Bheater

Flexible Heater

Design Guide




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Selecting a Flexible Heater

Follow these steps to select your heater

1.What should we consider before designing a flexible heater?

- **Size & Shape:**

We need to determine the size and shape of the flexible heater required based on the shape and size of the installation location.

- **Desired Temperature:**

We need to determine the desired temperature we need.

- **Installation Method:**

We need to determine the best method to install flexible heaters in your application so you can achieve desired results in your thermal system.

- **Electrical Termination:**

We need to determine a convenient connection method for your devices.

- **Sensor & Temperature Controller:**

We need to determine whether we need assembly with sensors or temperature controllers like Pre-set or adjustable thermostats, Thermocouples, RTDs, Thermal fuses and other electronic components are commonly incorporated as part of designs of our flexible heaters.

2.Knowledge related to the design of flexible heater.

- **Ohm's Law**

I = current (ampere, A)

U = electrical potential (volts, V)

R = resistance (ohms, Ω)

P = electrical power (watts, W)

R Ohms (W)	P Watts (W)	I Amps (A)	U Volts (V)
$\frac{U}{I}$ $\frac{U^2}{P}$ $\frac{P}{I^2}$	UI I^2R $\frac{U^2}{R}$	$\sqrt{\frac{P}{R}}$ $\frac{P}{U}$ $\frac{U}{R}$	$\sqrt{PR}$ $\frac{P}{I}$ IR

A flexible heater has a specific resistance. Its power output, in watts, depends on supply voltage ($P=U^2/R$).

- **Calculate required wattage to warm the heated object to control temperature in the desired time**

The total amount of power required for an application is the larger of two values:

1.Warm-up power+Heat lost during warm-up
2.Process heat+Heat lost in steady state

Heat loss factors include conduction, convection and radiation, a more accurate wattage estimate will take these into account. A safety factor of 25% additional wattage is recommended to compensate for unknow variables.

Warm-up power: Watts required to bring an object to temperature in a given time.The basic thermodynamic formula is:

$$P(watts)=\frac{mC_p(T_f-T_i)}{t}$$

where:

m = Mass of object (g)
C_p = Specific heat of material (J/g/°C)
T_f = Final temperature of object (°C)
T_i = Initial temperature of object (°C)
t = Warm-up time (seconds)

Material	Specific heat (J/g/°C)	Density (g/cm³)
Air	1.00	0.0012
Aluminum	0.88	2.71
Copper	0.38	8.97
Glass	0.75	2.64
Oil (typical)	1.90	0.90
Plastic (typical)	1.25	Varies
Silicon	0.71	2.32
Solder	0.19	8.65
Steel	0.50	7.85
Water	4.19	1.00

Example

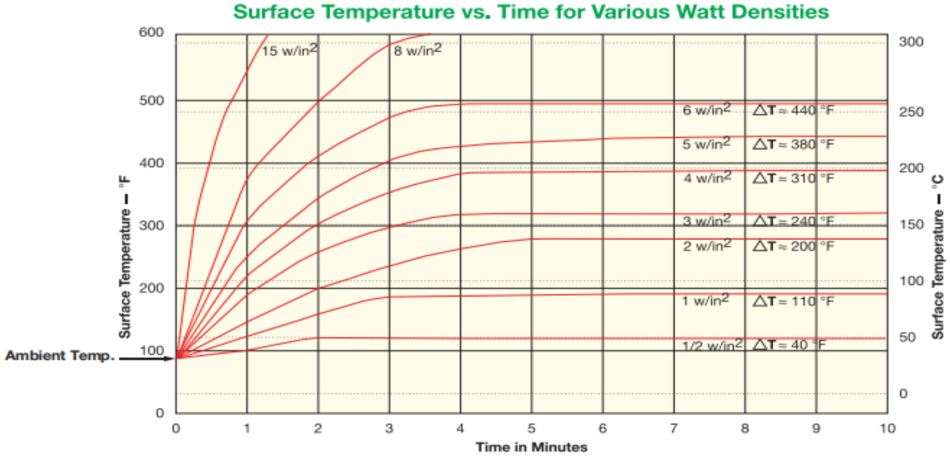
To raise the temperature of an aluminum plate 100mm*200mm*10mm(542g) 130°C (from 20°C to 150°C) in 10 minutes:

$$P = \frac{542g \times 0.88J/g/°C \times 130°C}{600s} = 103J/S = 103W$$

Add safety margin: 103W x (1+25%) ≈ 129W

- **Determine the heater size and watt densities**

Through this graph, we can estimate the maximum temperature the heater can reach in relation to its watt density.



ΔT = Temperature Rise From Ambient at Specified Watt Densities

$$\textbf{Watt Density} = \frac{P}{S}$$ (P: Heater wattage S: Area of the Heater)

Continuing the aluminum plate example: if we design the heater with the same size as the aluminum plate 100mm*200mm(This is the largest size we can use).

$$S = 10cm * 20cm = 200cm^2$$

$$\textbf{Watt Density} = \frac{P}{S} = \frac{129W}{200cm^2} = 0.645\ W/cm^2 = 4.16\ W/in^2$$

(Notes: $1w/cm^2 = 6.45w/in^2$)

From the chart above, we can see if the watt density is $4W/in^2$, the surface temperature of heater can reach up around 198°C, so the watt density of $4.16W/in^2$ can meet the need to heating the aluminium plate up to 150°C.

3.Current capacity for some main of leadwires we will use

AWG gauge	Area (mm^2)	Normal current (A)	Max current (A)
10	5.26	20.8	23.7
11	4.17	16.5	18.8
12	3.31	13.1	14.9
13	2.62	10.4	11.8
14	2.08	8.2	9.4
15	1.65	6.5	7.4
16	1.31	5.2	5.9
17	1.04	4.1	4.7
18	0.823	3.2	3.7
19	0.653	2.6	2.9
20	0.518	2.0	2.3
21	0.41	1.6	1.9
22	0.326	1.3	1.5
23	0.258	1.0	1.2
24	0.205	0.8	0.9
25	0.162	0.6	0.7
26	0.129	0.5	0.6
27	0.102	0.4	0.5
28	0.081	0.3	0.4
29	0.0642	0.3	0.3
30	0.0509	0.2	0.2

4.The steps to selecting the type of flexible heater.

Step 1: Choose the insulation type

Selecting insulation type according to the temperature range, maximum heater size, maximum resistance density and thickness.

Items	Polyimide Heater (Kapton heater)	Polyester Heater (PET heater) (Transparent heater)	Silicone Rubber Heater
Maximum Operating Temperature	260°C/500°F (Intermittent)	130°C/266°F (Intermittent)	250°C/482°F (Intermittent)
	200°C/392°F (Continuous)	80°C/176°F (Continuous)	200°C/392°F (Continuous)
Maximum Size	400mm*1000mm	400mm*1000mm	1200mm*10000mm
Thickness	0.13mm~0.3mm	0.13mm~0.3mm	1.8mm~3mm

Step 2: Choose the installation method

Selecting installation method according to application requirement, normally for small size heater, we recommend to use back with adhesive, but for some large sizes heater, especially for large size silicone rubber heater, we can choose to use some other method to fix the heater on heated object.

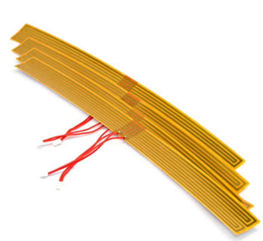
Step 3: Calculate required wattage

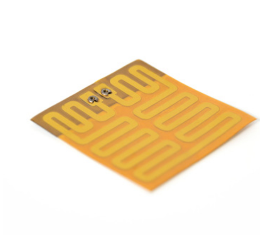
The heater you select must produce enough power to warm the heated object to control temperature in the desired time and maintain that temperature. The way to calulate the required wattage can following the above information.

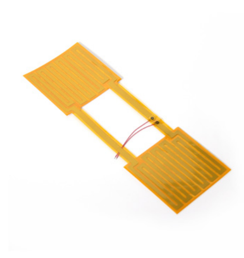
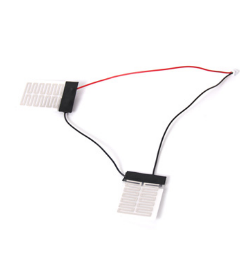
Step 4: Make prototype & test

The best way to make a final determination of heat requirements is make prototype and test.

Cases











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