

Thermodynamics and Heat Transfer

Lecture 11: Heat Transfer

LE6: Heat Transfer, Part 1, (50 Points)

Problem 1: A certain superinsulation material having a thermal conductivity of $2 \times 10^{-4} \text{ W/m}\cdot^\circ\text{C}$ is used to insulate a tank of liquid nitrogen that is maintained at -196°C ; 199 kJ is required to vaporize each kilogram mass of nitrogen at this temperature. Assuming that the tank is a sphere having an inner diameter (ID) of 0.52 m, estimate the amount of nitrogen vaporized per day for an insulation thickness of 2.5 cm and an ambient temperature of 21°C . Assume that the outer temperature of the insulation is 21°C (10 points).

Problem 2: Two infinite black plates at 500 and 100°C exchange heat by radiation. Calculate the heat-transfer rate per unit area. If another perfectly black plate is placed between the 500 and 100°C plates, by how much is the heat transfer reduced? What is the temperature of the center plate (10 points)?

Problem 3: Regarding the lecture 11, describe the receiver power loss in a solar power tower system. You should report all figures regarding power loss in a power tower system, preheater, boiler and superheater parts as well as total values, (use SAM) (30 points).