

Homework Problems for Monday June 24, 2019

1. Read chapter 1 in Barron, interesting history and background for cryogenics.
2. A stainless steel rod with a circular cross section of 15 mm diameter and a length of 3 meters connects room temperature (300 K) to a 5 K heat sink. Considering only conduction, what is the heat leak from 300 K to 5 K? What would be the heat leak if the rod were made of copper?
3. List 2 effects of the significant decrease of specific heat of metals at cryogenic temperatures
4. Calculate the Coefficient of Performance for an ideal Carnot Cycle Refrigerator operating between 300 K and 30 K. How many Watts of power at 300 K are required to remove 1 Watt of heat at 30 K using this refrigerator?
5. Wet engine. An expander for which the exhaust contains some (or 100%) liquid is called a "wet" engine. This can be a problem for a turbo-expander but can be an efficiency improvement over a J-T valve for the final expansion in a liquefier. A reciprocating wet expander was part of every Fermilab satellite refrigerator.

For a helium expander with the following conditions:

18 bar inlet pressure

2.0 bar exit pressure

Efficiency = 70%

At approximately what inlet temperature would the exhaust become 2-phase?

For helium expanded isenthalpically with the following conditions:

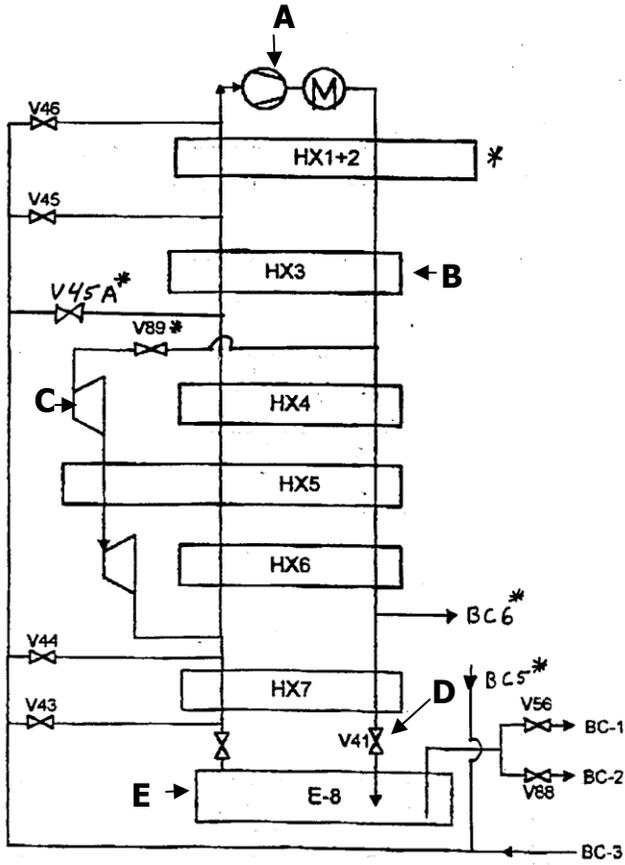
18 bar inlet pressure

2.0 bar exit pressure

At approximately what inlet temperature would the exhaust become 2-phase?

You may use <http://webbook.nist.gov/chemistry/fluid/> for helium properties.

6. Identify the indicated components on the Collins cycle refrigeration plant schematic shown below:



<b>A:</b>	
<b>B:</b>	
<b>C:</b>	
<b>D:</b>	
<b>E:</b>	

CTI 4000 Upgrade 12 / 2 / 99

\* Indicates new or changed component