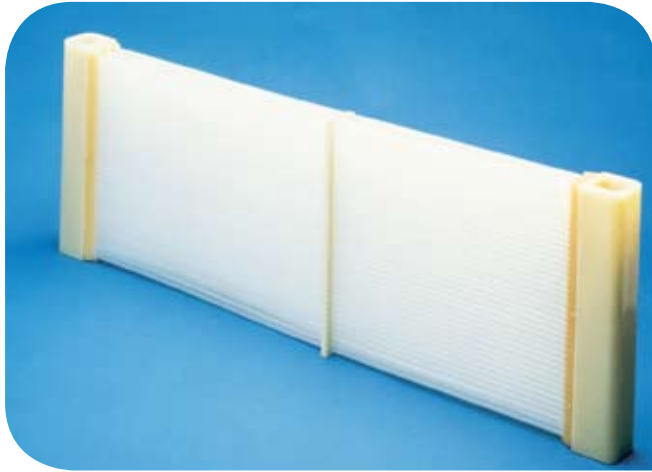


Available from Aetna Plastics
1.800.634.3074
www.aetnaplastics.com



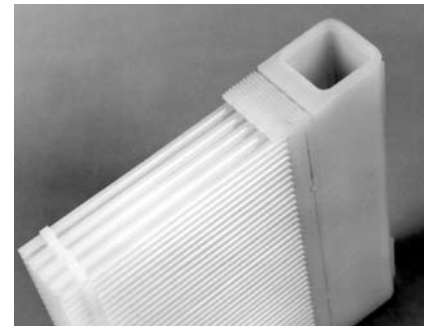
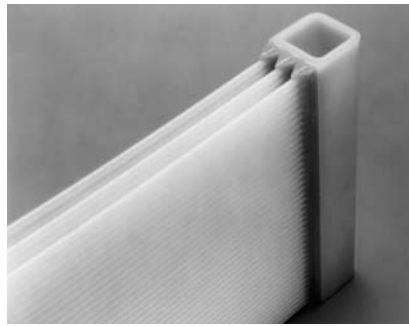
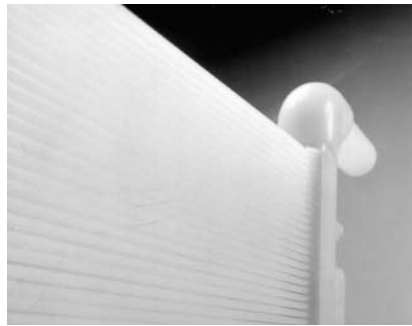
CALORPLAST Heat Exchangers

For Heating or Cooling of
Corrosive Media

- Immersion
- Tube Plate
- Gas/Liquid
- Shell and Tube

Immersion Style Heat Exchangers

Introduction



In highly corrosive media, the process of **exchanging** heat between two fluids is extremely critical. Its success depends not only upon the mechanical properties of materials, but also their resistance to the combined elements of chemical attack, high temperatures and pressures.

There are many exotic materials that can be used to handle corrosive chemicals, such as special glass, titanium, zirconium, tantalum, and chrome/nickel containing alloys. However, a short service life may be expected.

CALORPLAST is an all-plastic heat exchanger designed specifically for heating or cooling highly corrosive media. CALORPLAST heat exchangers are manufactured from PVDF (polyvinylidene fluoride), polypropylene, and polyethylene. The extreme chemical inertness of PVDF and its flexibility in fabrication make it an ideal material of construction in many chemical processes. The smooth surface of plastics tends toward very low contamination and incrustation, even in extreme applications. This enables use of the CALORPLAST in applications where metal exchangers require frequent maintenance to remove buildup from exchanger tubes.

Although fluoropolymer heat exchangers have successfully replaced costly metallic designs, until introduction of CALORPLAST there had always been problems in satisfactorily connecting heat exchanger tubes to the header manifold. CALORPLAST is produced by a patented process of continuous tube extrusion and manifold injection overmolding assuring tight connections between the exchanger tubes and the manifolds. There are no mechanical joints which can in other exchanger designs be weak spots subject to chemical attack and stress cracking.

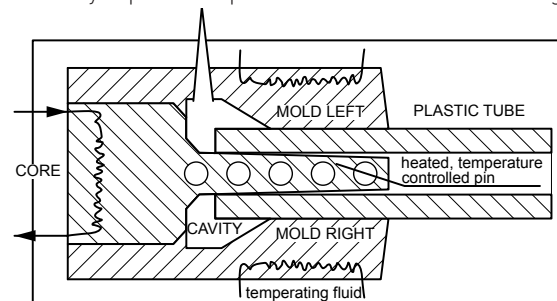
CALORPLAST is constructed of modular elements which enable the heat exchanger to be adapted to suit a

particular vessel geometry. In addition, large heat transfer surfaces are contained in a relatively small volume. Unlike many other plastic heat exchangers, CALORPLAST is a self-supporting design. Hangers, brackets, etc., are not necessary unless specifically requested by the customer.

Most heat transfer media can be used in the CALORPLAST. The most commonly used heat transfer media are steam and hot water for heating and water/glycol for cooling.

Advantages of CALORPLAST Heat Exchangers

1. Superior corrosion resistance to most acids and solutions.
2. Large heat transfer surface in a confined space.
3. All-plastic design with no elastomers, seals or mechanical joints.
4. Plastic design eliminates effect of stray current in plating applications.
5. Open flow tube bundle – tubes do not touch.
6. Modular construction enables custom adaptability to particular vessel geometry.
7. Exceptionally low fouling factors.
8. Tough, impact resistant tubes, not capillary-type tubing.
9. Low pressure drops enhancing turbulent flow resulting in maximized heat transfer capability.
10. Handle steam up to 35 psig saturated.
11. Easily repaired at plant site with a hot air welding gun.



Mechanical Strength

	Temperature of Medium	°F	68	104	140	176	212	248	281
PVDF	Maximum Operating Pressure	psig	232	174	145	109	87	65	35
PP	Maximum Operating Pressure	psig	116	87	58	29	—	—	—
PE	Maximum Operating Pressure	psig	116	87	58	[160°F max.] 29	—	—	—

Limitations

1. Maximum continuous use temperature = 281°F (PVDF)
2. Maximum saturated steam pressure = 35 psig (PVDF)
3. Maximum operating pressure at 68°F = 232 psig (PVDF)
4. Superheated steam may not be used as a heating medium.

Chemical Resistance

The CALORPLAST immersion heat exchanger can be used for heating or cooling most corrosive chemicals in open tanks. Generally, the application areas for PVDF, polypropylene, and polyethylene heat exchangers will be the same as those for SYGEF® PVDF, polypropylene, and polyethylene piping systems. The following guidelines are used when selecting the appropriate heat exchanger for a specific application:

- 1) For steam heating of inorganic and organic acids commonly used in plating (chrome, phosphoric, nickel, sulfuric, hydrochloric, nitric, hydrofluoric etc.) use PVDF.
- 2) For aqueous salt solutions and alkali solutions, use polypropylene, or polyethylene.
- 3) For any heating application utilizing steam as the heating medium, PVDF must be used. PVDF can be used up to 281°F (35 psig saturated steam).
- 4) For cooling sulfuric acid solutions, polypropylene or polyethylene should be used, as it is most economical.
- 5) For detailed chemical resistance information, visit our website at www.gfpiping.com or refer to the GF Piping Systems Engineering Handbook, Chemical Resistance Guide.

Exchanger Configurations

The CALORPLAST heat exchanger is designed in modular elements connected to provide the required heat transfer surface area for a specific application. The exchanger modules are one foot wide and are available in the following lengths: 1.7, 2.4, 3.1, 3.7, 4.4, 5.0, 5.7, 7.0, and 8.3 ft. The modules are heat fused together at the manifold headers to provide a continuous heat exchanger grid.

- Individual tubes are 6mm OD/4.8mm ID
- Modules in PVDF are available with 3 or 5 tube rows
- Modules in PE-RT are only available in 5 tube row design
- Modules in PP are only available in 3 tube row design
- Modules with 3 rows have 117 tubes each module, and modules with 5 rows have 195 tubes in each module

Tubular spacers support the consistency of shape and intertubular distances in the grid. Assembly of modules is performed using heat fusion techniques between headers, with standard accessories and tools. Interconnection of modules is made to give parallel or series flow patterns according to the specific design requirement of the heat exchanger.

As an example, refer to Table No. 1. Suppose a particular application for polypropylene requires 17 sq. ft. of heat transfer area. This could be accomplished by either a 1 ft. x 3.1 ft. heat exchanger (consisting of a single module 3.1 ft. long) or a 2 ft. x 1.7 ft. heat exchanger (consisting of two 1.7 ft. long modules fused together at the header). The configuration selected depends on price and tank configuration.

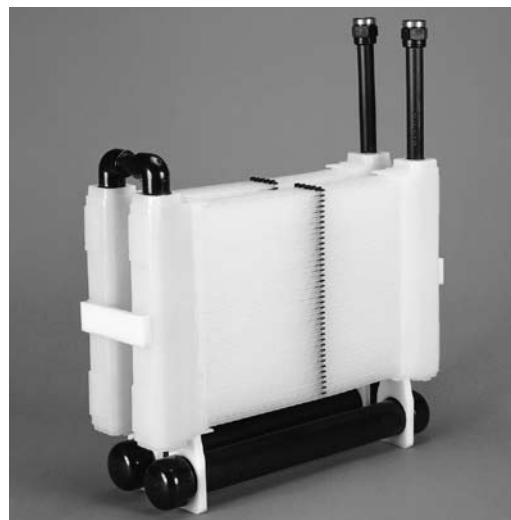
If for PVDF or polyethylene 180 sq. ft. of heat transfer surface were required, a single heat exchanger 2 ft. x 8.3 ft. or one heat exchanger 4 ft. x 4.4 ft. could be used. Both have the required 180 sq. ft. and tank configuration will determine which is selected. All modules are 2.2 inches thin which is the thickness of all CALORPLAST heat exchangers. This thin profile enables the exchanger to fit most plating/pickling tanks without interfering with parts being processed.

CALORPLAST immersion heat exchangers may be used with either vertical or horizontal tubing. Selection of a specific configuration depends on tank geometry. Generally, vertical tubing is preferred for steam heating applications because this is the most efficient design. In the vertical configuration, the height of the exchanger will be the length of a module plus 4 inches to add an anti-buoyancy weight. The anti-buoyancy weights may be



PVDF Heat Exchanger fabricated for cylindrical tank.

added to the side of the exchanger if the vessel is limited in vertical space. The horizontal dimension will be 1 ft. times the number of modules plus approximately 7" for the inlet and outlet piping. For example, a PVDF 60 sq. ft. steam heat exchanger consisting of two 3.1 ft. modules fused together will have an overall dimension of approximately 3'4" vertical x 2'7" horizontal x 2.2" thick.



Polyethylene heat exchangers offer excellent chemical resistance to sulfuric acid at temperatures up to 160°F.

Table No.1: Surface Area for Polypropylene CALORPLAST Modules (Square Feet)

H(ft) \ L(ft)	1.7	2.4	3.1	4.4	5.7	7.0	8.3
1.0	8.8	13.1	17.4	26.0	34.8	43.5	52.2
2.0	17.6	26.2	34.9	52.1	69.5	86.9	104.4
3.0	26.5	39.3	52.3	78.1	104.2	130.4	156.5
4.0	35.3	52.4	69.7	104.1	139.0	173.9	208.7
5.0	44.1	65.5	87.1	130.2	173.8	217.3	260.9
6.0	52.9	78.6	104.6	156.2	208.5	260.8	313.1

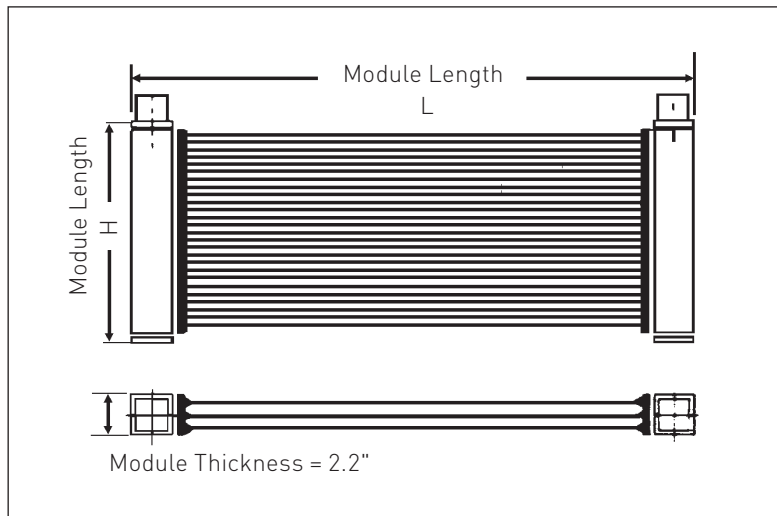
Table No. 2: Surface Area for PVDF and Polyethylene CALORPLAST Modules (Square Feet)

H(ft) \ L(ft)	1.7	2.4	3.1	3.7	4.4	5.0	5.7	7.0	8.3
1.0	15	23	30	38	45	52	60	75	90
2.0	30	45	60	75	90	105	120	150	180
3.0	45	68	90	113	135	158	180	225	270
4.0	60	90	120	150	180	210	240	300	360
5.0	75	113	150	188	225	263	300	375	450
6.0	90	135	180	225	270	315	360	450	540

Anti-Buoyancy Weights

A plastic heat exchanger may float in a fluid depending on the heating or cooling medium and on the specific gravity of the tank fluid. To prevent floating, weights are added to the bottom of the heat exchangers where needed. The weights consist of steel bar encapsulated in either PVDF, polypropylene or polyethylene. The weights are welded to the exchanger manifold. No metal is exposed to the tank fluid. A weight is always required for the following heat exchange applications.

1. Steam heating applications (always PVDF).
2. All polypropylene and polyethylene applications.
3. PVDF – heating or cooling with water when specific gravity of tank fluid is greater than 1.35.



General Applications

For any heat exchange application, there are four resistances to heat transfer encountered: the heat exchanger tube wall, the inside film and outside film resistances and an additional fouling resistance.

When comparing metal versus plastic heat exchangers, the following should be noted. For metal heat exchangers, the tube wall provides very little resistance to heat transfer. The surface and fouling resistances have the greatest effect on the overall heat transfer coefficient. Plastic heat exchangers are generally less efficient than metal ones because the tube wall is the greatest resistance to heat transfer. However, metal heat exchangers have a much greater tendency to become fouled than do plastic exchangers. Fouling greatly reduces the overall heat transfer coefficient of metal exchangers. As an example, when comparing metal with plastic exchangers, assuming no fouling of the tube wall, a plastic exchanger will require approximately 6 times as much heat transfer surface as a

metal exchanger. When normal fouling of the tube wall is considered, this ratio is reduced to about 3:1. (**Note:** The overall heat transfer coefficient is not directly related to the thermal conductivity of the exchanger tubing. As can be seen in **Table No. 3**, the ratio of thermal conductivities for stainless steel and PVDF is 900:1 but the ratio of heat transfer coefficients is approximately 3:1.)

The relatively low thermal conductivity of the plastic material will be less and less significant if the outer and inner film become the limiting resistances. Such conditions are encountered in the following applications:

1. One of the heat exchange fluids is highly viscous and flows at low velocity (open tank applications)
2. Heat is exchanged between a liquid and a gas.
3. Heat is exchanged between two gases.
4. Heat is exchanged between a condensable and a non-condensable.

Basic Calculations for Immersion Heat Exchangers

The integrated steady state modification of Fourier's general equation is accepted as: $Q = UA\Delta T_m$

Using variations of this basic equation, it is possible to readily calculate the heat exchanger surface needed, the time to accomplish a heat-up operation, or the temperature of a fluid bath at the conclusion of a preset period of time for the following basic heat exchanger applications:

1. Maintaining a constant batch temperature using condensing steam.
2. Condensing steam to heat up an aqueous chemical solution.
3. Circulating hot water to heat up an aqueous chemical solution.
4. Circulating cold water to cool an aqueous chemical solution.

To determine the heat exchanger surface area needed, it is recommended the heat exchangers be sized according to the following approximate calculations. For a detailed sizing, please contact a GF representative.

- A = heating surface (ft²)
- Q = total heat transferred (BTU/hr)
- U = overall heat transfer coefficient (BTU/hr ft²°F)
- t = tubing wall thickness (ft)

Table No. 3
Thermal Conductivity of Materials

	$k \left(\frac{\text{BTU}}{\text{hr ft } ^\circ\text{F}} \right)$	$k \left(\frac{\text{W}}{\text{m K}} \right)$
Copper	225	390
Aluminum	117	203
Graphite	87	151
Tantalum	31	54
Carbon Steel	27	47
316 SS	94	16.3
Titanium	9.2	16
Ni-Cr-Mo Alloys	5.2	9
PE (HD)	0.24-0.29	0.42-0.51
Nylon	0.12-0.17	0.21-0.30
ETFE	0.133	0.23
PFA	0.127	0.22
PP	0.127	0.22
FEP	0.116	0.20
PVDF	0.104	0.18

ΔT_m = mean logarithmic difference in temperature between hot and cold side (°F)

k = thermal conductivity of tubing material (BTU/ft hr°F)

$$A = \frac{Q}{\Delta T_m \cdot U} \text{ (ft}^2\text{)}$$

Typical Steps for Heat Exchanger Calculations

1. Determine heat losses from open top and tank walls.
2. Determine heat loss or gain from addition of liquids or metals to tank.
3. Determine heat load to heat or cool the bath liquid, if a time limit for heat up or cool down exists.
4. Calculate the required and available heating or cooling capacity.
5. Establish in/out temperatures for both liquids or media and calculate the log mean temperature difference.
6. Calculate/estimate overall heat transfer coefficient U.
7. Calculate required heat transfer area.
8. Size the module(s) according to tank dimensions and calculated heat transfer area.
9. Check tolerable pressure drop through module(s).

Heat Loss Tabulation

Heat losses to be considered include:

1. Total heat to be given or taken away from the bath or tank.
2. Heat losses from the top surface of an open tank or vessel.
3. Heat losses through the tank wall.
4. Heat losses from heating/ cooling any materials being treated and/or added to the bath.
5. Heat losses due to makeup fluids being added.
6. Heat losses due to splashing of treated materials.

Pressure Drop

Very low pressure drops occur in CALORPLAST heat exchangers due to the extremely smooth inside tube surfaces and the optimal tubing I.D. of 0.189 inches. Additionally, the heat exchanger surface consists of many parallel tubes enabling very low pressure drops. Pressure drop values per linear foot of module may be approximated by the following equations (for PVDF).

For laminar flow:

$$\Delta p(\text{psi/ft}) = 0.00035 \times \text{velocity in ft/min}$$

For turbulent flow:

$$\Delta p(\text{psi/ft}) = 0.0006 \times \text{velocity in ft/min}$$

Cross sectional area of tubes in one module = 5.46 sq. in.

For example, the pressure drop for a module 8.2 ft. long with fluid flow at 20 gpm (70 ft./min. velocity) is approximately 0.25 psi. The pressure drop across a 180° close return bend elbow (used to join two modules in series in some designs) is 0.04 psi under these conditions.

Tank Fluid Heat Requirements

Regardless whether the heat exchange requirement is for heating or cooling of the tank fluid, the heat load is calculated using the following:

$$Q = mC_p\Delta T$$

Where Q = Heat to be removed or added, in BTU/hr.

m = Quantity of fluid to be heated or cooled in lbs per hour (incorporates rate of heat-up/cool-down).

C_p = Heat capacity of the fluid to be heated or cooled (consult factory or assume value of 1 BTU/lb°F).

T = Difference between initial and final temperature of tank fluid, in °F.

Note that if the heat exchanger is to be sized to overcome tank heat losses only, the calculation for media heat up requirement may be ignored.

Cooling to Remove Electrical Energy Input

Calculate the electrical heat input using:

$$\text{Watts} = \text{Amps} \times \text{Volts}$$

To convert to BTU/Hour, use:

$$\text{Volts} \times \text{Amps} \times 3.412 = \text{BTU/HR}$$

Calculation of ΔT_m

$$\Delta T_m = \frac{\Delta T_1 - \Delta T_2}{\ln \left(\frac{\Delta T_1}{\Delta T_2} \right)}$$

ΔT_1 = Hot fluid inlet temperature—
cold fluid inlet temperature

ΔT_2 = Hot fluid outlet temperature—
cold fluid outlet temperature

Calculating the Overall Heat Transfer Coefficient (U)

“U” is an overall heat transfer coefficient based on temperature differential and unit heat transfer area. The reciprocal of U is an overall thermal resistance which can be considered as having the following components:

1. An inside film coefficient (h_i).
2. A wall coefficient (k/t).
3. An outside film coefficient (h_o).
4. Fouling factors to allow for scaling on both sides of the heat exchanger tubes (f).

Fouling Factors: Industrial experience has shown that fouling factors (f) for CALORPLAST heat exchangers may be considered inconsequential for most applications.

Determinations of the overall heat transfer coefficient (U), the inside film coefficient (h_i) and the outside film coefficient (h_o) take into account several factors, including the Nusselt Number, laminar flow, turbulent flow, natural convection (unagitated bath) and forced convection (agitated bath). Precise values for the film coefficients may be calculated only for extremely well defined heat transfer (conduction) and flow regimes.

Approximated for PVDF:

$$U = \frac{1}{\frac{1}{h_i} + \frac{0.00197}{0.104} + \frac{1}{h_o}} \quad (\text{BTU/hr} \cdot \text{ft}^2 \cdot \text{°F})$$

Approximated for Polypropylene:

$$U = \frac{1}{\frac{1}{h_i} + \frac{0.00197}{0.127} + \frac{1}{h_o}} \quad (\text{BTU/hr} \cdot \text{ft}^2 \cdot \text{°F})$$

Approximated for Polyethylene:

$$U = \frac{1}{\frac{1}{h_i} + \frac{0.00197}{0.25} + \frac{1}{h_o}} \quad (\text{BTU/hr} \cdot \text{ft}^2 \cdot \text{°F})$$

Approximation of Overall Heat Transfer Coefficient "U"

For estimates of heat transfer area requirements, an approximate value may be used for the overall heat transfer coefficient. Please refer to the following table for approximate "U" values:

Application "U" Value	(Btu/hr-sqft-°F)
Steam Heating (PVDF only)	42
Hot water PVDF	38
Cold water PVDF	33
Hot water polypropylene	40
Cold water polypropylene	35
Hot water polyethylene	48
Cold water polyethylene	39

Low temperature (below 50°F) , contact GF.

Note: These are only approximate "U" values. For detailed calculation contact a GF representative.



PVDF exchangers for cooling acid

Tube Plate Heat Exchangers

Material of construction

PVDF polyethylene and polypropylene

Applications

For heat transfer between corrosive fluids. Very suitable for high purity DI water and other high purity fluids. For condensation of aggressive vapors.

Cleaning

Heat exchangers constructed entirely of corrosion resistant plastics should be chemically cleaned.

Temperature

In accordance with the material of construction and allowable operating pressure, the following temperature is possible:

PVDF: 281°F PP: 180°F

PE: 160°F

Layout

All CALORPLAST heat exchangers are custom designed for specific operating conditions. Please submit your operating data to receive a quotation (see data sheet at back of this section)

Design

The CALORPLAST tube plate heat exchanger is an entirely new concept in heat exchanger design. It is designed to handle most corrosive heating and cooling applications when an external type heat exchanger is required.

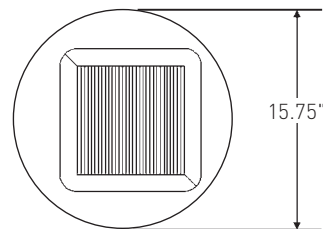
The heat transfer surface consists of a number of tube plates which are heat fused one on top of the other. The stacked tube plates form a continuous parallel series of tubes across which the shell fluid flows. The tube fluid flows within the individual tubes.

A double wall plastic pressure vessel is obtained by stacking of the tube plates. Each tube plate consists of 35 plastic tubes which terminate in a square open sided header. The tube plates are heat fused together at the side of the header so that a continuous header is formed; the length of the header depends on the number of tube plates. The flow direction of the tubing is perpendicular to the length of the exchanger.

The square header of each tube plate is partitioned diagonally at the corners to form an inlet and outlet header. If all of the tube plates are lined up in the same direction, the tubeside fluid will flow through the tube plates in a parallel flow pattern. If every other tube plate is rotated 90°, the tube side fluid will flow in series through each row of tubes. Regardless of the tubeside flow configuration, the shellside fluid always flows in the central channel formed by the inside of the tube plate header. The flow of the shellside fluid is always perpendicular to the tubeside fluid flow.

Since the entire heat exchanger is heat fused, there is no need for a mechanical seal between the shellside and tubeside fluids. Because the entire heat transfer surface is fabricated from corrosion resistant plastic, Calorplast heat exchangers are ideally suited for applications where both the tubeside and shellside fluids are corrosive.

Tube Plate Cross Section



Shell side cross flow pattern



Tube side flow pattern, customized to achieve the required thermal and hydraulic performance.

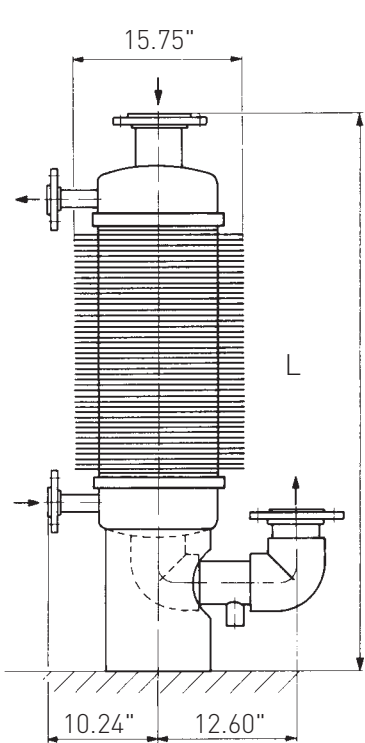


PVDF tube-plate exchangers are ideal for high-purity media.

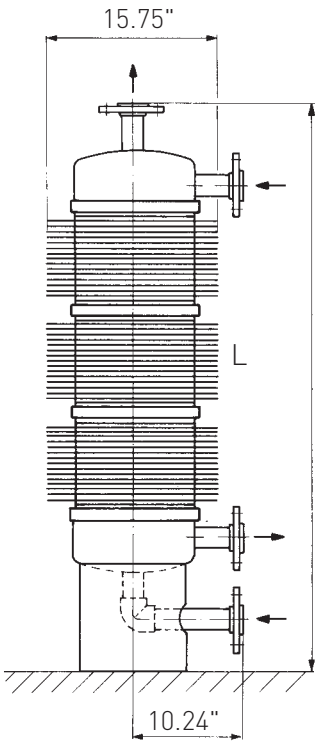


Dimensions

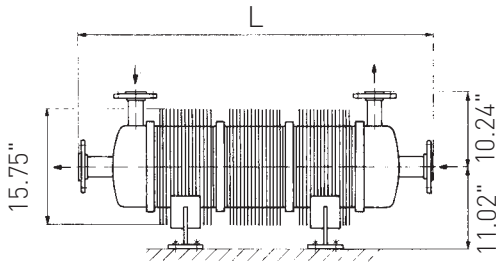
Tube size: 5 mm o.d. Ø
4 mm i.d. Ø



Condenser

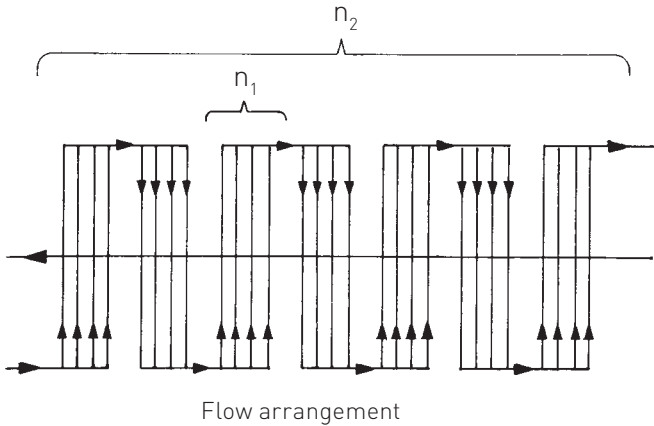


Heat exchanger in vertical position



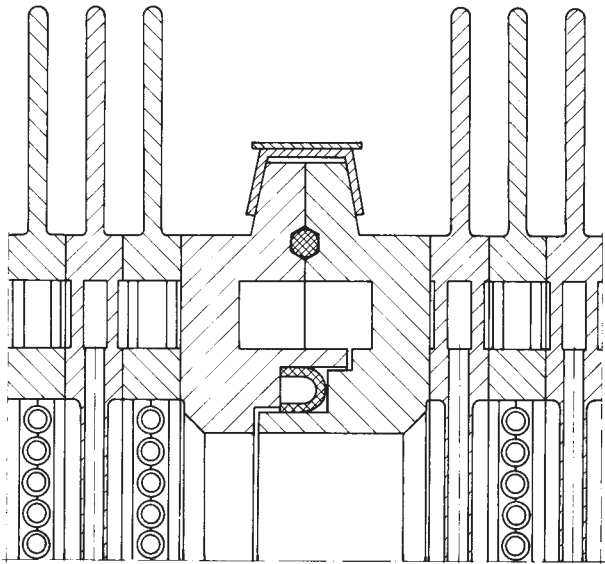
Heat exchanger in horizontal position

L = Length depending on design requirements



Flow arrangement

n_1 = Number of plates per pass
 n_2 = Number of passes per heat exchanger



Joining of modules

Permissible Working Pressures

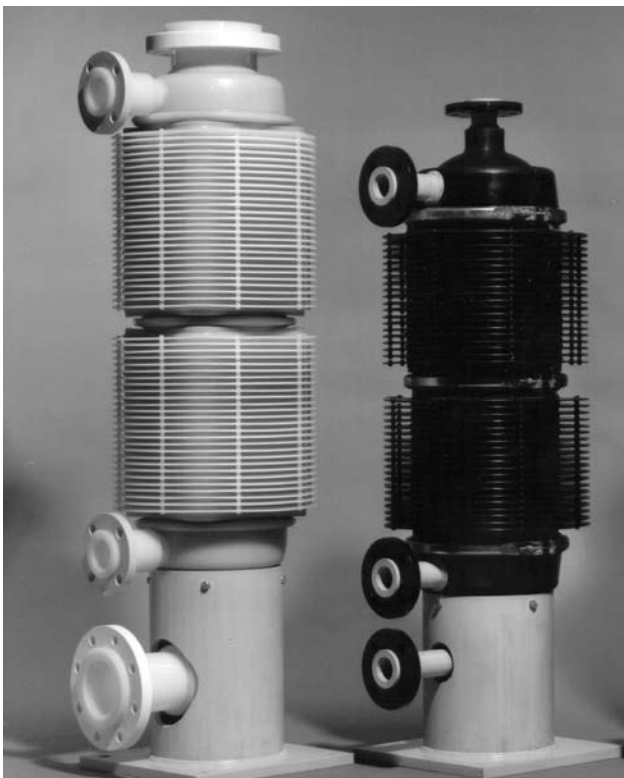
Temperature of medium (°F)		68	104	140	176	212	248	284
PVDF	rupture pressure (psig)	1160	798	725	580	435	325	253
	max working pressure (psig)	232	174	130	108	87	65	35
PP	rupture pressure (psig)	362	260	203	116			
	max working pressure (psig)	115	87	58	29			
PE	rupture pressure (psig)	362	260	203	116			
	max working pressure (psig)	115	87	58	29 at 160°F			

Typical Overall Heat Transfer Coefficients

For estimating required heat transfer surface, the following values may be used for overall heat transfer coefficient. For detailed sizing, consult a GF representative.

Application

	"U" (Btu/hr-sqft - °F)		
	PVDF	Polypropylene	Polyethylene
steam to aqueous solutions	60	—	—
hot water to aqueous solutions	53	60	80
cold water to aqueous solutions	48	53	71



PVDF, polyethylene and polypropylene tube-plate heat exchangers, in vertical orientation.

CALORPLAST Gas/Liquid Heat Exchangers for Corrosive Gases

CALORPLAST gas/liquid heat exchangers are designed specifically for condensing and/or reheating highly corrosive gas streams. Manufactured from tough, impact-resistant PVDF (polyvinylidene fluoride) polyethylene or PP (polypropylene), these exchangers are capable of handling gas stream temperatures up to 280°F (PVDF). Though standard configurations exist, each exchanger is custom built to operate for the specific heat load, gas volume and velocity of the application. They provide a significant cost savings when compared to conventional alloy/metallic exchangers. Their smooth plastic surface tends toward very low fouling and incrustation, even in severe

environments. A patented process completely eliminates elastomers, seals and mechanical joints which might otherwise produce weak spots subject to chemical attack, stress cracking and leakage.

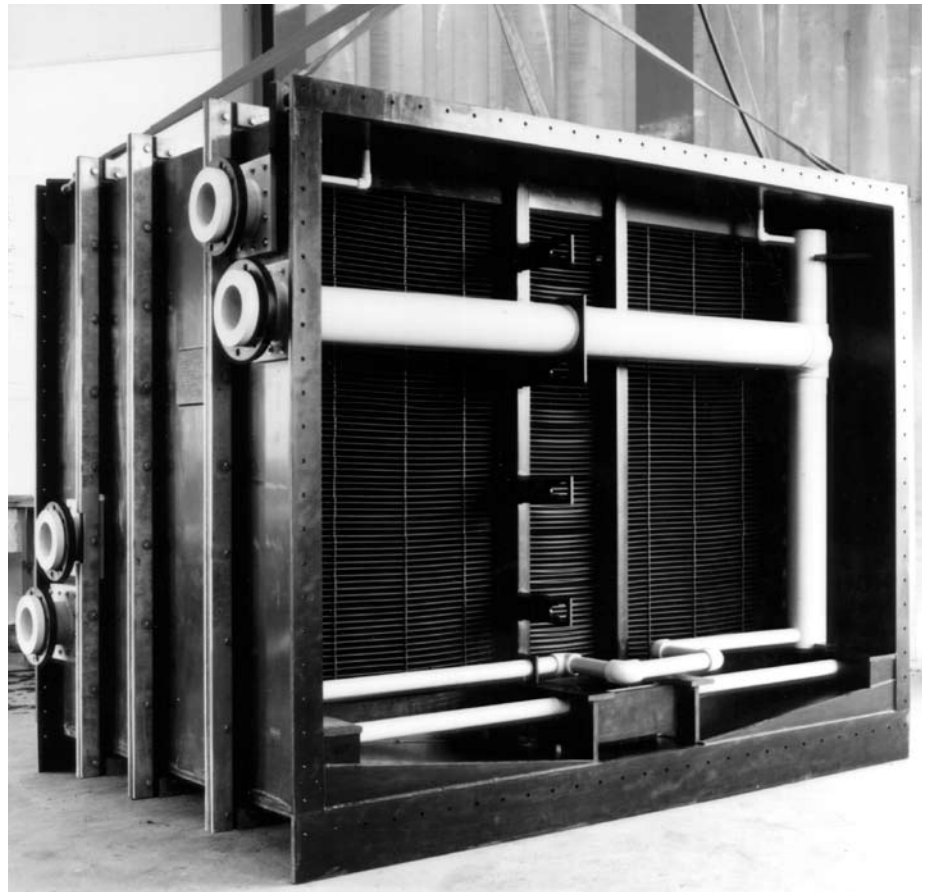
Typical uses, among others include:

- Condensation recovery of acidic components from gas streams generated in garbage and biological waste incineration
- Reheating of stack gases for plume reduction
- Waste heat recovery from corrosive streams

Design

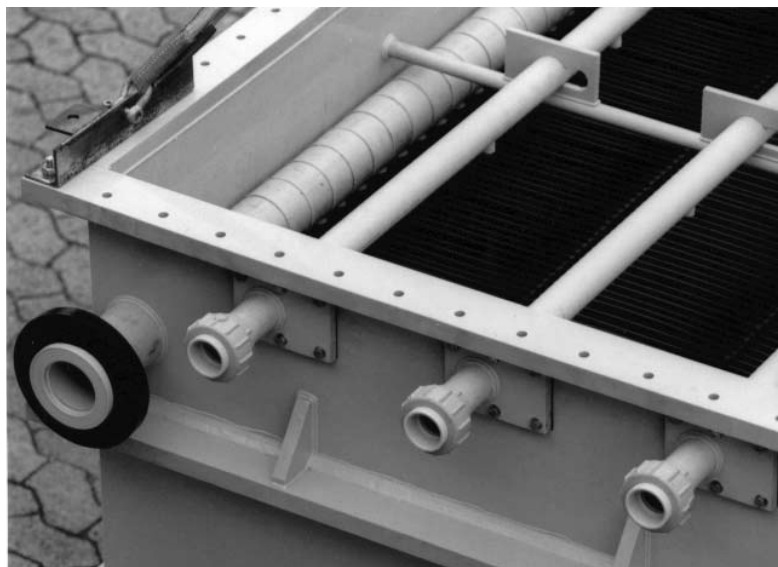
The exchanger plastic tubing is contained within standardized injection molded modules. These modules are configured depending on process requirements and installed within the corrosion resistant housing. The utility fluid flows through the tubing while the gases cool and condense on the outside tube surface.

CALORPLAST heat exchangers are cleaned by means of pressurized water or, if necessary, by use of chemical detergents. The high degree of corrosion resistance allows chemical cleaning of the CALORPLAST heat exchanger.



Characteristics

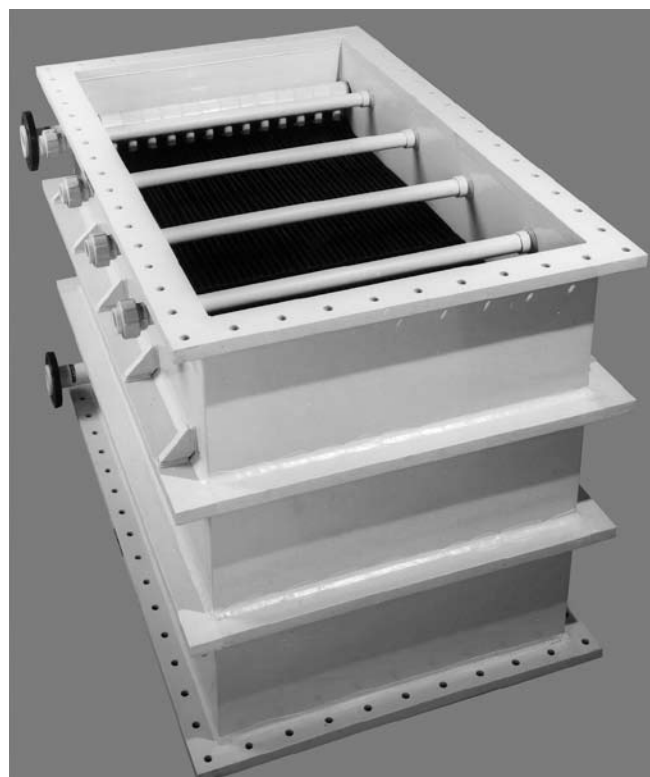
- Materials: PVDF, polyethylene and polypropylene
- Allowable operating temperature as a function of the material chosen -22°F to 280°F (PVDF)
- Outer pipe diameter 0.25"/6.4 mm, wall thickness 0.024"/0.6 mm
- Liquid collector and cleaning system, constructed of plastic, can be installed
- Strong plastic casing with load-bearing reinforcing ribs
- Casing gastight welded including condensate collector
- Casing pressure is dependent on temperature (consult factory)



Each heat exchanger can be equipped with spray nozzles for cleaning. Tubing is available in PVDF polyethylene or polypropylene. Casing available in plastic or other materials, depending on application.

Tubeside Pressure Ratings

Temperature of medium		°F	68	104	140	176	212	248	280
PVDF	Working pressure	psig	232	174	145	109	87	65	35
PP	Working pressure	psig	116	87	58	29	—	—	—
PE	Working pressure	psig	116	87	58	29 at 160°F			



Gas/liquid heat exchanger: for condensing/recovery of acid from low-pressure corrosive gas streams.

Shell and Tube Heat Exchangers

Material of Construction

PVDF, PFA, polyethylene (PE) and polypropylene (PP)

Applications

For cooling, heating, condensing or evaporating of aggressive, clean or high purity media.

Cleaning

The heat exchangers are easy to clean with pressurized water, steam or chemicals.

Temperature

In accordance with the selected material of construction and allowable pressure of media, the following maximum temperature is possible:

PVDF: 284°F	PFA: 390°F
PE: 160°F	PP: 180°F

Layout

All CALORPLAST heat exchangers are custom designed for specific operating conditions. Please submit your operating data to receive a quotation (see data sheet at back of this section). The tube bundle can be used without the shell.

Design

The CALORPLAST Shell and tube heat exchanger is designed to handle most corrosive heating and cooling applications, as well as high purity applications. The shell and tube is manufactured without seals or gaskets, providing a leak-free system for low maintenance and long service life.

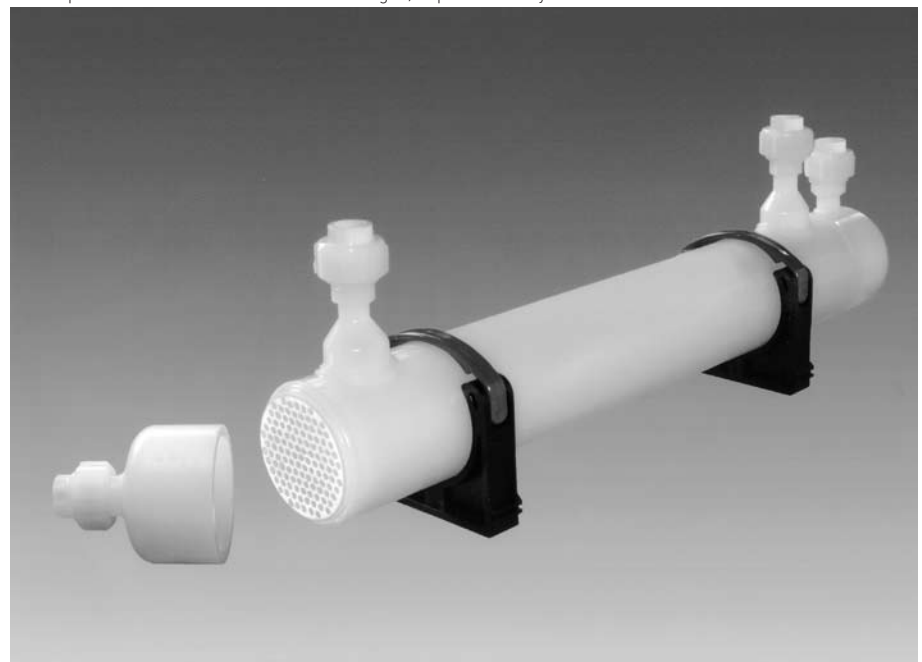
The counter flow orientation provides more efficient heat transfer between the hot and cold media. The tube fluid will flow within the individual tubes, while the shell fluid flows around the tubes.

For high purity applications the shell and tube can be fabricated and pressure tested in a Clean Room.

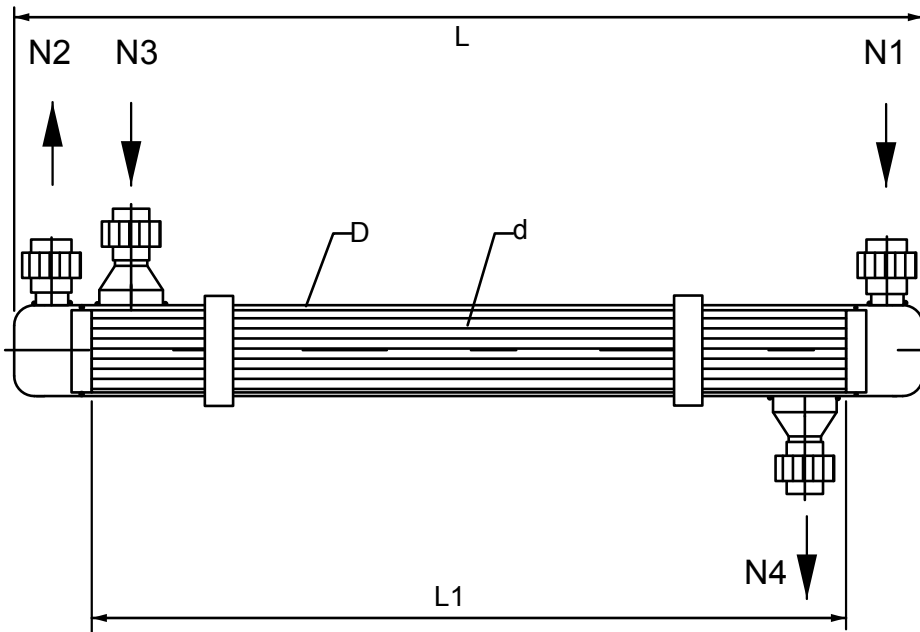
Characteristics

- High duty of heat transfer capacity by the employment of thin-walled, smooth non-fouling tubes.
- High resistance to highly corrosive media.
- Easy, compact design
- Small pressure loss: approx. 0.1 – 0.5 bar (1.2 – 7.3 psig)
- Small maintenance cost

End cap removed to show inside the exchanger; cap is normally welded on.



Shell and Tube Arrangement



Heat Transfer Area: 0.1 to 25 m² [1.08 to 269 ft²]
 Tube Diameter, d: 4; 6; 8 mm
 Wall Thickness: 0.4; 0.6; 0.8 mm
 Shell Diameter, D: up to 180 mm [~7 in.]

Total Length, L: up to 6000 mm [~236 in.]
 Connections N1-N4: Flanges
 Pipe Unions
 Threaded Connections

Permissible Working Pressures

Temperature of medium (°F)		68	104	140	176	212	248	284
PFA	Rupture pressure (psig)	870	696	565	435	290	174	87
	Max working pressure (psig)	145	116	94	73	51	29	15
PVDF	Rupture pressure (psig)	1160	798	725	580	435	325	253
	Max working pressure (psig)	174	145	109	87	65	51	43
PP/PE	Rupture pressure (psig)	362	261	203	116			
	Max working pressure (psig)	116	87	58	29			