

# Chiller heating element examination.

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ISU WEEKLY MEETING

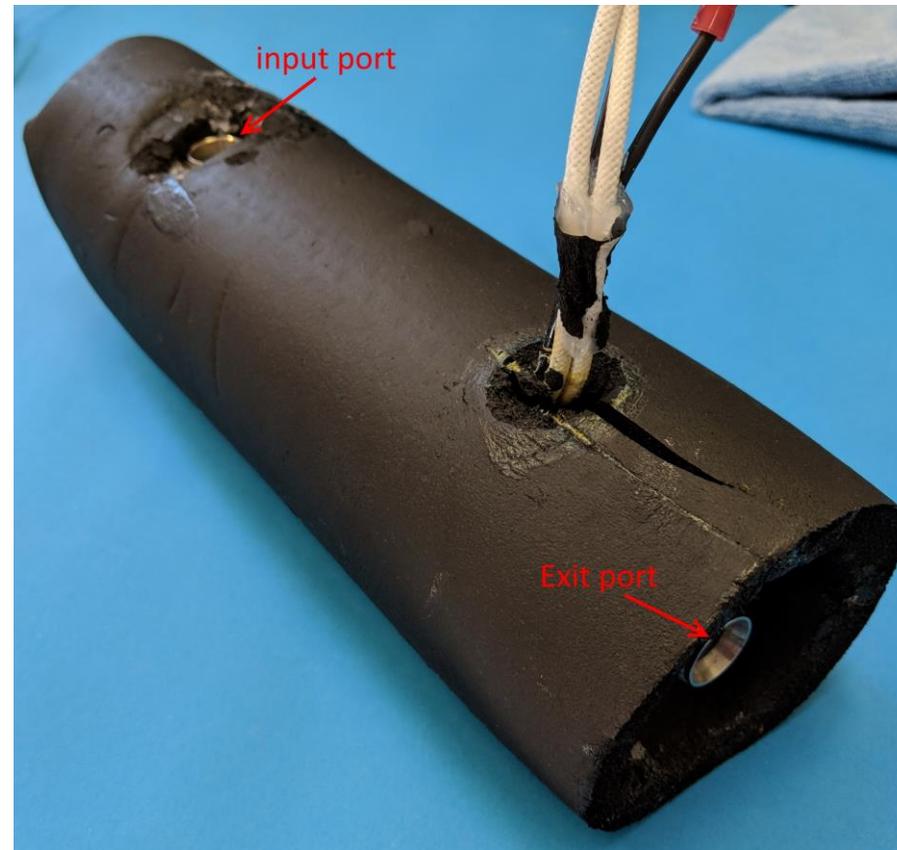
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# Brief History

- ▶ Back in January 2018 we suffered a catastrophic failure of the chiller's internal heating element. The cause was determined to be insufficient fluid flow over the heating element. It was noted all the zinc coating was missing from the burned out heating element.
- ▶ After replacing the heating element, we frequently noted a gray scum floating on the HFE fluid in the reservoir and a gray coating on the reservoir walls. Chemical analysis of the scum indicated mostly carbon with a few % of oxygen, fluorine, nitrogen, zinc and other elements.
- ▶ Estimates of the heat flux at the heating element was beyond the  $18\text{W}/\text{cm}^2$  3M stated as the point of HFE decomposition. The fear was the HFE was decomposing and attacking the zinc coating on the heating element.
- ▶ The original heating element failed after ~370 hours. We have logged 1,794 hours with the replacement heating element.
- ▶ The module containing the heating element was removed from the chiller. The following photos are of the heating element inside the module looking through the I/O ports.

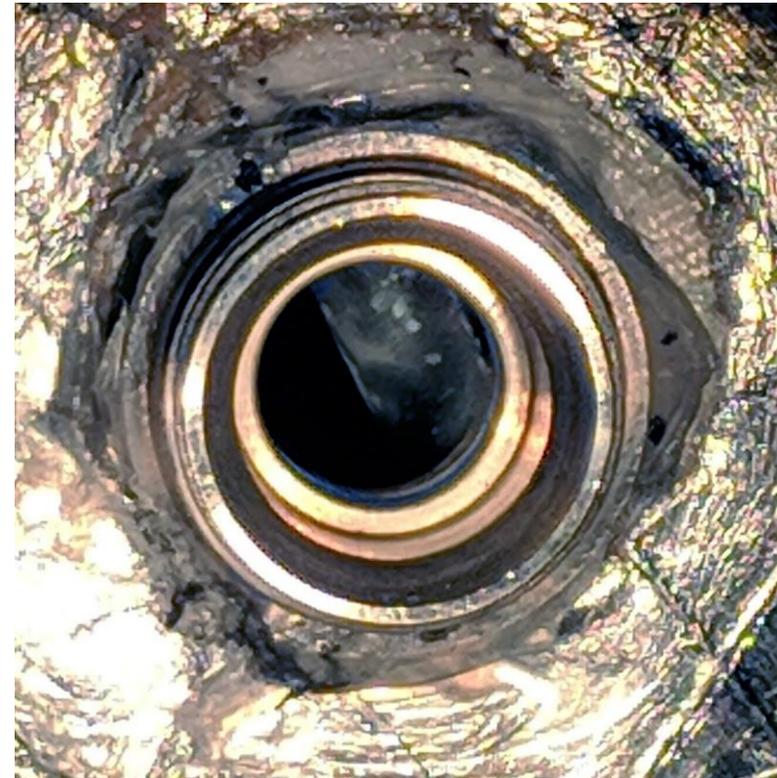
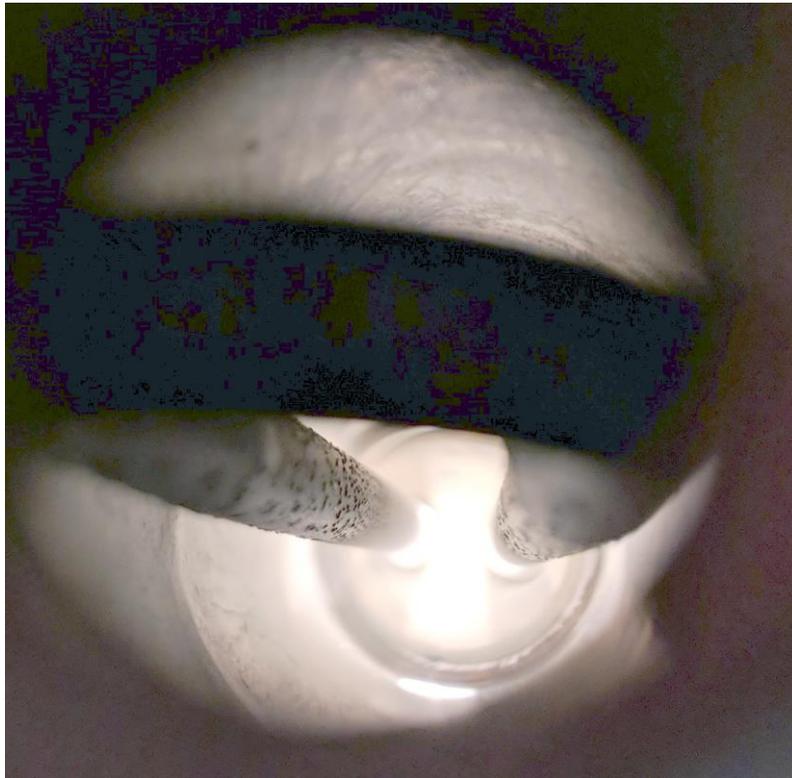
# Photo of heater module



# Photos of heating element. Input port



# Photos of heating element. Exit port



# Modified energy to heating element.

- ▶ Recently we added a ~4 ohm, 50W resistor in series with the heating element. The 4 ohm resistor is placed inside the chiller reservoir. The wires to the heating element were extended. The wires exit the chiller chassis through a port and enter the reservoir through a pair of holes drilled into the reservoir lid.
- ▶ The heat flux at the 4 ohm resistor is about 4 W/cm<sup>2</sup>. The heat flux at the heating element is about 14 W/cm<sup>2</sup>.
- ▶ Only a few hours of run with the modified heater. Too soon to tell if we have solved the question where is the source of scum.

# Concluding

- ▶ We still find some scum in the reservoir. Not near the volume as before modifying the energy to the chiller heating element. The scum we see now may well be leftover in the HFE fluid in the pipes. We will flush the HFE and clean the plumbing where we can.
- ▶ We will continue to monitor the HFE fluid in the reservoir.
- ▶ The result of dumping some energy into the reservoir has decreased the rate of changing the HFE fluid. It now takes ~1 min longer to heat 3.5 liters of HFE from room temperature to +40°C. (7.5 min. instead of 6.5 min.) More measurements needed. For example, time to heat from -40 °C to +40 °C.