COMPARING CERAMIC FIBER-BACKED HEATING ELEMENTS WITH RAYTEQ HEATING ELEMENTS

CERAMIC FIBER BACKED HEATING ELEMENTS - Ceramic fiber backing for heating elements has been used as a low cost alternative to high fired ceramic for individual heating element support panels because they are much less expensive to produce. The tooling is simple and inexpensive and the material itself need only be dried in an oven instead of fired at high temperature in a kiln.

Strong, dense, high fired ceramic of the type used by Rayteq is a good thermal ***conductor*** which will rapidly conduct heat away from the resistance element and direct it toward the crucible. In contrast, ceramic fiber is an excellent thermal ***insulator*** that effectively traps heat dissipated by the buried portion of the resistance element, greatly elevating its temperature. This trapped heat can cause untimely element burnouts, particularly if the manufacturer uses large diameter coils of heavy gauge resistance wire (up to 1/4" diameter) which must be buried deeply in the poorly conductive ceramic fiber.

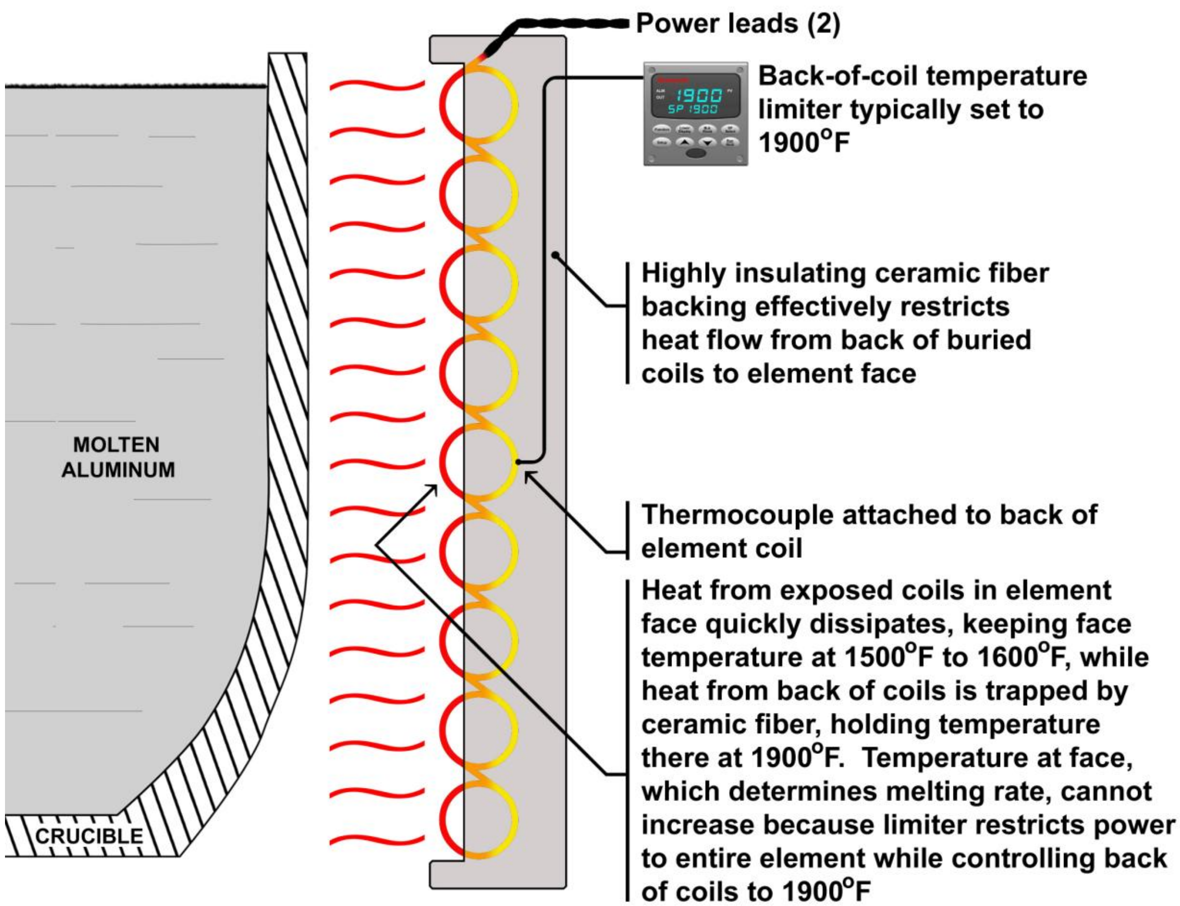

FIGURE 1 - LIMITATIONS OF CERAMIC FIBER BACKED HEATING ELEMENTS

The larger the coil diameter and the wire gauge, the deeper it must be buried to gain even minimal mechanical support, and the deeper it is buried, the hotter it becomes. If the face of such a heating element is brought up to normal aluminum and magnesium melting temperatures in the region of 2000°F, the back of the deeply buried element coils will begin to approach the melting point of the coil alloy which will quickly lead to burnouts. At the same time, thermal expansion of these large diameter coils at such temperatures can result in breakage of the weak fiber bonds supporting the coils causing them to break free of the ceramic fiber backing (see Photo 1 showing such damage).

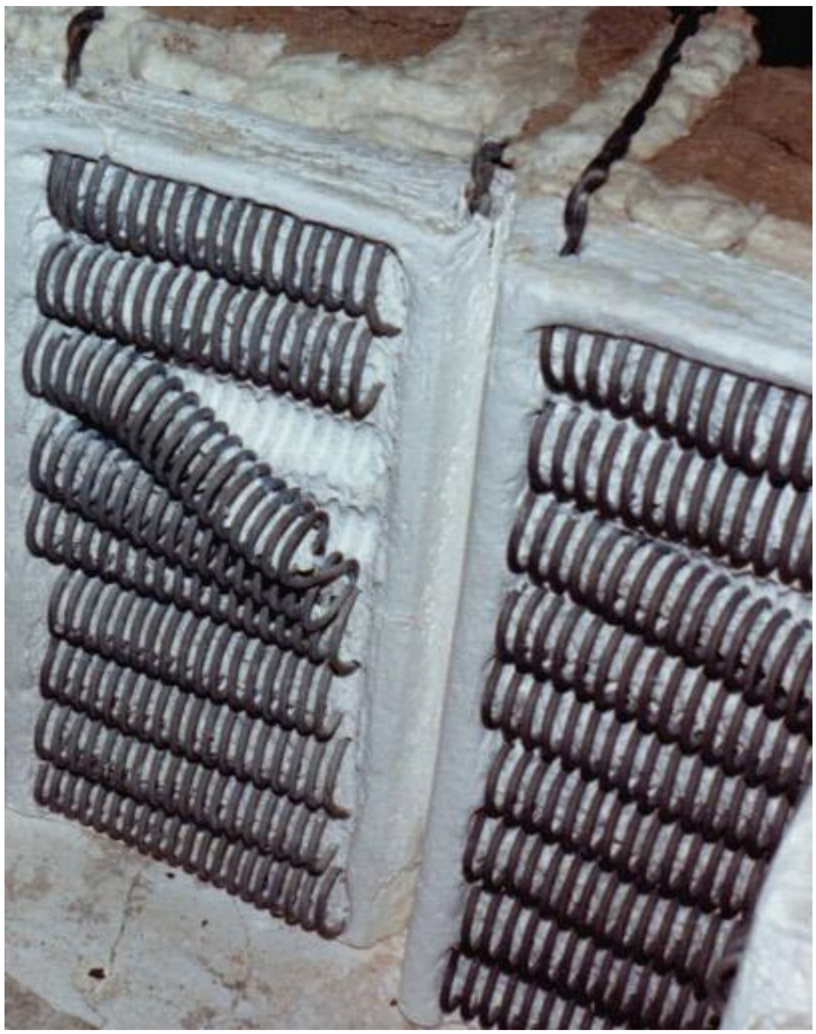

Photo 1

One ceramic fiber element manufacturer found a novel way to delay this process by attaching a thermocouple connected to a temperature limiter onto the back of the deeply buried element coil and setting the temperature limit there to a nominal 1900°F (refer to Figure 1). Unfortunately, limiting the temperature of the buried, heat-trapped back of the element to 1900°F cuts the temperature at the face of the heating element which the crucible "sees" that determines the melting rate down to 1500°F to 1600°F, drastically reducing the furnace's melting capacity.

The Stefan-Boltzmann Law dictates that the amount of melting power that will transfer from the face of any heating element to the crucible is directly proportional to the ***fourth power*** of the temperature difference between the two. This means that a seemingly small reduction in the heating element face temperature will greatly reduce the furnace's melting capacity, regardless of the power rating of the heating elements. However, the user will still have to pay utility demand charges associated with the element power rating even though the commensurate melting rate is not being attained, a situation that represents the worst of both worlds, which results in unnecessarily higher utility cost per pound of metal melted.

The effect of the fourth power Stefan-Boltzmann Law is dramatic. For example, the melt rate of any electric resistance melting furnace will drop by***two-thirds*** when the heating element face temperature is reduced from 2000°F to 1600°F! Thus, a furnace which can melt 500 lbs/hr with an element face temperature of 2000°F can only melt 180 lbs/hr when the face temperature is reduced to 1600°F. This makes ceramic fiber backed heating elements a poor choice for aluminum and magnesium melting since these elements cannot maintain the normal 2000°F face temperature required to reach acceptable light metal melting rates.

By contrast, Rayteq uses small diameter heater coils permanently cemented into highly conductive ceramic to a very shallow depth which means that the temperature difference between the back of the coils and the face of the element is very small. This enables the face temperature of Rayteq heating elements to operate at maximum output up to 2000°F over very long production melting campaigns while the Rayteq element coils remain firmly in place because the cement supporting them is hundreds of times stronger than soft ceramic fiber.

As a result of these advantages, Rayteq heating elements routinely maintain substantially higher melting rates, longer element operating life, and lower melting cost per pound than ceramic fiber-backed heating elements, due to their inherent limitations, can ever attain.

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