Cryogenic Engineering

Problem Set 1

Due Feb 15, 2016

1) List three current applications of cryogenic engineering. What added value does the presence of cryogenic temperatures bring to each of these applications?

2) NbTi is the principal superconductor used in the Large Hadron Collider main ring magnets. These magnets operate at 1.8 K. What important property of NbTi is improved by operation at 1.8 K rather than say 4.2 K?

3) Consider an aluminum bar 5 meters in length. The bar is rigidly supported at its center (at x = 2.5 m) and free at its ends. The bar is cooled to 4.2 K. How much does the bar shrink when cooled down?

4) A Ti 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?

5) Consider the original Ti Rod in problem #4. Assume now that it has an intermediate heat sink operating at 80 K and located at 1.5 M from the end. Considering only conduction, what is the heat leak to 80 K? What is the heat leak to 5 K?

6) List 2 effects of the significant decrease of specific heat of metals at cryogenic temperatures

7) 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?