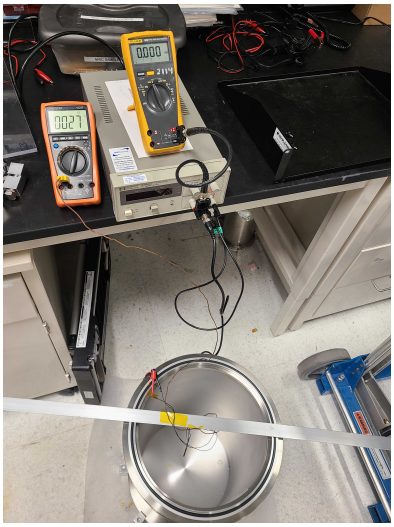
Estimate Metal to Air HTC in iso320 Full Nipple (one side open)

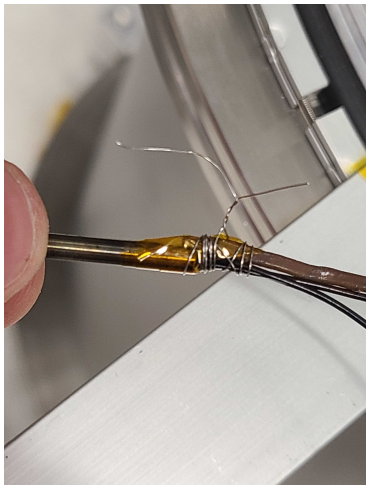
Status	Done
Project	Heat Fiber Bundle Mounting Block
Tags	

Goal: Estimate Heater Cart Heat transfer coefficient to air in inside non-capped chamber. Use this as a reference to see if we can Heat up mounting block.

EQ: $P = uA\Delta T$ u = Heat Transfer coefficient ($\frac{W}{m^2K}$), A = Area (m^2), ΔT = Temperature difference from environment (T2 - T1) (K)

Experiment Setup:





Surface area of Heater Cartage = $2\pi rh$ = 2pi*(3.175/2 mm) * (25.4 mm) = 253mm^2 = 2.53e-4 m ^2
Initial room Temperature T1 = 26 C = 299.15K

Trial #	T1 Environment Temperature (K)	T2 Heater Cart Temperature (K)	Voltage / Current	Power (W)	u = P / A*dT (W / m^2 K)
Trial 1	299.15	384.15	5.72V / 0.23A	1.32	61.38

Trial 2	299.15	455.15	7.99V / 0.32A	2.56	74.40
Trial 3	299.15	347.15	4V / 0.16A	0.64	52.70

Using HTC Data from Above

Goal: If we heat our current mounting block design to +100C from room temperature, what's is the power required to achieve this with our estimated heat transfer coefficient to air?

Current Mounting Block surface Area = 0.01243 m^2
T2 = 100C over room temp, 130C = 403.15 K
T1 = Room Temp at 26C = 299.15K
Heater transfer coefficient = (61.38 + 74.40 + 52.70) / 2 = 62.83 W / m^2 K
P = (62.83 $\frac{W}{m^2K}$)*(0.01243m^2) * (403.15K - 299.15K)
Result = 81.22 W

Then also taking into account black body radiation from our object into the environment:

$P = A\sigma\epsilon(T^4 - T_o^4)$, Where A is the surface Area, σ =5.67e-8$\frac{W}{m^2K^4}$ Stefan–Boltzmann constant, ϵ = Emissivity (assumed worst case of 1 & 0.5), T = Temperature of object, T_o = Temperature of environment.

P = (0.01243m^2)*(5.67e-8$\frac{W}{m^2K^4}$)*(1)*(403.15^4 - 299.15^4)

Result = 12.97 W

Total Required for our mount just being exposed to air (no other thermal connections) = 94.2W $\approx$ 100W

Our Carts are rated for 25W each. Not enough wattage with current setup/

- Solutions
  - Decrease Mounting Block Surface Area
  - Increase Heater Cart Wattage
  - Enclose Heat