FDE 208 HEAT TRANSFER AND THERMAL PROCESSES

Doç. Dr. Aslı İŞÇİ YAKAN
Doç. Dr. Özge ŞAKIYAN DEMİRKOL

EXAMPLES

- The sausage with an initial temperature of 5°C is frozen at -18°C. The diameter and length of sausage is 2 cm and 15 cm, respectively. Calculate the freezing time of sausage by using Tao graphics and Plank equation. Discuss the difference of results obtained from these two methods. The freezing point of sausage is -3°C.
- h (air) = 15 W/m^2K
- ρ (frozen sausage) = 950 kg/m^3
- ρ (unfrozen sausage) = 1047 kg/m^3
- λ (sausage) = 250 kJ/kg
- k (frozen sausage) = 0.48 W/mK
- Cp (sausage)= 3.4 kJ/kg K

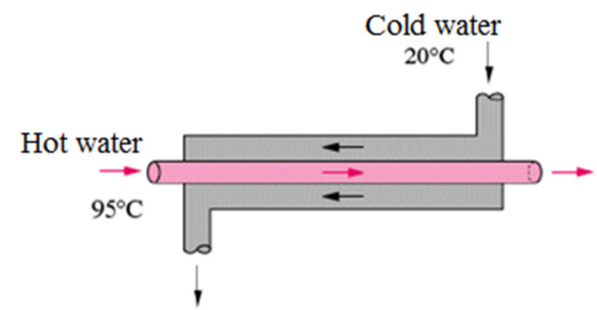
- A 2m X 1.5m section of wall of an industrial furnace is not insulated and the temperature of the outer surface of this section is measured to be 80°C. The temperature of the furnace room is 30°C and the convective heat transfer coefficient at the outer surface of the furnace is 10 $W/m^2 °C$. It is proposed to insulate this section of the furnace wall with glass wool insulation (k=0.038 W/m°C) in order to reduce the heat loss by 90%. Assuming the outer surface temperature of the metal section still remains at about 80°C, determine the thickness of the insulation that needs to be used.

- Water at 20 °C will be heated with a hot water at 90 °C in a double pipe parallel flow heat exchanger. The cold water flows through the inside of the double pipe at a rate of 2 L/min. The temperature difference between the two outlet streams is 20 °C and the overall heat transfer coefficient is 240 W/m^2K. (Note: It is known that the hot water mass flow rate is higher than that of cold water, ε=0.6, Cmin/Cmax =0.5, ρ_{water}=1000 kg/m^3, Cp_{water}=4.182 kJ/kg.K)
- Calculate the length of the tube if the diameter of the inlet tube is 5 cm.
- Calculate the heat transfer rate.

- A person is found dead at 5^{PM} in a room whose temperature is 20 °C. The temperature of the body is measured to be 25 °C when found, and the convective heat transfer coefficient is estimated to be 0.8 $W/m^2°C$. Modelling the body as a 30 cm diameter, 1.50 m long cylinder, estimate the time of death of that person.
- **Note:** The body temperature for a healty person can be assumed as 37 °C.
- Since the average human body is 72% water by mass, the body can be assumed to have the properties of water.

- Citrus fruits are very suscetiple to cold weather, and extended exposure to subfreezing temperatures can destroy them. Consider an 8-cm- diameter orange that is 15 °C. A cold front moves in one night and the ambient temperature suddenly drops to -6 °C, with a heat transfer coefficient of 15 $W/m^2 °C$. Using the properties of water fort he orange and assuming the ambient conditions to remain constant for 4 h before the cold front moves out, determine if any part of the orange will freze that night.

- The spores of a m/o were inoculated to a medium(tube) at a level of 20000/l. The amount of the inoculation was given as 5 ml. The tube was kept at 105 °C for 12 min in an oil bath. If the alive organism count was reported as 20/ml after 12 min, calculate D value.



- The hot and cold water enters at 95°C and 20 °C into the heat exchanger shown below, repectively. The outlet temperature of the hot water is 15 °C higher than that of cold water. In addition, the mass flow rate of the hot water is 50 % higher than that of cold water. If the heat transfer surface area times the overall heat transfer coefficient is 1400 W/ K. Calculate the followings:
    - The outlet temperature of the cold water (K)
    - The mass flow rate of the cold water (kg/s)
    - Heat transfer rate (kW)
    - Effectiveness of the heat exchanger
- (You can take the specific heat capacity of both water as 4.18 kJ/kg.K)

- A water pipe is to be burried in soil at sufficient depth from the surface to prevent freezing in winter. When the soil is at a uniform temperature of 10 °C, the surface is subjected to a uniform temperature of -15°C continuously for 50 days. What minimum depth is needed to prevent the freezing of the pipe? Assume that thermal diffusivity of the soil is $0.2x10^{-6}$ m^2/s and that the pipe surface temperature should not fall below 0 °C. h=8.52 W/m^2K, k_{soil}=1.384 W/mK