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Watt Density:

Heater watt density (w/in2) is calculated using the following formula:

$$\text{Watt Density} = \frac{\text{Heater Wattage}}{\text{Heated Length} \times \text{Heater Diameter} \times 3.1416}$$

Cartridge heater watt density is defined as the wattage dissipated per square inch of the heated sheath surface.

All these factors are essential to a correct heating of the application and for the life expectancy of the heater. Heaters with very high wattage ratings can lead into premature heater failure.

In the design of a thermal system, watt density is one of the most important considerations. The ability of the heater to dissipate heat from the resistance element to the heater sheath and then for it to process is determined by watt density.

For liquid immersion heaters, the maximum watt density depends on the type of liquid being heated. The heavier or thicker the liquid, the lower the maximum watt density.

We advise using heaters with lower than the maximum watt densities in order to get the longest heater life.

A watt density too high can result in:

- Damage to the heater and its components.
- Damage to the material being heated.
- Failure of the heater.

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If your watt density is already too high and close to the recommended maximum, there are ways to correct it by following some of these steps below:

• Increase the diameter, length and diameter of the heater
• Get a tighter fit, as it is desirable to a long heater life
• Lower the total wattage, although this may result in a longer heat-up time.

Watlow high density cartridge heaters have been widely used in very different applications, as they can operate at higher watt densities while maintaining the lowest resistance wire temperatures.

These will allow the smallest heater to obtain the required wattage with a longer-lasting service life. ***However, the optimised service life will be provided by a lower watt density heater.***

Fit:

Fit is also a really important factor in determining the life expectancy of a heater.

At high watt densities and higher temperature applications, a close fit is important. For these, we recommend that the holes are reamed and drilled for the tightest possible fit.

A tight fit minimises air gaps and reduces the instances of hot spotting.

Please see Sensemaster Link for Maximum allowable Watt Density:

https://sensemaster.co.uk/wp-content/uploads/2020/03/Maximum-allowable-watt-density.pdf

The fit is the difference between the minimum diameter of the heater and the maximum diameter of the hole.

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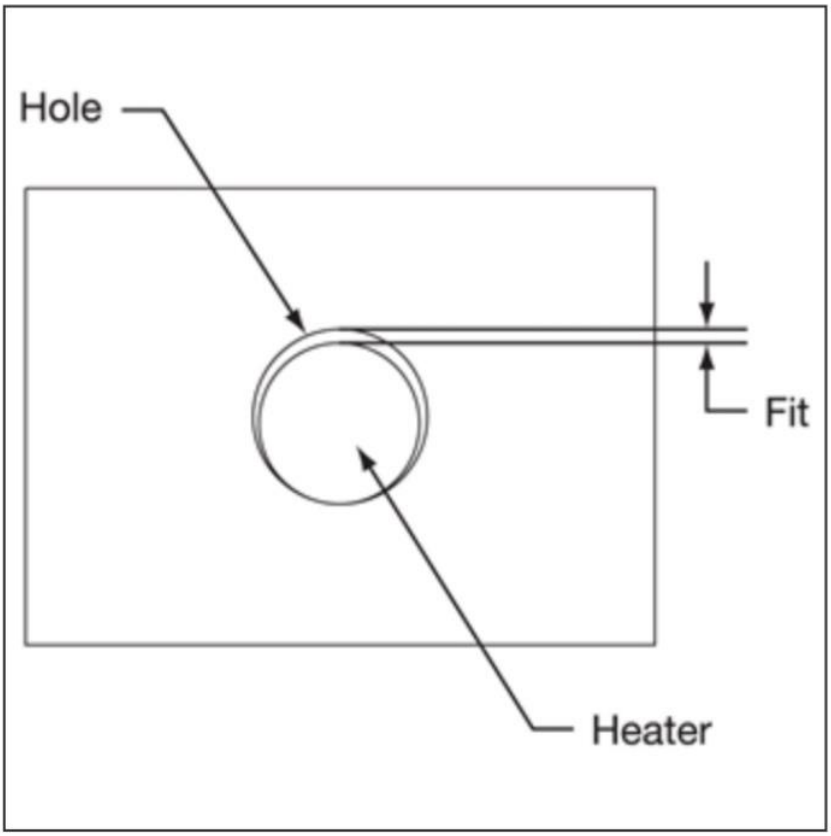

Example: A 3/8" nominal OD Hi-Density cartridge heater has an actual diameter of .371" ±.002, which translates to a minimum diameter of .369". If used in a .376" ±.002 hole, the fit would be .009" (.378" − .369" = .009").

Even though a tighter fit is desirable for a longer-life heater, it will make the instal and removal of the heaters more challenging. That's why we recommend that you use a suitable anti-seize cartridge heater coating such as Watlube as it will make this process easier while improving heat transfer.

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Power Controls:

Power Controls can improve the life expectancy of heating elements by reducing the temperature oscillations of the internal heating element.

Economical on-off controls can play a part in increasing thermal fatigue and oxidation of the heating elements by causing those temperature oscillations.

Watlow power control products will help you avoid these temperature swings and therefore, improve the life expectancy of your heating systems:

Watlow Solid State Power Controls.

https://sensemaster.co.uk/power-controllers/

Watlow Heating.

https://sensemaster.co.uk/heating/

Temperature

The life expectancy of a heating element is directly related to the internal operating temperature. Therefore, the temperature of a heater is a key factor for the life expectancy of the heating element.

The life of the heater depends on the temperature of the resistance wire within the heater and the not on the process operating temperature.

Care should be taken to make sure that the heater end temperatures don't exceed their limitations.

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Temperature Controls

Higher watt density heaters can generate heat faster than the surrounding area is able to dissipate, which creates a thermal lag in between the heater and the sensor.

These temperature gradients are a common cause of heater failure.

The closer the heater and the sensor are, the better you can control the temperature.

Our range of Temperature and Power Control Products and Temperature sensors can help you minimise these swings of temperature by using the proportional and PID functions of the temperature controllers.

Watlow temperature & Process Controls.
https://sensemaster.co.uk/temperature-and-process-control/

What is PID Control.

https://sensemaster.co.uk/wp-content/uploads/2022/10/What-is-PID-Control.pdf