

## Case Study #185: The Mystery of the High-Temperature Hose

### The Problem

A customer was having an issue with a stainless steel hose getting too hot when the heater was powered on. This happened when the heater, a new standard item, was being powered up for the first time. The customer stated that after about 8 to 10 minutes, the hose temperature was getting up to 138°F.



### The Details

This heater was one of four that Thermal Corporation had built with stranded nickel lead wire.

Now, the reason the leads on this heater were getting hotter was either because more heat was generated or less heat was removed. It was hard for us to visualize how less heat would be removed from the leads. Therefore, it was more likely that more heat was being generated. The first question we asked was how much heat is normally supposed to be generated by the leads on this heater.

### The Math Behind the Mystery

The heater was a 1,000W, 120V heater. Its lead length was about 100 inches. We measured the resistance of one lead using a bench model volt ohm meter. It measured 0.35Ω. Because there are two wires generating the heat, the total resistance would be twice that measurement.

$$\begin{aligned}2 \times 0.35\Omega &= 0.7\Omega \\I &= 1000W / 120V = 8.33 \text{ Amp} \\Heat (W) &= I^2R = (8.33)^2 \times 0.7\Omega \\Heat &= 48.6 \text{ Watts}\end{aligned}$$

The hose was approximately 3/8" in diameter. For a 3/8" diameter surface,

$$\begin{aligned}\text{Surface Area} &= 0.375 \times \pi \times 100 = 118 \text{ in}^2 \\ \text{Watt Density} &= 48.6 / 118 = 0.41 \text{ Watts/in}^2\end{aligned}$$

If we look at a combined radiation convection losses curve for 0.41 Watts/in<sup>2</sup> under oxidized steel, the temperature should at least be 150°F. The hose most likely had more surface area than a 3/8" diameter smooth surface, so the actual temperature would be less than 150°F.

So, the 138°F does not seem wrong.

### **A Solution**

A possible solution would be to lower the temperature by using a nickel clad copper lead wire. Nickel clad copper wire has less resistance than stranded nickel, so less heat would be generated.

### **The Mystery**

But, the question still remains: why were the leads on the other heaters not hot? Perhaps the hose was touching something and conducting heat to another object? This seems like a likely explanation. All lead wires generate some heat, but often the lead wires are in a hot environment and the heat is not noticed. Or, sometimes the lead wires are short, thus they have a low resistance, and not enough heat is generated to be noticeable. But every once in a while a long lead wire length in a cooler environment will lead to this type of question.

### **Have a Problem with a Heating Application?**

Let us troubleshoot the issue by contacting our engineering department!

Engineering Department Contact

Toll-Free: (800) 633-2962

Local: (256) 837-1122 x152  
Email: [engineering@thermalcorp.com](mailto:engineering@thermalcorp.com)

Written by Jim Dixon  
Edited by Shelby Reece and Kyle Otte  
Date Published: 07.26.2019  
Last Updated: 07.26.2019