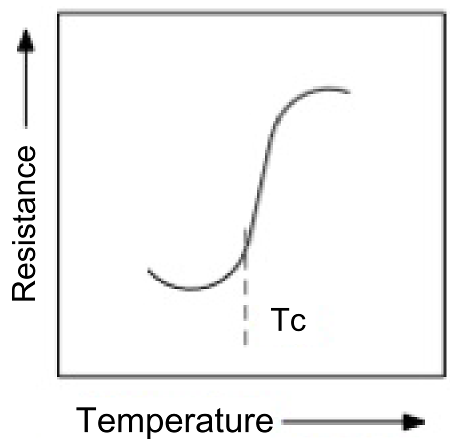
“INTRODUCING THE PRINCIPLES OF PTC HEATING TECHNOLGY”

IHC, Innovative Heat Concepts, LLC heaters incorporate a specific unique design of PTC heating elements. Most consumers are not specifically aware of what a “Positive Temperature Coefficent” heater exactly is, so we have taken the initiative to explain in greater detail.

Unlike traditional heating elements that are comprised of Nichrome resistance wire to generate heat, PTC heating elements are made as ceramic stones, based on barium titanate. These fabricated ceramic stones have exceptional unique characteristics as semiconductors and their ferro-electric properties can be precisely determined during their design.

In other words, if a voltage is placed across a PTC, current will flow and begin to heat the part. Initially, the resistance drops, allowing more current to flow, not unlike the “inrush” of an electric motor, and thus begins to heat more quickly. Once the heater starts to rise in temperature, this ceramic element exhibits a truly remarkable feature. It reaches the point where the heat generated by the part is sufficient to make up for the loss of heat to the ambient. In this situation, the heater is in equilibrium. In other words, the resistance value of the heater has suddenly increased several times to the factor of 10, and current flow diminishes towards zero, thus making the heater self-limiting in many cases. If the ambient temperature starts to decrease, the heaters resistance will decrease drawing more current and countering the cooling tendency. Conversely, any tendency to increase its temperature has the opposite effect.

The PTC ceramics are manufactured to have different fixed temperatures at which the dramatic resistance change takes place. This temperature point is called the Curie point of the PTC heater.



R-T Curve of PTCR

Even with the regard to voltage changes, the constant temperature mechanism will be effective. If the operating voltage increases, the PTC initially consumes more power, but as a result, its temperature increases more rapidly, and thus the current stabilizes more quickly at a lower level. Therefore, unlike traditional resistance wire, the performance of the PTC is not proportional to the square of the voltage as in the case of the ohmic resistance. For this reason, we can use the same heater at either 120 Vac, or 240 Vac and provide essentially the same wattage output.

A PTC heater can therefore be an effective highly energy efficient source of heat. These heaters provide lower operating costs because the wattage constantly varies from minimum to maximum based on the temperature required. In some cases, because PTC heaters have this self limiting temperature characteristic, they can be operated without the traditional need of thermostatic control and fail safe fusing as a backup safety protector to the thermostatic control. Of course, there are instances where the use of a supplementary thermostat is useful to control the heater near the required operating temperature level. This could be something that is manually adjusted to obtain various temperature settings.

IHC offers heaters that range from 1KW to 24KW and can be custom configured to meet just about any specification of wattage level. Most of IHC products carry UL, CUL and various international safety agency recognitions. Please consult the factory for specific up to date agency approval and ratings.

Most all of us have already experienced using product with PTC style heaters on a smaller scale. Our patented approach to Industrial heating along with Aquatics is somewhat unique. Small products such as plug-in air fresheners, curling irons, espresso machines and many styles of heating cables used for de-icing pipes have used this technology for years.

Another interesting feature is that PTC heaters have a virtually unlimited service life, and do not generate RFI noise and no Inductive radiation.

Electric Heater Sizing Information

This chart provides an easy reference to estimate the KW required to heat a tank. Heat losses from the surface of the solution and from the sides of the tank have been taken into account. Find the gallons at the left, move to the right of the column with the temperature at which you will be heating the solution. The number indicated here is the KW required to do the heating job. The KW figure assumes a heat-up period of six hours; for a twelve hour heat-up time simply divide the KW figure in half.

TEMPERATURE °F

Gallons	100	110	120	130	140	150	160	170	180	190	200	210
50	1	1	1	2	2	2	2	3	3	4	4	5
100	2	2	3	3	3	4	4	5	6	6	8	8
200	4	4	5	6	6	7	8	9	10	11	12	14
300	6	6	7	8	9	10	12	14	15	16	18	20
400	8	8	9	10	12	14	16	18	20	21	24	25
500	9	10	12	13	15	18	20	24	24	27	30	32
600	11	12	15	16	18	21	24	28	30	32	36	38
700	13	14	17	18	21	24	28	32	36	38	42	44
800	15	16	19	21	24	28	32	36	40	44	48	54
900	17	18	21	24	27	32	38	40	44	48	54	58
1000	18	21	24	27	30	36	40	44	48	54	58	64

Determining Specific Heating Requirements for Electric Heaters

To determine the heating requirement of a tank, first obtain the following information:

1 **Total cubic feet of tank.** (Multiply the inside dimensions of the tank - depth x width x length.)
2 **Total gallons of solution.** (Multiply by 7.48 the cubic feet of the tank occupied by the solution. If the solution is normally 6" below the top of the tank, allow this when figuring)
3 **Average ambient (room) temperature** at which the tank will be used.
4 **Temperature level** at which solution is to be held.
5 **Heat up time desired.**

After this information is known, the following calculations can be made:

Formula: $\frac{A \times 1.0^{*} \times 8.35^{**} \times B}{3412 \times C} = \square$

$D \times E = \square$

Add the results of both calculations. The total is the Kilowatt requirement of the tank.

A = Total gallons of solution.
B = Difference from ambient temperature and desired solution temperature.
C = Desired heat-up time (hours).
D = Heat loss of tank - refer to charts on following page.
E = Square feet of top of tank (multiply length x width).
* Specific heat of water. Insert specific heat of you solution here.
** Weight of water. Insert specific weight of your solution here.

Sample Problem

Tank Specifications:
Dimensions: 4' deep x 3' wide x 5' long or 488 gallons
Operating Temperature: 160°F
Heat-up Time: 6 hours
Assume tank heat up to be from room temperature (70°F to 160°F)

INITIAL HEAT UP FORMULA APPLICATION

$\frac{448 \text{ gallons} \times 1.0 \times 8.35 \times 90}{3412 \times 6 \text{ hours}} = \frac{336672}{20472} = \textbf{16KW}$

Surface Loss Calculation
15sq. ft. (surface area) x .34 (open tank surface loss factor) = 5KW
Total KW needed = 16KW + 5KW = **21KW**

Surface Loss From Open Hot Water Tank with Mild Air Agitation or Ventilation (120) FPM

(Expressed in KW)

TANK TEMPERATURE	
80	.03
85	.05
90	.07
95	.09
100	.11
105	.13
110	.15
115	.18
120	.21
125	.25
130	.30
135	.35
140	.41
145	.45

(Expressed in KW)

TANK TEMPERATURE	
150	.51
155	.58
160	.65
165	.73
170	.83
175	.95
180	1.1
190	1.3
195	1.6
200	2.35
205	2.80
210	3.25
215	3.75

Surface Loss From Open Hot Water Tank

(Expressed in KW)

TANK TEMPERATURE	
80	--
85	.01
90	.02
95	.04
100	.05
105	.065
110	.09
115	.10
120	.12
125	.14
130	.16
135	.18
140	.21
145	.24

(Expressed in KW)

TANK TEMPERATURE	
150	.27
155	.30
160	.34
165	.37
170	.41
175	.45
180	.50
185	.55
190	.60
195	.66
200	.72
205	.80
210	.87
215	.95

Immersion Heater Solutions Guide

IHC Innovative Thinking
1.800.241.0412
www.innovativeheatconcepts.com

Solution	Type of Heater
Acetic	TEFLON* or Quartz
Acid Sulfate	TEFLON* or Quartz
Alkaline Cleaners (Electrified)	304 Stainless Steel
Alkaline Soaking Cleaners	304 Stainless Steel
Alodine	316 Stainless Steel
Aluminum Anodizing	TEFLON* or Quartz
Aluminum Bright Dip	TEFLON* or Quartz
Aluminum Cleaners	304 Stainless Steel †
Aluminum Chloride	TEFLON* or Quartz
Aluminum Sulfate	304 Stainless Steel
Ammonia Persulfate	TEFLON* or Quartz
Ammonium Bi Fluoride	TEFLON*
Anodizing	TEFLON* or Quartz
Arsenic	304 Stainless Steel
Black Nickel	TEFLON*, or Quartz
Black Oxide (Hi-Temp)	Mild Steel; 304 Stainless Steel †
Black Oxide (Low-Temp)	Titanium
Bonderizing	316 Stainless Steel
Brass Cyanide	304 Stainless Steel
Bright Nickel	TEFLON*, Quartz or Titanium
Bright Copper-Cyanide	304 Stainless Steel
Bronze	304 Stainless Steel
Brown Oxide	Titanium
Cadmium Black	TEFLON* or Quartz
Cadmium (Alkaline)	304 Stainless Steel
Cadmium Fluoborate	TEFLON*
Caustic Etch	Steel †
Caustics	Steel
Caustics (highly concentrated 20% & over)	Steel †
Chloride	TEFLON* or Quartz
Chromic Anodizing	TEFLON* or Quartz
Chromium (No Fluorides)	TEFLON*, Quartz or Titanium
Chromium (Fluoride)	TEFLON*
Clear Chromate	TEFLON* or Quartz
Cobalt Nickel	TEFLON*, Quartz or Titanium
Cobalt Plating	304 Stainless Steel
Copper Acid	TEFLON* or Quartz
Copper Bright Acid	TEFLON* or Quartz
Copper Cyanide	304 Stainless Steel
Copper Fluoborate	TEFLON*
Copper Pyrophosphate	304 Stainless Steel
Copper Strike	304 Stainless Steel
Copper Sulfate	TEFLON* or Quartz
Cyanide	316 Stainless Steel
Deionized Water	316 Stainless Steel
Deoxidizer (Etching)	Quartz
Deoxidizer (Non-Chromated)	316 Stainless Steel
Dichromic Seal	Steel
Dye Solutions	304 Stainless Steel
Ebonal Copper	Titanium
Electroless Copper	TEFLON*
Electroless Nickel	316 SS; TEFLON* or Titanium †
Electroless Tin (Acid)	TEFLON* or Quartz
Electroless Tin (Alkaline)	316 Stainless Steel
Electro Cleaner	304 Stainless Steel
Electro Polishing	TEFLON* or Quartz
Ethylene Glycol	Steel
Ferric Sulfate	304 Stainless Steel †
Ferric Chloride	TEFLON*, Quartz or Titanium
Fluoborate	TEFLON*

Solution	Type of Heater
Immersion Gold	304 Stainless Steel
Gold Acid	TEFLON*, Quartz or Titanium
Gold Cyanide	304 Stainless Steel
Grey Nickel	TEFLON*, Quartz or Titanium
Hot Seal Dichromate	316 Stainless Steel
Hydrogen Peroxide	TEFLON* or Quartz †
Hydrochloric Acid	TEFLON* or Quartz
Hydrofluoric Acid	TEFLON*
Iron Fluoborate	TEFLON*
Iron Phosphate	316 Stainless Steel †
Lean Acetate	304 Stainless Steel
Lime Saturated Water (Alkaline)	316 Stainless Steel †
Magnesium Hydroxide	304 Stainless Steel †
Manganese Phosphate	316 Stainless Steel †
Muriatic Acid	TEFLON* or Quartz
Nickel (Plating Solution) (Watts)	TEFLON*, Quartz or Titanium
Nickel Acetate Seat	316 Stainless Steel
Nickel Chloride	Titanium
Nitric Acid	Quartz
Oil	Steel †
Paint Stripper (Alkaline)	304 Stainless Steel †
Perchlorethylene	316 Stainless Steel †
Phosphoric Acid (No Fluoride)	TEFLON* or Quartz †
Phosphate Cleaner	304 Stainless Steel †
Phosphate	316 Stainless Steel †
Potassium Acid Sulfate	TEFLON* or Quartz
Potassium Cyanide	304 Stainless Steel
Potassium Hydroxide	304 Stainless Steel
Potassium Hydrochloric	TEFLON* or Quartz
Potassium Permanganate	TEFLON* or Titanium †
Rhodium	TEFLON* or Quartz
Rochelle Salt Cyanide	304 Stainless Steel
Sea Water	Titanium
Silver Bromide	316 Stainless Steel
Silver Cyanide	304 Stainless Steel
Silver Nitrate	316 Stainless Steel
Sodium Dichromate (Hot Seal)	316 Stainless Steel
Sodium Hydroxide	Steel
Sodium Persulfate	TEFLON* or Quartz
Stannate	Steel
Stanostar	TEFLON* or Quartz
Sulfamate Nickel	TEFLON*, Quartz or Titanium
Sulfuric Acid	TEFLON* or Quartz
Sulphamic Acid	TEFLON* or Quartz
Tannic Acid	Titanium
Tin Nickel	TEFLON*
Tin Plating (Acid)(Stanus/Sulphate)	TEFLON* or Quartz
Tin Plating (Alkaline)	304 Stainless Steel
Trichlorethylene	316 Stainless Steel †
Trioxide (Pickle)	TEFLON* or Quartz
Water	316 or 304 Stainless Steel
Wood's Nickel Strike	TEFLON* or Quartz
Yellow Dichromate	TEFLON* or Quartz
Zinc Acid	TEFLON* or Titanium

† Should Be Derated Heater

This information is provided as a courtesy selection guide only. Due to the complexities of solutions and applications, IIHC cannot assume responsibility for any advice furnished. We do not guarantee heaters against premature failure due to corrosive action caused by unusual conditions. It is solely the customers' obligation to contact his chemical supplier for heater sheath compatibility.

NEVER USE ELECTRIC IMMERSION HEATERS TO HEAT FLAMMABLE SOLUTIONS!

*Registered trademark for fluoropolymer resins, films and fibers made by DuPont.

Control Amperage Selector

Heater Wattage	Heating Load Amperage							
	Single Phase				Three Phase Balanced			
	120V	208V	240V	480V	208V	240V	480V	600V
500	4.2	2.4	2.1	1.1	1.4	1.2	0.6	0.5
1,000	8.4	4.8	4.2	2.1	2.8	2.5	1.2	1.0
2,000	16.7	9.7	8.4	4.2	5.6	4.9	2.5	1.9
3,000	25.0	14.5	12.5	6.3	8.4	7.3	3.7	2.9
4,000	33.4	19.3	16.7	8.4	11.2	9.7	4.9	3.9
5,000	41.7	24.0	20.8	10.4	14.0	12.1	6.0	4.8
6,000	50.0	28.9	25.0	12.5	16.7	14.5	7.3	5.8
7,000	58.3	33.7	29.2	14.6	19.5	16.9	8.4	6.7
8,000	66.7	38.5	33.4	16.7	22.3	19.3	9.7	7.7
9,000	75.0	43.3	37.5	18.8	25.1	21.7	10.9	8.7
10,000	83.3	48.1	41.7	20.9	27.8	24.1	12.0	9.6
12,000	100.0	57.7	50.0	25.0	33.4	29.0	14.5	11.6
15,000	125.0	72.1	62.5	31.2	41.7	36.1	18.1	14.5
18,000	150.0	86.6	75.0	37.5	50.1	43.4	21.7	17.3
21,000	175.0	101.0	87.5	43.8	58.3	50.6	25.3	20.5
24,000	200.0	115.4	100.0	50.0	66.7	57.8	28.9	23.0
27,000	225.0	129.9	112.5	56.3	75.1	65.1	32.6	26.0
30,000	250.0	144.2	125.0	62.5	83.3	72.3	36.1	28.9
36,000	300.0	173.1	150.0	75.0	100.1	86.8	43.4	34.7

Controls are determined by finding the amperage per line and multiplying by 1.25 factor.

How To Calculate Control Amperage

For **single phase** or two wire power supplies to heaters

Formula: $\frac{\text{Total Capacity (Watts)}}{\text{Line Voltage}}$ = AMP Rating Per Pole

Example: $\frac{\text{4000 Watts}}{\text{240 Volts}}$ = 16.67 Amps

For **three phase or three wire** power supplied (Delta or Wye connections) to heaters using a three-pole contactor

Formula: $\frac{\text{Total Capacity (Watts)}}{\text{Line Voltage x 1.73}}$ = AMP Rating Per Pole

Example: $\frac{\text{4000 Watts}}{\text{240 Volts x 1.73}}$ = 9.63 Amps