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Why high voltage/lower wattage parameters don't make good industrial heaters

Occasionally customers specify industrial heaters that have a higher voltage such as 480 volts in combination with a wattage of several hundred watts. This is sometimes done because 480 volts is readily available or sometimes because it may seem that this combination would produce good heater life. In fact, this frequently produces a heater that has rather poor life.

The wattage of industrial heaters is the product of the voltage (E) multiplied by the current (I). Thus: $W = E \times I$.

If for a particular heater, the voltage is on the high side, to have medium or low wattage requires that the current (I) be rather low. Now, to get a low current for a particular voltage, we need typically a higher resistance. Higher resistance is obtained either by using longer (more) element wire or by using wire that has a high amount of resistance (ohms) per foot. Usually, there is a limit on the amount of wire you can put in a heater unless it is a large heater, so in most cases we must use a wire with high ohms per foot. The higher the ohms/foot, the smaller the diameter of the element wire. Thus, most of the time we end up using wire that is very fine (small diameter). Perhaps, a wire that is finer than the hair on someone's head.

Sometimes the wire size required is smaller than any wire we have in stock.

One of the main ways industrial heaters fail in manufacturing processes, like injection molding, is for the element (heater) wire to oxidize. As the wire oxidizes, the outside of the wire becomes a nonconductive oxide and the current is carried by the smaller diameter of unoxidized metal on the inside of the wire. All nichrome heater element wire goes through this aging process. But if we start with a very small diameter wire, it does not take as long for the element wire to oxidize and burn into.

Thus, in most cases, the combination of higher voltage and lower wattage results in a heater that has a rather short life. Sometimes, we may try to improve industrial heater life by lowering the watt density or lowering the wattage, where the real problem is that the element wire is just too small. In general, if the wattage is lower than the voltage you are probably getting into an area where the heater life is being compromised.

Usually, the best alternative is to locate a lower voltage such as 240 volts or 120 volts. Sometimes, this can be achieved by putting two heaters in series, such as two 240 heaters of equal wattage across 480 volts. Sometime with 480 volts, 277 volts is also available or with 240 volts, 138 volts may be available. (Line-to-neutral voltage from a 3 phase line-to-line supply voltage).