Immersion Coil Installation, Operation and Maintenance Guidelines

INTRODUCTION

AMETEK Immersion Coils are assembled using fluoropolymer tubing which will not corrode and minimizes fouling. Immersion Coils are available with the following:

Standard Tubing— made from 100% FEP fluorocarbon resin.

Q-Series— made from a PFA fluorocarbon resin containing a proprietary filler.

High Purity— produced from special high purity PFA and FEP resins.

AMETEK Immersion Coils have been used in many types of plating, pickling, and crystallizing baths since 1965. The following information will assist you to understand the product and its uses as well as its operating parameters. All information provided herein applies to Immersion Coils made from either Standard Q-Series, or High Purity tubing.

Care should be taken not to accidentally cut or burn the fluoropolymer tubing. Keep knives and other sharp tools away from the tubing.

CAUTION: Tubes will be damaged if allowed to freeze with water in them. New coils may contain some water from testing; coils should be carefully drained if freezing potential exists.

INSTALLATION

Unpacking

Keep the coil in the shipping container until installation. Coil contact with floors, gratings, and other rough surfaces should be prevented to avoid possible damage.

Paperboard Shipping Cartons— Supercoils of standard lengths and configurations are shipped in heavy-duty cartons. After carefully cutting the tape which secures the carton, lift off the cover. The coil can then be removed from the box.

Wooden Shipping Boxes— Slimlines and special products may be shipped in wooden boxes. Lay the box down with lid facing upward. After carefully removing the lid, the coil can be lifted from the box.

Fiberpack Drums— Reactor Coils and Braided Coils may be shipped in fiberpack drums or boxes with a protective cotton "sockette" covering the entire bundle. These "sockettes" must be removed from the bundle by untying the knot and sliding them over one end. **DO NOT CUT THE COTTON SOCKETTE TO REMOVE IT FROM THE BUNDLE.** Carelessness in cutting can result in tube damage.

End Protectors— All coils with end hardware of fluoropolymer or stainless steel are shipped with plastic thread protectors. These protectors should remain on the coil until installation.

The successful performance and length of service of AMETEK Fluoropolymer Heat Exchangers depends on proper installation, including the design of hangers, supports and piping, operation and maintenance as outlined in this manual.

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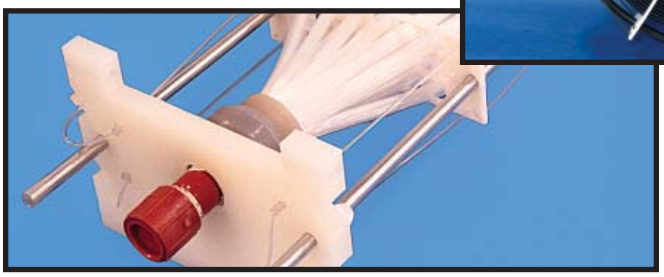
A. SUPERCOILS

M100, M168, M280, QM100, QM168, QM280, P100, P168, P280 Supercoils are used in a wide variety of electroplating, anodizing, and acid dipping operations. Ends of fluoropolymer or stainless steel are available. Lengths range from 3-16 ft. with areas of up to 113 ft^2 (10.5 m^2).

B. SLIMLINES

D105, D500, Q105, QD500, P105, P500 Slimlines are used widely in metal finishing and chemical processing industries. The 500s are frame mounted and can be configured in a variety of "U" shapes. The frame constrains the tubing to reduce movement. They are also available in a straight configuration for tankside or tank bottom installation. Lengths range from 4-16 ft. with areas up to 245 ft^2 (22.8 m^2). End fittings of fluoropolymer or stainless steel are available.



E. BRAIDED COILS

B160, B280, and B500 are used for general heating and cooling applications. The braiding provides some restraint for the tubes while still providing flexibility for installation. Fluoropolymer or stainless steel end fittings are available, with through the wall fittings available for the B500. Lengths range from 4-16 ft. and up to 245 ft^2 (22.8 m^2) in area.

Mounting of AMETEK Immersion Coils

Slimline and Supercoil heat exchangers are typically installed along a tank wall. Coils with stainless steel end connections should have the end hardware positioned at least 3 inches (7.6 cm) above the liquid surface (6 inches (15 cm) for electroless nickel plating solutions). Stainless steel end connections should not be immersed in the liquid or mounted in front of a fume exhaust as they are susceptible to chemical attack by liquid or vapor.

Coils with fluoropolymer end hardware can be completely submerged in most chemicals. Threaded fluoropolymer piping systems for use with Slimlines having fluoropolymer end connections are available. See your AMETEK representative for more details on the piping.

Coils should be located in the tank where they will not come in contact with the work being processed. In most cases the coil should be mounted approximately 10 inches (25.4 cm) from the tank bottom to reduce the possibility of temperature stratification and to keep the coils clear of any sludge buildup. If the tank is sludge free, the coil may rest on the bottom of the tank.

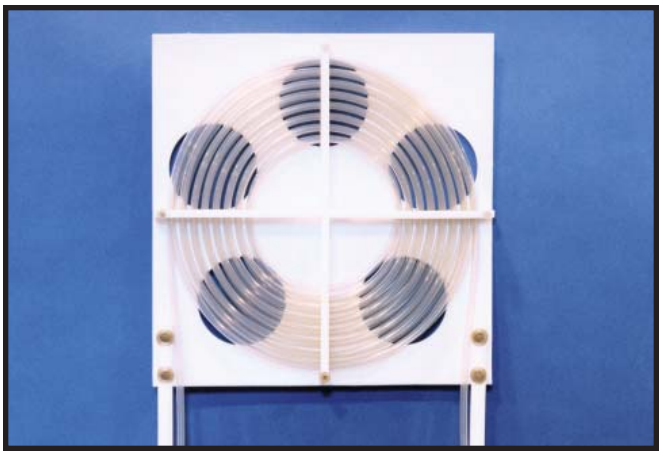
A. Supercoils are typically installed in a "U" configuration and mounted by supporting devices attached to the tank rim. "U" bolts should be used only with stainless steel end connections. "U" bolts may be fastened around the pipe nipple of the stainless steel end cap or the connecting piping, and secured to the mounting bracket. "U" bolts should not be used around ends of PTFE. These units should be mounted by use of a yoke to support the weight of the hardware. The yoke should be manufactured of a suitable corrosion resistant material and should be placed so that the underside of the end assembly rests on the yoke. Supercoils may also be suspended directly from support piping if sufficient strength and rigidity exists.

B. Slimlines are provided with mounting brackets or stands which can be attached to the tank. Additional fixturing may be required to utilize the bracket. Contact your AMETEK Sales Representative for guidance with your application.

C. Reactor Coils are supplied with either fluoropolymer or stainless steel end fittings. Additionally, the Reactor Coil can be supplied with special fittings for mounting the coils through tank nozzles either vertically or horizontally. These units are made to order for given length dimensions. All

D. MINICOILS

Minicoils are small, single or multi-tube heat exchangers mounted on a support plate, having up to 10 ft² (93 m²) in area. Minicoils are used in small metal plating or finishing baths.



C. REACTOR COILS

R160, R280, R500 Reactor Coils are designed for crystallizer operations and are also widely used as tank heaters. End fittings of stainless steel, fluoropolymer, and a special through the wall mounting configurations are available. Lengths range from 4-16 ft. with areas up to 245 ft² (22.8 m².)

nozzles should be lined with a material compatible to the process fluid.

D. ***Minicoils and Modular Coils*** are provided with mounting rods which can be utilized for support.

E. ***Braided Coils*** are typically supplied with fittings that can be mounted either as Supercoils or Reactor Coils.

Detailed mounting directions for each of the coil types listed above would depend on the application involved.

Unless weighted or restrained, coils used with steam will float on the surface of most liquids and perform unsatisfactorily. Standard Supercoils are self-weighted to prevent this (although in tanks containing fluids with a high specific gravity or high agitation, may require additional weighting or may need to be secured to the wall). Supercoils with PTFE or Polypropylene assembly hardware are not self-weighted and must be weighted or constrained to prevent flotation. Slimlines have integral support rods which provide sufficient rigidity to prevent the coil from floating or moving in the tank. Reactor Coils and Braided Coils are not weighted and must be constrained or anchored if used in steam service or in application where an agitator is present.

D105, QD105 and P105 Immersion Coils are not self-weighted, but have tie-down holes in the spacers which may be used to anchor the coil or to attach weights. Anchor weights may be constructed of any material compatible with the contents of the tank.

Protection of AMETEK Immersion Coils

When properly installed and operated, AMETEK Fluoropolymer Immersion Coils provide corrosion-free service with minimum maintenance in heating and cooling applications.

Solids buildup around the coil will not only inhibit heat transfer, it can also cause mechanical damage to the unit. Although fluoropolymers have non-stick properties, solids can still build up around the coil over time. AMETEK recommends a regular preventive maintenance program where the coils are inspected for solids buildup. For applications susceptible to solids buildup, a regularly scheduled light acid/water bath for the immersion coils can remove buildup. Contact AMETEK for more details.

In tanks where workpieces or metal strip could contact the coils, protection of the coils from possible damage is advised.

A variety of protective devices have been designed and used successfully in many existing and new tanks. The Immersion Coils should be placed in an area of the tank where physical contact is impossible, or a barrier can be installed to prevent contact. The method must be selected to accommodate the tank design and type of operation. Protective screening should not impede fluid circulation. A minimum of 70% open area is suggested for good fluid mixing.

Typical installations are illustrated in Figures 1 and 2. In many cases, variations or adaptations of these protective methods can be applied to existing tanks. For new installations, protection by remote location or with mechanical barriers can be designed into the tank.

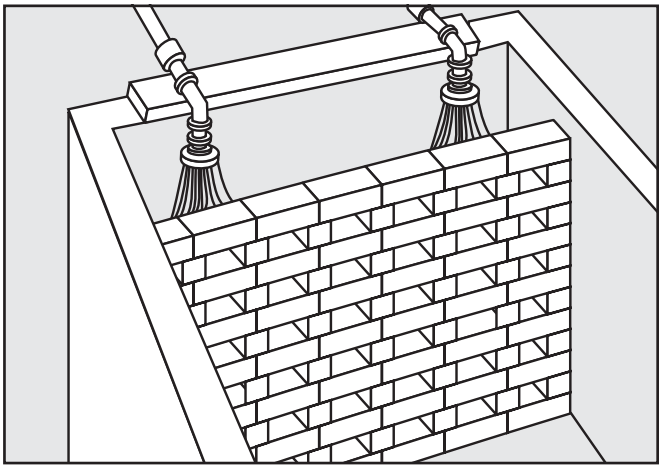


Figure 1
Place the coil behind a brick lattice. Protective shields also can be constructed of other corrosion-resistant materials such as plastic, wood, or fiberglass grating.

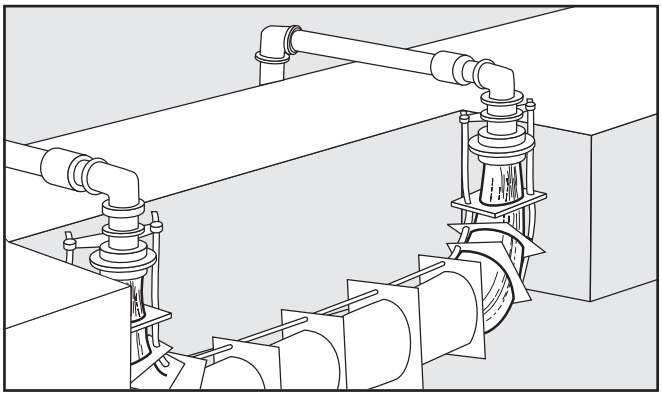


Figure 2
Install piers or pilasters at both ends of coils or create a protective cavity for the length of each coil.

AMETEK also offers guarded Slimlines and Supercoils. Contact your AMETEK representative for more information.

Piping

If the installation requires more than one coil, the coils must be connected in parallel. Coils should be positioned uniformly within the tank area. One coil per 25 ft. tank length is a minimum recommendation.

Installation piping should include valves and unions to facilitate disassembly should the coil require removal.

The following piping practices are recommended:

- **To avoid plugging by pipe scale or other solid debris, a standard "Y" strainer with a 40-60 mesh screen of suitable material should be installed in the inlet piping of the coil for both steam or liquid heating, and all cooling applications.**
- **Since fluoropolmers are polymeric materials, permeation of some corrosive chemistries through the tubing of can occur under certain circumstances. Generally rates are extremely low ($1X10^{-6}$ lbs/hr/ft^2) and do not create operation problems. Closed loop coolant/condensate systems should be avoided in applications where fluids have high permeation rates. Contact your AMETEK representative for more information on your specific application.**
- **If the steam supply exceeds the allowable temperature/pressure limits, install an adequately sized steam pressure reducing valve and/or temperature control.**
- **A safety relief valve set at 5 psi over the maximum allowable operating pressure should be mounted downstream of the reducing valve.**
- **If a temperature controller is used, it should be installed in accordance with the manufacturer's recommendations. Figures 3 and 4 show the suggested locations for controller mounting.**

Maximum allowable saturated steam pressure is as follows:

	Ends of PTFE	Stainless Steel Ends
All FEP	30 psig	42 psig
Supercoil "Q"	30	50
Slimline "Q"	50	50

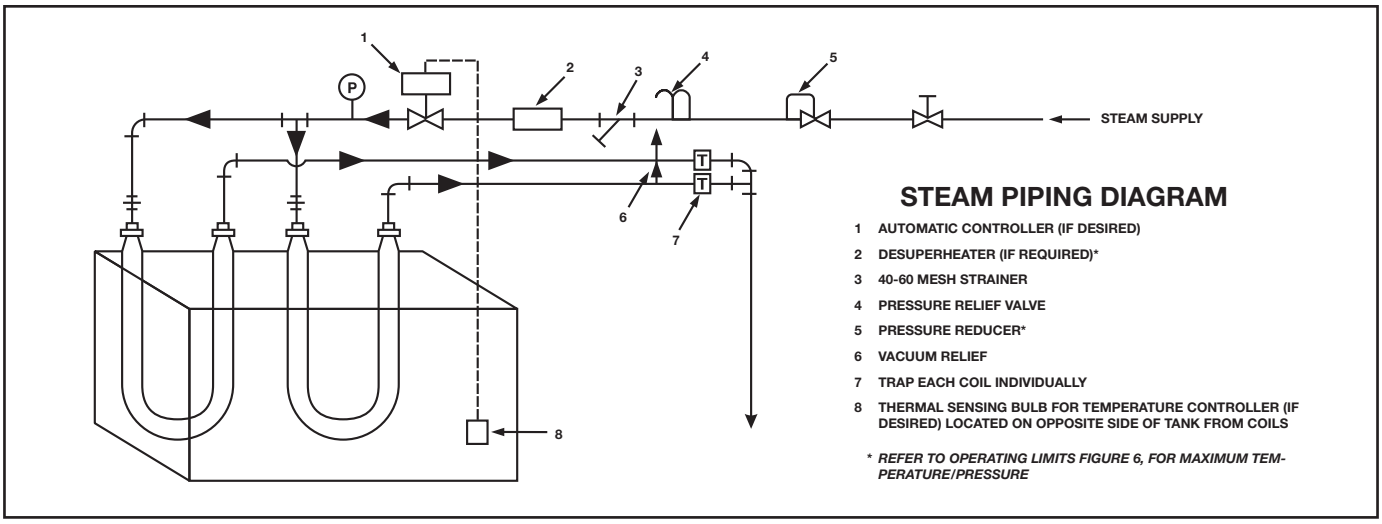


Figure 3

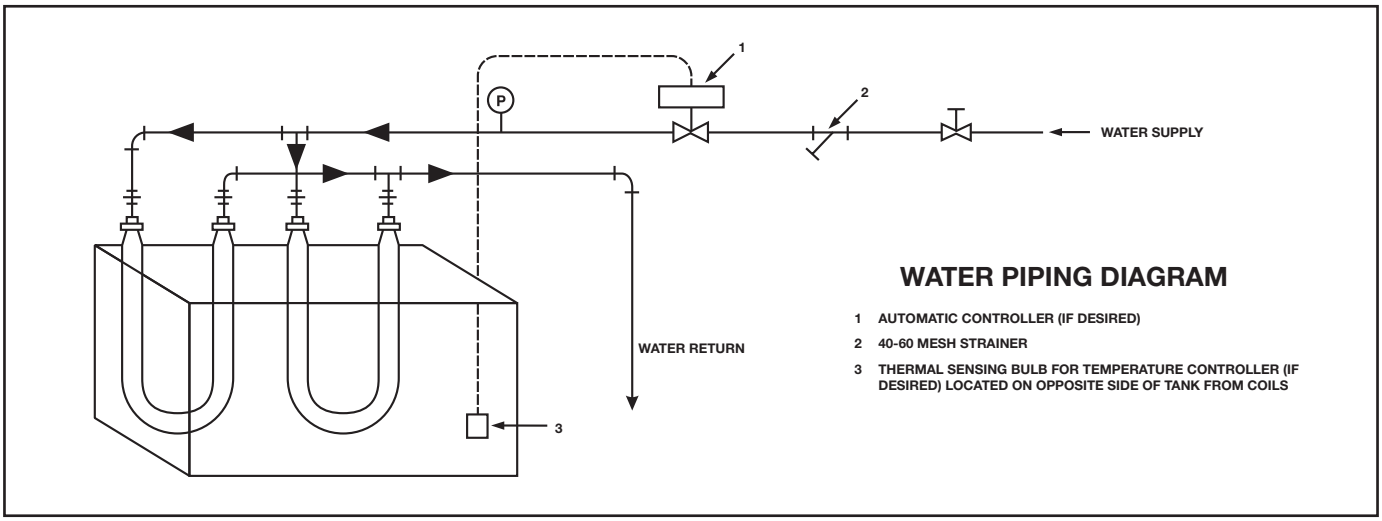


Figure 4

- ***Steam Traps*- Maximum discharge of the condensate is important to the proper operation of the coil.**

  Each coil should be trapped individually to assure complete condensate discharge.

  The traps should be mounted downstream of the coil and sized to discharge 125% of the steam flow at the discharge pressure. Failure to provide adequate steam traps may result in tube flooding which can significantly reduce heat exchanger performance. Contact a steam trap manufacturer to assure proper sizing of traps.

- **It is important to prevent the occurrence of a vacuum on the steam side of the coil. If a vacuum occurs, the corrosive bath may flow into the steam line in the event of tubing failure. Proper location of a vacuum breaker on the steam exit line can prevent such an occurrence (See Figure 3). A bleed line around the steam controller can also be used to keep a positive pressure on the tubing.**

On rare occasions, FEP Immersion Coils are susceptible to a phenomenon known as "pinholing". Pinholes occur when a steam-generated dielectric charge forms on the inside wall of the tubing. This does ***not*** occur in all steam applications, but is more of a concern where steam quality is poor. Pinholes have a minimal impact on the performance of the immersion coil, and a properly placed vacuum relief valve eliminates any concern of corrosive bath fluids flowing into the tubes. Contact AMETEK if you have any concerns over pinholing.

Typical Installation of Reactor Coils

Reactor Coils can be installed in several ways. The simplest method is to use the service piping for support mounting. Where this is not practical, through-the-wall mounting should be considered. See Reactor Coil product literature for through-the-wall mounting details.

When designing an installation with an agitator, such as crystallizer, it is important to allow for the proper amount of movement in the tubing. This is accomplished by setting the distance between the mounting surfaces slightly less than the length of the coil. The difference is referred to as "slack". In a properly designed installation, the midpoint of the tubes is free to move. Figure 5 and Table 1 shows how lateral deflection is affected by slack. Note that the effect varies with coil length.

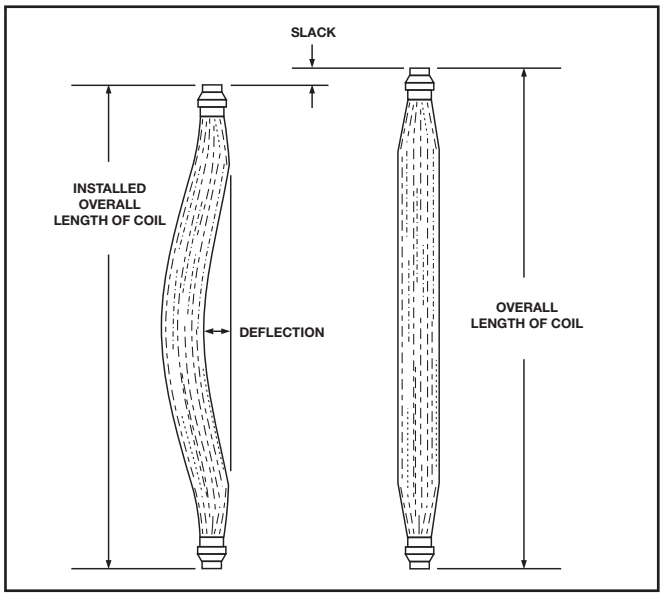


Figure 5
Coil Deflection

SLACK	COIL LENGTH (FEET)					
IN.	6	8	10	12	14	16
1/2	4.24	4.89	5.47	6	6.48	6.92
1	5.98	6.91	7.73	8.5	9.15	9.79
1 1/2	7.31	8.45	9.46	10.38	11.20	11.98
2	8.43	9.75	10.91	12.00	12.93	13.82
2 1/2	9.40	10.88	12.18	13.38	14.44	15.44
3	10.28	11.91	13.33	14.63	15.8	16.90
3 1/2	11.09	12.84	14.39	15.75	17.06	18.25
4	11.83	13.71	15.36	16.88	18.22	19.49

Table 1 Coil Deflection (Inches)

Note also that a small difference in slack has a significant effect on deflection. For that reason, it is important to keep the mounting dimensions as close to specifications as possible. A tolerance of plus or minus 1/8 inch (3 mm) is recommended. Close tolerance coils are manufactured to ± 1/2 inch (12 mm) tolerance. Spacers under the flanges can then be used for adjustments.

The following guidelines should be observed to attain optimum performance and maximum coil life:

When the Vessel is Not Agitated—

- Restrain the coil so it cannot float.
- Protect the coil from entanglement with conveyors or workpieces passing through the tank.
- Assure that tubes will not come in contact with tankwall or other parts of the tank.

When the Vessel is Agitated—

- Use a fluid velocity across the tubes in the 1 to 3 ft./sec. (.3 - .9 m/sec.) range. Velocity should not exceed 3 ft./sec. (.9 m/sec.).
- Support reactor coils only by the end connections. Intermediate restraining devices between the ends such as bands, hooks, or clamps must be avoided as they will cause tube leaks.
- Locate reactor coils so that the tubing cannot contact the wall of the vessel or any other stationary object such as baffles or pipe, and at least 18 inches (46 cm) from the agitator. (Base distance measurement on closest tube.)
- Observe the recommended distance between reactor coils (centerline to centerline) based on Deflection Table 1 - minimum should be 12 inches (30.5 cm).
  As a general rule, 0.5-1.0 inches (1.3-2.5 cm) of slack provides adequate tube movement.
  For further guidance in this area consult your AMETEK representative.

OPERATION

Pre-Operating

Be certain that the entire system is clean before starting operation. Tubes and nozzle connections to the coil can be blinded or plugged by refuse left in the piping during installation. **All piping should be flushed with water before connecting the coils.**

Integral air sparger systems are available upon request. Their use may improve tank mixing and

enhance heat distribution. However, the use of these spargers is not generally required. An air supply of 3-5 psig (21-35 kPa) maximum is sufficient to obtain effective sparger operation.

If the coil is used to heat a halogenated bath, the steam condensate should be taken to drain rather than back to the boiler since such materials have a high permeation rate through fluoropolymer tubing and will contaminate the condensate.

DO NOT OPERATE AMETEK IMMERSION COILS AT TEMPERATURES OR PRESSURES IN EXCESS OF THOSE SHOWN IN FIGURE 6.

OPERATING LIMITS

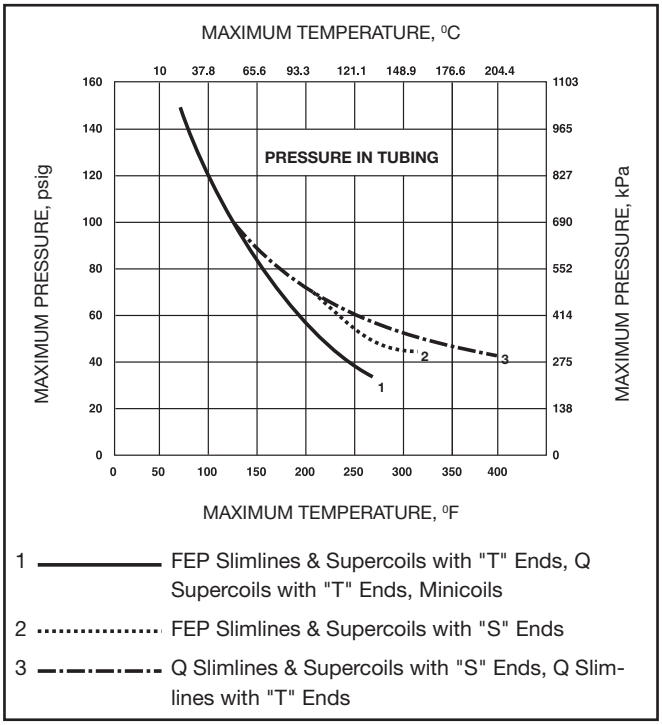


Figure 6

Start-Up

Always open all discharge valves first. This will prevent excessive pressure buildup on the coils. After the discharges are open, slowly open the supply side valves. This will ensure a safe start-up.

Excessive pressure buildup at the coil inlet will damage the tubesheet. Any "hammer" impact on the inlet will distort the tubesheet and cause irreparable damage to the coil.

TUBESIDE PRESSURE DROP

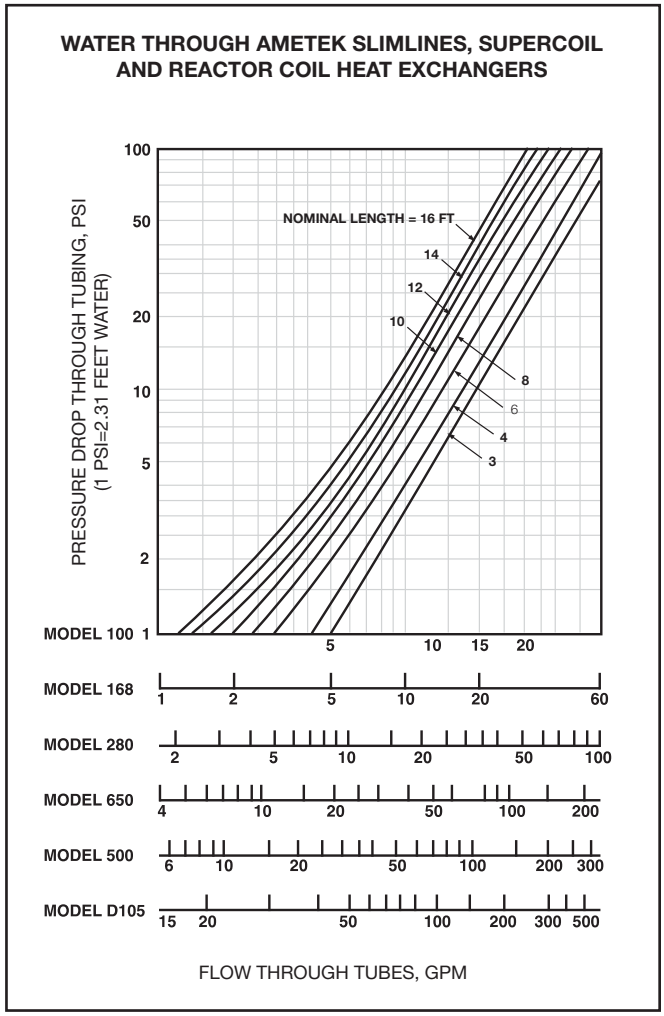


Figure 7

MAINTENANCE OF AMETEK FLUOROPOLYMER HEAT EXCHANGERS

If you have questions or need assistance in evaluating performance please call your AMETEK Heat Exchanger Representative.

Troubleshooting

If the coil does not provide the proper performance, check the following:

A. Check filters or strainers for debris. Clean as required.

B. Check steam pressure, temperature and flow rate at coil inlet vs. design specifications.

C. Check cooling water flow and temperature vs. design conditions.

D. Check temperature controllers for proper functioning.

E. Check steam trap for proper size and operation.

F. Check back pressure in condensate or water return line for obstruction which restricts flow through the coil.

G. Check the inlet end of the heat exchanger for accumulated debris. Clean if necessary.

Inspect coils for damaged or corroded end hardware which may require replacement. Replacement parts can be obtained from AMETEK. Inspect coils for leaking tubes by removing coil from the tank, capping one end of the coil, and supplying water pressure to the other end. When testing the coil, adhere to the operating limits shown in Figure 6. Water will spray out of cut or damaged tubes. If tube leaks are found, see the Heat Exchanger Repair Guidelines.

If a leak occurs under the end connection hardware (O-ring leak or tubesheet damage), the end hardware must be removed to repair the leak. The elastomers used for gaskets are subject to compression set. Periodically these gaskets should be replaced. Gaskets are available as repair kits from AMETEK. If damaged tubesheets are discovered, contact your AMETEK Representative for assistance. Fluoropolymer end fittings which are welded and have no O-ring must be returned to AMETEK for repair.

CAUTION: Supercoils with fluoropolymer end hardware may leak after storage due to compression set of elastomers. Careful tightening of the end can correct this. Overcompression may damage threads or cut elastomer; use no more than 1/4 turn when tightening.

Fluoropolymer resins are generally considered inert to most chemicals. Under certain conditions of pressure and temperature, or combinations of chemicals, fluoropolymer tubing should not be used. Please contact AMETEK for discussion of your specific process to be certain that our products are appropriate for your intended use.

Adequate ventilation should be used where fluoropolymers are heated during tube repairs. Flu-like symptoms may occur from exposure to vapors evolved from fluoropolymers at very high temperatures, up to 800°F or from smoking materials that contain particles of fluoropolymers. Symptoms pass within 48 hours and are the only adverse effects observed in humans to date. Unheated fluoropolymers are essentially inert and are nonirritating to the skin.

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