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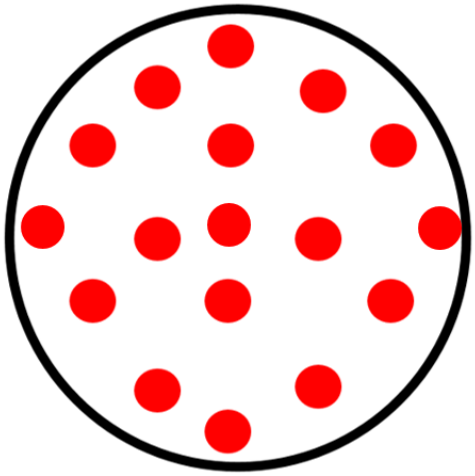
Problems on Refrigeration Systems

Problem. 1: **Calculate the mean condensing heat-transfer coefficient when refrigerant R-12 condenses on the outside of the horizontal tubes in a shell-and-tube condenser. The outside diameter of the tubes is 19 mm, and in the vertical rows of tubes there are respectively, two, three, four, three, and two tubes. The refrigerant is condensing at a temperature of 52 C and the temperature of the tubes is 44 C.**

Problem. 2: **An air-cooled condenser is to reject 75 kJ/s of heat from a condensing refrigerant to air. The condenser has an air-side area of 200 m^2 and a U value based on this area is 40 $W/m^2.K$; it is supplied with 5 m^3/s of air, which has a density of 1.15 kg/m^3 and its specific heat at constant pressure is 1000 J/kg.K If the condensing temperature is to be limited to 50 ºC, Determine;**

1. **LMTD**
2. **Inlet and exit temperature of air**

Problem. 3: **Determine the mean condensing heat-transfer coefficient when refrigerant R – 22 condenses on the outside of the horizontal tubes in a water – cooled condenser. The outside diameter of the tubes is 15 mm. The refrigerant is condensing at a temperature of 50 ºC and the temperature of the tubes is 42 ºC.**



Problem. 4: **Water – cooled condenser used a refrigerant R-22 flows over the tubes while the water flows inside the tube. The refrigerating system provides a capacity of 70 kW for air conditioning. The evaporating temperature is 10°C, and the condensing temperature is 50°C at design conditions. Water from a cooling tower enters the condenser at 28°C and leaves at 35°C. Consider the compressor is hermetically sealed. A two – pass condenser with 28 tubes, arranged as shown below in the figure inserted below. The tubes are made of copper with its thermal conductivity is (380 W/m.K), 12 mm ID and 14 mm OD.**

Determine, step by step and in – full details each of the following points;

I. **Rate of transfer that rejected at the condenser in watts units.**
II. **Mean condensation coefficient for vapor condensing on the outside of horizontal tube.**
III. **Reynolds Number, Prandlt Number, Nusselt Number for water flows inside the pipe.**
IV. **Water – side heat transfer coefficient.**
V. **The overall heat transfer coefficient.**
VI. **LMTD**

Take the thermophysical properties of water;

$$\mu = 0.000773\ Pa.s \quad \rho = 1\ kg/\text{Liter} \quad k = 0.619\ W/m.K \quad C_p = 4200\ j/kg.K$$