Practice Heat-Transfer Problems:

Forced Convection Free Convection

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Practice 1: A wide, deep rectangular oven (1.0 *ft* tall) is used for baking loaves of bread. During the baking process the temperature of the air in the oven reaches a stable value of 100°*F*. The oven side-wall temperature is measured at this time to be a stable 450°*F*. Dease estimate the heat flux from the wall per unit width. Practice 2: A hydrocarbon oil enters a pipe (0.0303 ft inner diameter; 15.0 ft long) at a flow rate of 80 lb_m/h . Steam condenses on the outside of the pipe, keeping the inside pipe surface at a constant $350^{\circ}F$. If the temperature of the entering oil is $150^{\circ}F$, what is temperature of the oil at the outlet of the pipe?

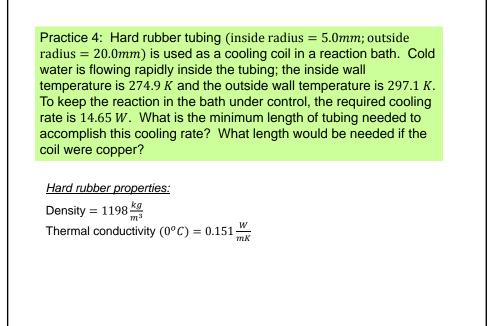
Hydrocarbon oil properties:Mean heat capacity = $0.50 \frac{BTU}{lbm^{\circ}F}$ Thermal conductivity = $0.083 \frac{BTU}{h ft^{\circ}F}$ Viscosity = $6.50 cp, 150^{\circ}F$ $5.05 cp 200^{\circ}F$ $3.80 cp 250^{\circ}F$ $2.82 cp 300^{\circ}F$ $1.95 cp 350^{\circ}F$ Reference: Geankoplis Ex. 4.5-5 page 269

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Practice 3: Air flows through a tube (25.4 mm inside diameter, long tube) at 7.62 m/s. Steam condenses on the outside of the tube such that the inside surface temperature of the tube is 488.7 K. If the air pressure is 206.8 kPa and the mean bulk temperature of the air is $(T_{out}+T_{in})/2 = 477.6 K$, what is the steady-state heat flux to the air?

Reference: Geankoplis Ex. 4.5-1 page 262

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Practice 5: A cold-storage room is constructed of an inner layer of pine (thickness = 12.7 mm), a middle layer of cork board (thickness = 101.6 mm), and an outer layer of concrete (thickness = 76.2 mm). The inside wall surface temperature is 297.1 K. What is the heat loss per square meter through the walls and what is the temperature at the interface between the wood and the cork board? <u>Material properties</u>: Thermal conductivity pine = $0.151 \frac{W}{mK}$ Thermal conductivity cork board = $0.0433 \frac{W}{mK}$ Thermal conductivity concrete = $0.762 \frac{W}{mK}$ Practice 6: A thick-walled tube (stainless steel; 0.0254 m inner diameter; 0.0508 m outer diameter; length 0.305 m) is covered with a 0.0254 m thickness of insulation. The inside-wall temperature of the pipe is 811.0 K and the outside surface temperature of the insulation is 310.8 K. What is the heat loss and the temperature at the interace between the steel and the insulation?

<u>Material properties of stainless steel:</u> Thermal conductivity = $21.63 \frac{W}{mK}$ Density = $7861 \frac{kg}{m^3}$ Heat Capacity = $490 \frac{J}{kgK}$ <u>Material properties of insulation:</u> Thermal conductivity = $0.2423 \frac{W}{mK}$

Reference: Geankoplis Ex. 4.3-2 page 247, but don't do it his way-follow class methods

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