Selection Guide

Heater construction is selected on the basis of the following criteria:

- Space Available for both elements and headers. If a great deal of heat must be concentrated in a small volume, one heater with multiple elements should be used. If it is desirable to distribute the heat over a large volume, multiple heaters should be installed at intervals along the vessel.
- Watt Density or watts per square inch of element surface area, compatible with the fluid heated and the maximum fluid temperature. See Table I for recommendations. The lower the watt density required, the larger the physical size of the heater.
- Structural Strength of the vessel, both for supporting the heater(s) and to maintain system pressure.
- Controllability, to determine how closely the temperature will be maintained. In addition to the selection of a control system it is often necessary to stage the heater to achieve good control. Distribution of heat also affects controllability.

Application Factors

Carry-over - Avoid contaminating the process with chemicals carried over from other processes. This can be particularly critical in plating and cleaning lines where parts may be dipped successively in different solutions.

Sludge - Be sure that heaters are located above the point of maximum sludge buildup since sludge will insulate the heater from the solution and cause premature failure.

Temperature - Control the process temperature as closely as possible. Excess temperature reduces heater life.

Heater Cycling - Match the heater wattage as closely as possible to the actual load requirements to limit on-off cycling.

Galvanic Action - Between the heater and adjacent metallic surfaces will cause premature heater failure and may similarly corrode the tank.

Maintenance - Routine heater maintenance will help prevent small problems from becoming serious. Heaters should be examined at regular intervals for corrosion and scale buildup.

Iron Content - In critical processes where no trace of iron can be tolerated, stainless steel heaters can be electropolished before installation.

Headers - In some applications, the header material can be as critical as the sheath material. In those cases, specify the header to match the sheath and specify “welded joints” if the solution will attack silver solder.

Calculating KW Capacity

In general, KW capacity will be determined by one of two factors: the heat required to bring the process up to temperature, and the heat required to maintain the process at operating temperature. Both requirements must be calculated; heaters are selected on the basis of the method that results in the higher KW rating.

For assistance in calculating the KW capacity for your job, consult your local Heatrex representative.

Watt Density And Sheath Selection

Watt density and sheath material are the two most critical factors affecting immersion heater life. Watt density (watts per square inch of heater surface area) determines heater operating temperature for a given set of fluid conditions. Sheath material similarly determines the rate of corrosion. Both vary with fluid temperature.

Table I has sheath materials recommended for each fluid and temperature. Those with an “A” rating have the best corrosion resistance, a “B” rating indicates fair resistance. Where a range of watt densities are shown, the lower end of the range represents a more conservative design.

The maximum watt density shown is 75 watts per square inch. In some applications, even higher watt densities may be suitable depending upon the details of the application (fluid velocity, contaminants in the fluid, space between elements, etc.). Consult your local Heatrex representative if a higher watt density is desired.

Since we specialize in custom-built industrial heating equipment, Heatrex can review your applications that are out of the ordinary, including heaters for immersion in fluids not shown in the table.

While Table I represents our most current knowledge, many application factors are beyond our control. Thus, this table should be used only as a guide. Heatrex cannot be responsible for heater failures due to corrosion.

Recommended Sheath Material

Table I

Fluid	Boiling Point °F	Fluid Temp °F	Max. Watt Density W.Sq.In.	Recommended Sheath Materials: Copper	Steel	304 Stainless Steel	316 Stainless Steel	Monel 400	Titanium	Incoloy 800[6]	Inconel 600
Acetic Acid (50%)	225	100 200	50-65 20-25					B B	A A	B B	
Acetic Acid (100%)	244	100 200	30-40 10-15					B B	A A	B B	
Acetone (100%)										A	A
Alcohol (Butyl)[1]	117	110	5-7	A				A			
Alcohol (Ethyl)[1]	173	100 150	5-7 3	A A				A A			
Alcohol (Methyl)[1]	152	100 150	10-12 5	A A				A A			
Ammonia (Sat. Liquid)[5]		120	10-12		B	B	A		A		
Ammonia Chloride (50%)							A				A
Aniline (Commercial)[1]	363	100 200 300	40-55 30-55 10-15	B B B		A A A				A A A	
Asphalt (Tar)	400	300	5-9		A	A					
Benzene	176	100 150	20-25 10-15		A A	A A				A	
Calcium Chloride (30% Solution)	200	100 190	20-25 5-8	B B					A A		
Caustic Soda	215	180	25-40							B	
Chloroform	142	100 140	10-15 5-8				A A			A A	
Diphenyl $C_{12}H_{10}$	610	600	10-15		A	A				A	

Fluid	Boiling Point °F	Fluid Temp °F	Max. Watt Density W/Sq.In.	Recommended Sheath Materials: Copper	Steel	304 Stainless Steel	316 Stainless Steel	Monel 400	Titanium	Incoloy 800[6]	Inconel 600
Dowtherm-A	495	100 200 300 500	55-60 40-50 20-35 3-5		A A A A	A A A A				A A A A	
Dowtherm-E	356	100 200 300 350			A A A A	A A A A				A A A A	
Dowtherm-G	572	200 300 400 500			A A A A	A A A A				A A A A	
Ethylene Glycol (100% Solution)	392	200 300 390	30-40 20-30 5-10		A A A		A A A			A A A	
Gasoline[1] (Cracked)	405	200 300 400	35-45 15-25 3-6		B B B	A A A				A A A	
Glycerin[1]	554	300 500	15.20 3-5		B B	A A				A A	
Humbletherm 500 (Aliphatic Oil)	720-950	100 300 500 700	40-50 40-50 30-40 5-12		A A A A			A A A A		A A A A	
Jet Fuel JP-4											A
Kerosene	176	100 150	15-20 5-10		A A	A A				A A	
Methanol										A	A
Oil (Paraffin)	572	400	15-20		A	A				A	

[1]Lead sheath can be used satisfactorily with this solution up to a temperature of 250° F.
[2]Inconel sheath can be used satisfactorily with this solution.
[3]Copper sheath can be used satisfactorily with this solution.
[4]Higher watt densities could be applied depending upon specific application.
[5]Boiling point of ammonia at 14.7 PSI is 28° F and at 292.5 PSI.
[6]Incoloy can always replace steel or stainless steel.

Recommended Sheath Material

Table I

Fluid	Boiling Point °F	Fluid Temp °F	Max. Watt Density W.Sq.In.	Recommended Sheath Materials: Copper	Steel	304 Stainless Steel	316 Stainless Steel	Monel 400	Titanium	Incoloy 800[6]	Inconel 600
Oil (Vegetable)	550	100 300 400 550	30-35 15.20 5-10 2				A A A A			A A A A	
Oil (Fuel) 1&2 5&6 Bunder B&C	220	200 200 160	15-20 5-12 5-12		A A A	A A A				A A A	
Oakites 20,23,24,30,51,90	210	210	30-40		A	A				A	
Oil (Lubricating) SAE 10-20 SAE 40-60	350 370	250 160	15-20 5-12		A A	A A				A A	
Oleic Acid											A
Santowax ($C_{18}H_{14}$)	687-784	600	15-20		A	A				A	
Sodium Carbonate								A			A
Sodium Chloride[2] (25% Solution)	226	100 150 200	55-75 50-55 25-30	B B B						B B B	
Sodium Nitrate										A	A
Sulfuric Acid (30%)	332	68	25-30						A		
Therminal 44[4] (Max. Bulk Temp. 425° F)	734	100 200 300 425	25-30		A A A A	A A A A				A A A A	
Therminal 55 (Max. Bulk Temp. 575° F)	734	100 300 400 575	25-30		A A A A	A A A A				A A A A	

Fluid	Boiling Point °F	Fluid Temp °F	Max. Watt Density W/Sq.In.	Recommended Sheath Materials: Copper	Steel	304 Stainless Steel	316 Stainless Steel	Monel 400	Titanium	Incoloy 800[6]	Inconel 600
Therminal 60[4] (Max. Bulk Temp. 600° F)	741	100 200 300 500 600	25-30		A A A A A	A A A A A				A A A A A	
Therminal 66[4] (Max. Bulk Temp. 650° F)	745	100 300 500 600 650	25-30 25-30 25-30 20-25 10-15		A A A A A	A A A A A				A A A A A	
Therminol 88 (Max. Bulk Temp. 600° F) (Liquid only at 293° F)	784	300 600	30-40		A A	A A				A A	
Therminol FR-1 (Chlorinated Biphenyl)	515-680	100 200 300 400 500	20-25 20-25 20-25 10-15 3-5		A A A A A	A A A A A				A A A A A	
Trichloroethylene	189	70 100 180	20-25 15-20 3-7	A A A		A A A				A A A	
Turpentine	189	68	30-40				A			A	
Water (Potable)	212	100 212	75 50-75	B B				A A		A A	
Water (Sea)[3]	212	100 212	75 50-75					A A	A A	B B	
Water (Deionized)	212	100 212	75 50-75	B B		A A				A A	

[1]Lead sheath can be used satisfactorily with this solution up to a temperature of 250° F.
[2]Inconel sheath can be used satisfactorily with this solution.
[3]Copper sheath can be used satisfactorily with this solution.
[4]Higher watt densities could be applied depending upon specific application.
[5]Boiling point of ammonia at 14.7 PSI is 28° F and at 292.5 PSI.
[6]Incoloy can always replace steel or stainless steel.