



## **Mica Insulated Band Heaters:**

### ***Design Considerations and Application Of Mica-Type Cylindrical Heater Bands***



Mica Band Heater with Terminal Box & Barrel Nut(s)



Mica Insulated Metric Heater with S. Steel Armor Leads

### **Construction & Composition of a Mica-Type Band Heater**

“Band heaters” of all types are used to heat cylinders. Most frequently, they are used on the barrels and nozzles of plastic injection molding and extruding machines. Those termed “mica bands” are composed of an electrical resistance ribbon or wire, which is wound around a mica winding card and sandwiched between two sheets of mica, then wrapped in sheet metal. The resistance wire or ribbon that converts electrical energy to thermal energy is normally a nickel-chromium alloy of either 80% nickel which is useful to 2150°F or 60% nickel which is useful to 1950°F. The mica is, most often, one of three types: muscovite, useful to 930°F, phlogopyte, useful to 1380°F, and synthetic mica, useful to 1830°F. The sheet metal is normally either mild steel or stainless steel.

## **Design Considerations for Mica Insulated Band Heaters**

The expected maximum operating temperature of the heater is the major consideration in choosing the resistance alloy, the mica type, and the sheet metal alloy. Other important considerations in the choice of mica are the combination of the material's dielectric strength, specific resistance, thermal conductivity (at the design operating temperature) and sheet thickness. These parameters determine the adequacy of isolating the electric energy from the ribbon or wire element from the surroundings, and the ability of the thermal energy from the element to be efficiently transferred to the cylinder being heated.

Selection of the ribbon or wire size is based on minimizing the "watt density" on the surface of the element and on the overall area heated by the wound element. Watt density on the element is simply the number of watts of energy being released by the element, divided by its total surface area. Watt density on the heater is that same number of watts divided by the area created by the winding element on the surface on one side of the winding card. Ideally, these two watt densities should be nearly the same. For optimum performance of the heater, the winding card should be designed to minimize the unheated space between the edges of the winding card and the sides or ends of the metal sheath.

The heater is assembled in the flattened condition, and then rolled to the desired diameter, leaving a gap between the two heater ends. The rolling process should eliminate or, at least, minimize any spaces between the winding card, sandwiches and metal sheath.

## **Application Considerations for Mica Band Heaters-Metric & Imperial Designs**

The wattage chosen for the heater should be such as to (1) reach the desired heated cylinder operating temperature in the desired amount of time, and (2) minimize the amount of temperature cycling required to maintain the heated cylinder at its operating temperature. Frequently, these are conflicting objectives; the best compromise is up to the person specifying the heater.

For optimum heater performance and lifetime, the heated cylinder surface and the inside diameter of the band heater should both be smooth and without bumps or particles in-between. There must be an intimate contact between those surfaces for good heat transfer. Tests have demonstrated that the fit only needs to be snug; over-tightening of screws at the gap does nothing to increase heat transfer and could cause damage to screw threads or other parts of the heater.

Other than mechanical abuse of the heater, there are just three basic causes of shortened life and/or premature failure of mica band heaters: (1) contamination with foreign matter gaining access to the internal portion of the heaters, (2) over-temperature of the heater beyond its design maximum and (3) excessive on-off cycling. These causes are further described below:

Contamination is the presence inside the heater sheath of any foreign material that becomes electrically conducting. The conductive material makes a path between the resistance or lead wire and any "grounded" object (such as the heater sheath or metal lead protection), thus causing an electrical short. Typical contaminants are water, oil, plastic, or any hydrocarbon. Water, when soaked into the insulation of either the lead wire or the element makes a good short. Even high humidity can cause a problem. Oil, plastic and other hydrocarbons are insulators at room temperatures, but conductors at higher temperatures. It only requires trace amounts to cause a short.

Over-temperature is exceeding the design maximum temperature of any heater component. Mica is the component of the heater itself with the lowest allowable temperature, but, in some cases, the lead wire may be exposed to temperatures exceeding its maximum insulation capability. The basic cause of overheating is that heat is not being removed from the heating element fast enough (for example, wattage too high for application). If the wattage of the heater was selected well for the application, then these other factors are typically responsible for overheating:

Heater not in good contact with the surface of the object being heated  
Higher than design voltage applied to heater  
Heater not being used as directed (for example, clamping not snug)  
Thermocouple used to monitor the temperature of the part being heated  
is not in good contact with the part or is located too far away from the  
heater location

Excessive cycling is turning the heater on and off on a cycle that allows the resistance element in the heater to cool off by several hundred degrees below the temperature reached when "on". Any temperature cycle (even one) shortens heater life because of a combination of oxidation on the surface of the element and thermal fatigue within the element. The greater the temperature difference in the cycle, and the more cycles over time, the shorter the lifetime of the band heater. Excessive cycling occurs when the wattage of the heater is much larger than needed and being used with a temperature controller that turns the heater on long enough to get hot, then keeps it off long enough to become cool.

Typical causes of mechanical abuse are; pulling on the heater leads, over-tightening of post terminals, using only one nut (or tightening the bottom nut) on post terminals, and insulation being rubbed off of the lead wire by motion of the leads (can occur inside metal hose).



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