

### Recommendations for Improving the Life of Hi-Density Cartridge Heaters

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#### Determining Fit

When heating a platen, mold, die or hot runner probe with Hi-Density Cartridge Heaters inserted into drilled holes, fit is an important factor in determining the life expectancy of the heater. Fit is the difference between the minimum diameter of the cartridge heater and the maximum diameter of the hole. Unheated sections on a Hi-Density cartridge may be smaller in diameter due to swaging. To determine fit, use the smallest diameter on the heated length only.

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

When medium watt density heaters (less than 60 watts per square inch) are used in low temperature applications (less than 600°F [315°C]) general purpose drills are commonly used to drill holes. The typical hole size may be .003" to .008" over the drill size. For higher watt density and/or higher temperature applications, we recommend that the holes are drilled and reamed for the tightest possible fit. In applications where precise temperature control and heat transfer properties are required, Hi-Density cartridge heaters can be centerless ground to  $\pm$ .0005".

Although a tighter fit is desirable to efficiently transfer heat and to get long heater life, a looser fit will aid in installing and removing heaters, especially long heaters. We recommend that you apply Tempco's BNS anti-seize cartridge heater coating as it will improve heat transfer and will make the removal of heaters easier.

The graph in Fig 1. (page 2-5) shows the effect of fit in determining the maximum recommended watt density on a steel platen. As it is indicated in the graph, the tighter the fit, the higher the maximum recommended watt density.

#### Temperature Control and Location of Temperature Sensing Device

In order to better control the heater temperature and hence the resistance wire temperature, use of an appropriate temperature control and the proximity of the heater to the sensor is very important. The graph in Fig. 1 (page 2-5) shows the effect of operating temperature in determining the maximum recommended watt density on a steel platen where the sensor is located 1/2" from the heater. Higher watt density heaters can generate heat faster than the surrounding area's ability to dissipate heat. This creates a thermal lag between the heater and the sensor. The closer the sensor to the heater, the better you can control the heater temperature. By keeping the sensor further from the heater, temperature gradients of several hundred degrees can be observed in many applications, especially during initial start-up and heavy thermal cycling. Although the set operating temperature may be low, the heater may be running at a very high temperature. This is a common cause of heater failure. This can be minimized using time proportional and PID functions of the temperature controllers. See Section 13 for temperature controllers and Section 14 for thermocouples and sensors.

#### Power Control

Power control methods affect the life expectancy of heating elements. In general, although economical, on-off controls increase thermal fatigue and oxidation rate on heating elements by causing wide temperature swings of the internal heating element. Silicon Controlled Rectifiers (SCRs), Mercury Relays and Solid State Power Controls can increase the life expectancy of heating elements by reducing the temperature swings of the internal heating element. See Section 13 for power controls.

### Common Causes of Cartridge Heater Failures

#### Contamination

Contamination is a major cause of heater failure. Moisture, hydraulic oils, and melted plastic are the most common contaminants that are seen on failed heaters. Since the magnesium oxide insulation in a Hi-Density heater is hygroscopic in nature, moisture is easily absorbed into the heater and typically results in premature heater failure. Moisture absorption during machine washdown or cleanup also is a frequent problem. These contaminants, which are electrically conductive, will short out the heater. Most probably, the failures will be at the lead end of the heater and in some cases can split or blow a hole on the heater sheath. The disc end of a Hi-Density cartridge heater is welded shut with a stainless steel disc.

Generally, contaminants enter the heater through the lead end of the heater. The high temperature lead wires used on Hi-Density heaters have fiberglass or mica insulation. Oil and moisture can wick through the insulation on the lead wire into the heater. Tempco offers a wide variety of terminations to avoid this problem, including epoxy seals, Teflon® seals, convoluted cables, welded end discs, Teflon® insulated lead wires and SJO cable. However, there are temperature limitations on many of these terminations.



**Note:** If you should encounter premature cartridge heater failure, consult Tempco. Our team of professionals will have the solution to your problem.

#### Excessive Flexing of Leads

Tempco Hi-Density heaters use flexible grade A nickel stranded lead wires with fiberglass or mica insulation. On certain terminations the lead wires are connected externally to solid nickel conductor pins. In applications where there is excessive movement or vibration, the solid pins could break due to fatigue. A simple solution is to give enough slack on the leads to minimize the stress on the solid pins or provide an internal lead wire connection within the heater. Tempco also offers strain relief brackets and springs to prevent this problem.

Where heater leads can wear out by abrasion due to excessive flexing of the leads, Tempco offers several abrasion resistant terminations. See pages 2-41 through 2-47.

#### Lack of Heat Sink

Hi-Density heaters are designed with minimum unheated (cold) sections. If the heated sections project from the platen or mold, these sections will get extremely hot due to lack of heat transfer. This will lead to premature heater failure. Tempco can manufacture heaters with cold sections anywhere along the length of the heater to prevent overheating of the heater sheath.

When a Hi-Density heater is used as a liquid immersion heater, make sure the heater's sheath length is completely immersed in the liquid. The heater lead end should not be immersed in liquid, since most of the lead end seals are only moisture resistant, not moisture proof.