

USPAS Cryogenic Engineering (June 21 – July 2, 2021)

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Homework Problems for Tuesday June 22, 2021

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. Consider single phase liquid helium at 4 K flowing through a 10 mm tube of length 30 m at a mass flow rate of 1 g/s. The mean surface roughness is 10 μm . Calculate the Reynolds number for this flow condition and the overall pressure drop. How much lower would the pressure drop be if the tube were smooth? For both cases, neglect any heat transfer to the helium.
5. Using the homogeneous model, make a plot of the two-phase friction multiplier ϕ_l^2 as a function of vapor quality χ at 4.5 K and saturation conditions. Use the following dimensions of the tube: L = 5 m; d = 5 mm; mass flow = 1 g/s. Neglect any heat transfer to the helium. Use Blasius correlation for Fanning friction factor and n = 0.25 as exponent for the homogenous model two-phase multiplier.