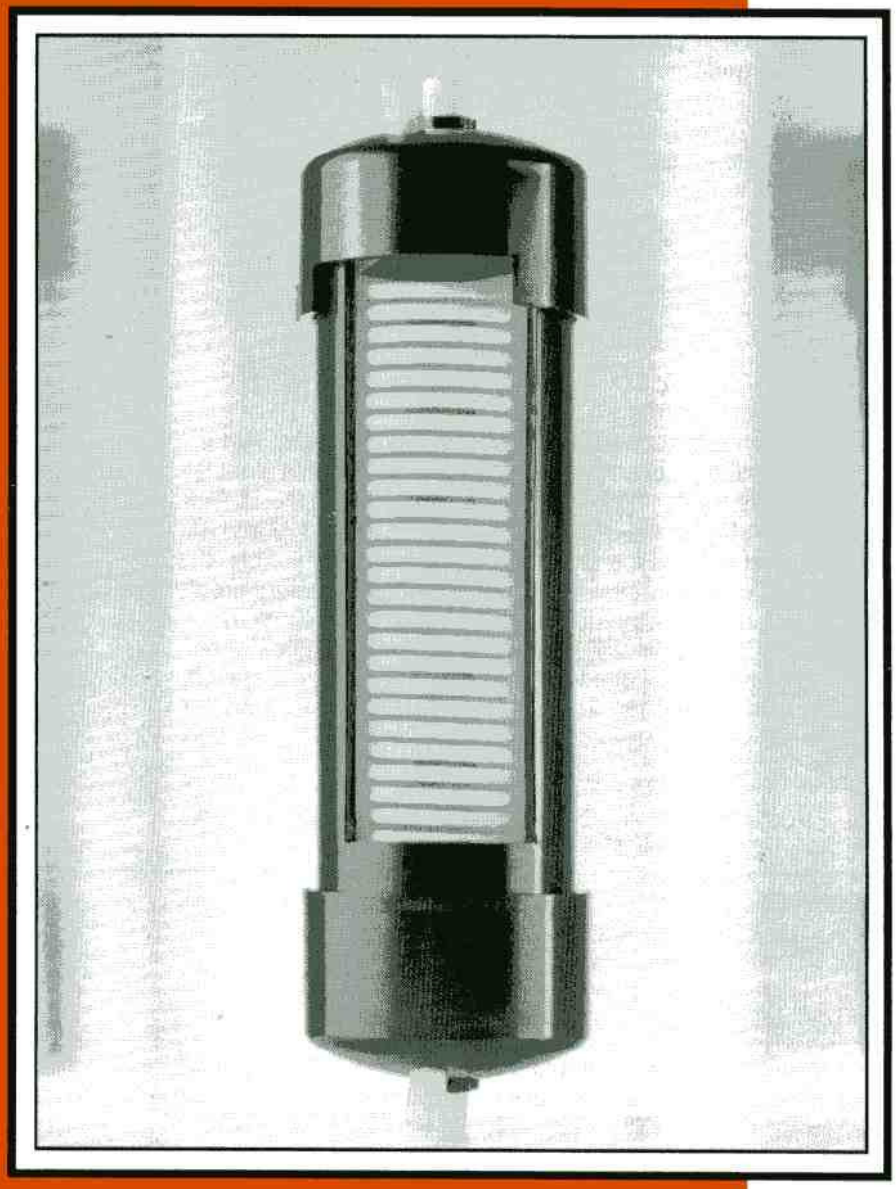
FLUOROTHERM™



ULTRAPURE SHELL AND TUBE HEAT EXCHANGER

Compact Shell and Tube Heat Exchanger – Sizing and Model Selection

1. General

Fluorotherm's shell and tube heat exchangers are designed for applications where chemical inertness at relatively high operating temperatures is critical. The major applications for these units are in the semiconductor and biotechnology (ultrapure), environmental, laboratory and products finishing industries. The design criteria employed in our shell and tube units have been developed using our experience base with Teflon® heat exchanger design and manufacturing in the US and in Europe.

2. Design Features (see Diagram)

The tube side fluid (see Diagram) flows through an ultrapure, chemically inert fluoropolymer pathway. The unit can be operated in true counterflow or in parallel flow mode[1]. Heat transfer is generally more efficient in counterflow. Except when one fluid is isothermal (e.g.: condensing steam) there is a thermal disadvantage to the use of parallel flow. The uni-directional shell and tube side flows allow for complete purging of the unit after a batch operation is completed[2]. Also, since there is no flow reversal, the formation of stagnant pockets is eliminated during continuous or batch operation. Baffles provided inside the shell increase the heat exchange contact time between fluids, thus yielding greater heat transfer efficiency[3].

1,2,3 - Key Features

3. Selection of Materials

Fluorotherm offers a variety of standard models spanning a range of operating conditions. The standard shell side materials available are PVC and CPVC. Tubing is available in PTFE, FEP, PFA and PVDF and is offered in three sizes (types 1, 2 and 3). Selection of tubing type is based on, among other factors, the maximum internal pressure and the expected pressure drop* during operation. Tube side fittings are available either in PFA or PVDF. Generally, your operating temperatures and pressures should be used to determine appropriate materials for the heat exchanger. In order to help you select materials, we have included the "Pressure Drop" and the "Maximum Operating Limits" for your reference. Be sure to check that your maximum fluid temperatures are acceptable for the shell and tube side materials (see "Notes" block). *Upon request, we will gladly provide you with assistance in materials selection in standard or in custom design options.*

** Liquid flows through the unit determine the pressure drop for a given tubing type.*

4. Sizing Your Heat Exchanger

After you have decided which materials to use, you need to size (determine sq.ft area required) your heat exchanger. List your available operating data in the *fax data sheet* provided. These include the hot and cold fluid properties, in/out temperatures, flow rates, heat load or duty (Q), the maximum operating pressure and the allowable pressure drops for both fluids. These parameters are used to calculate the log mean temperature difference ($T_{log\ mean,}$) and the overall heat transfer coefficient (U). The size or area (A) is then determined by the formula:

$$A,\ sq.ft = Q,\ Btu/hr / (T_{log\ mean,} °F \times U,\ Btu/hr./ft^2.°F)$$

If you wish, we can size the heat exchanger for you after we receive the completed fax data sheet.

The overall heat transfer coefficient U, is generally controlled by the choice of tubing material and type (size). For normal, turbulent flows, U ranges from 25 - 38 Btu/hr.ft.^{2}. °F for our standard tubing materials.

5. Model Specification

Once you have selected the materials and determined the sq.ft area required, you need to specify the model number. Check the "Pressure Drop" and the "Maximum Operating Limits" charts to be sure that your selection will perform within the constraints of your process. See the table below for the surface area currently available in standard models. Use the following procedure to specify the model number. The model is identified using the letters and numbers choices shown in the block "Notes" below:

	MATERIALS			DIA	AREA	CODE
Model No:	Shell...	Tubing...	Fitting (tube side)	– Shell.....	Heat Transfer Area.....	Tubing Type
	LETTERS				NUMBERS	

NOTES:

a. Shell Side Materials: PVC (P), CPVC (C)
Operating temperatures above 140°F for PVC and 200°F for CPVC are not recommended.
b. Tubing Materials: PTFE (T), FEP (F), PFA (P), PVDF (K)
c. Fitting Materials: PFA (P), PVDF (K)
d. Heat Transfer Area: See below for standard sizes.
e. Tubing Type: 1, 2, or 3.
Tubing type corresponds to size.

For example, a 4.74 sq. ft. unit with CPVC shell, FEP type 1 tubing, and PFA tube side fittings is described by Model CFP-641.
For information on custom sizes or OEM applications please contact Fluorotherm.

Selected Standard Models for Tube Types 1 and 3

MODEL*	...-411	...-421	...-621	...-631	...-643	...-643	...-693	...-6123
SURFACE, SQ. FT	1.38	2.08	2.25	3.37	4.74	7.17	9.48	12.18
UNIT LENGTH, IN.	16.5	21.5	16.5	21.5	25	35	44	54
UNIT DIAMETER, IN.	4	4	6	6	6	6	6	6

* For letters preceding model number in the table above refer to "MODEL SPECIFICATION" section above.

Only popular selected models are listed here. For other models, please contact Fluorotherm.

Technical Specifications

Item: Shell & Tube Heat Exchanger
Shell Side Materials: PVC/CPVC/Custom
Tube Side Materials: FEP *(Teflon®)* / PVDF *(Kynar®)*
PTFE / PFA

Maximum Operating Temperature

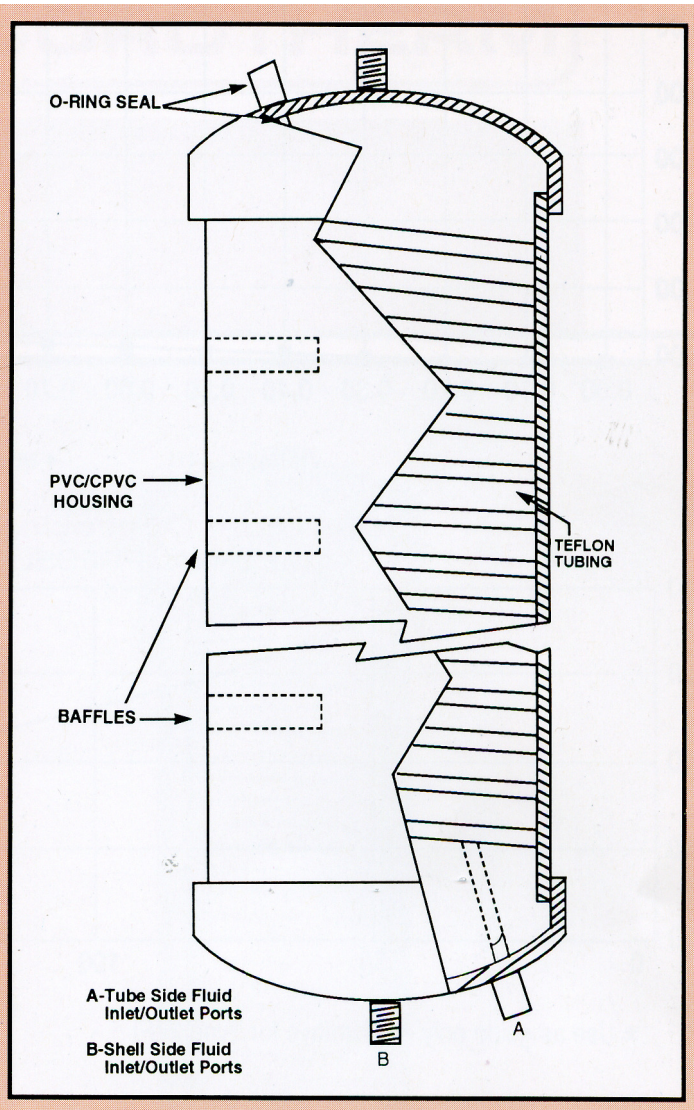
For PVC Shell: 140°F
For CPVC Shell: 200°F

Temperature and Pressure Data
– refer to Flow Rate-Pressure Drop and
"Maximum Operating Limits" Charts.

Average Heat Transfer Coefficient: 25-38 BTU/hr. ft^2. °F

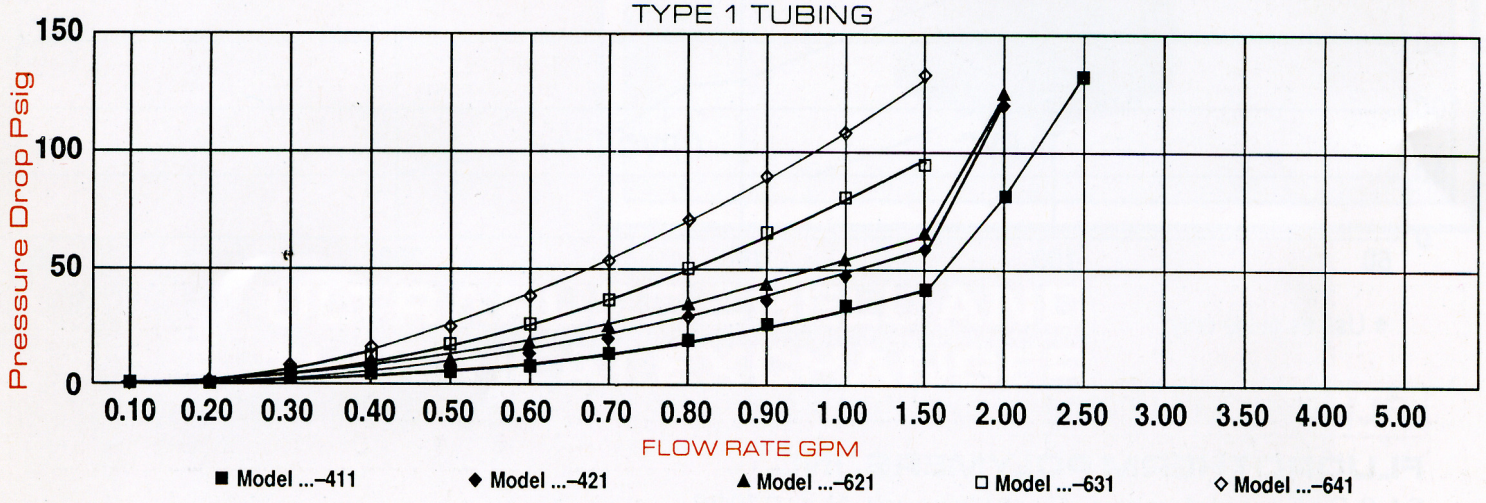
Standard Shell Side Connections:
1/2" to 1 1/2" Male or Female NPT

Standard Tube Side Connections:
1/4" or 3/8" Compression Fitting
Compatible with Tube Size



Flow Rate vs Pressure Drop

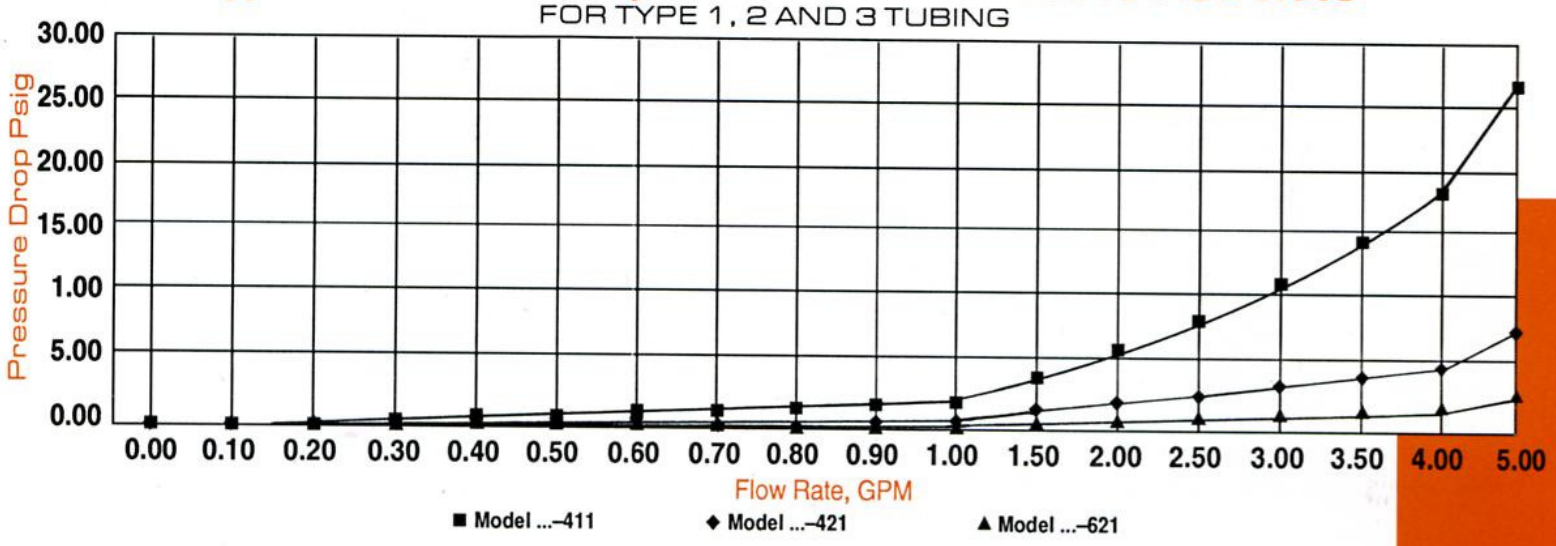
TYPE 1 TUBING



Teflon® is a registered trademark of E.I. DuPont De Nemours & Company.
Kynar® is a registered trademark of Atochem North America

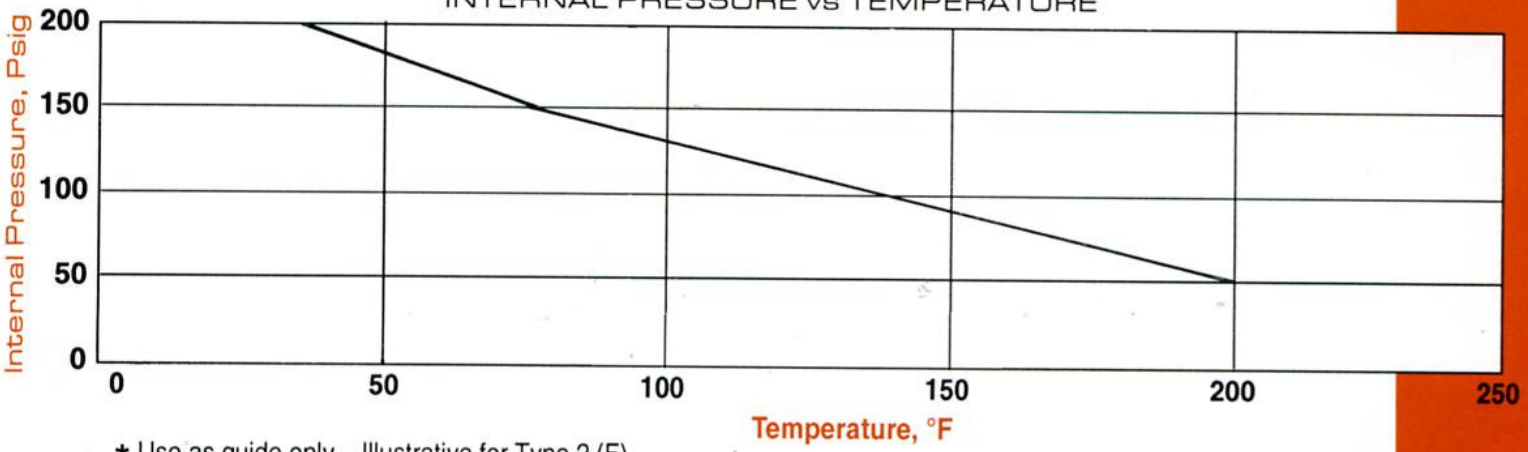
Typical Pressure Drop Per Linear Tube Feet vs Flow Rate

FOR TYPE 1, 2 AND 3 TUBING



Maximum Operating Limits * – Tube Side

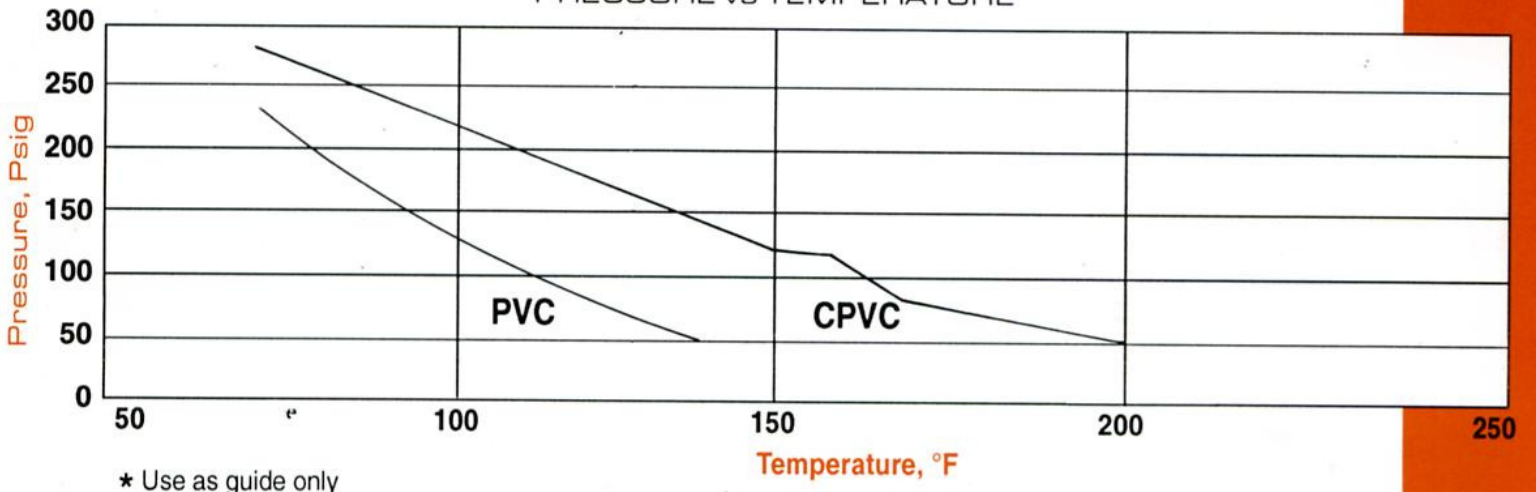
INTERNAL PRESSURE vs TEMPERATURE



* Use as guide only – Illustrative for Type 2 (F)

Maximum Operating Limits * – Shell Side

PRESSURE vs TEMPERATURE



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