Heat Removal from Reactor Systems

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1 Quiz

1.1 *Questions*

1. Which one of the following mode of heat transfer is of less importance in nuclear reactors?
(a) convection (b) radiation (c) conduction (d) all of a, b & c

2. Thermal conductivity (k) of a material, as a function of temperature (T) is given by the following relationship:

k=10.5+0.005T; where 'T' is in °C and 'k' is in W/mK.

Determine the average thermal conductivity of the material between 200 and 300 °C.

3. Determine the rate of heat transfer per unit area across a slab of 100 cm thickness, whose thermal conductivity as a function of temperature is given by:

k=10.5+0.005T; where 'T' is in °C and 'k' is in W/mK.

The temperature on one side of the slab is 200 °C while that on the other side is 300 °C.

4. Which one of the following is not true about subcooled nucleate boiling?
(a) surface temperature greater than saturation temperature
(b) the hydrodynamic flow is bubbly flow
(c) heat transfer is maximum
(d) bubbles condense in the liquid

5. Which one of the following is attributed to the vapor blanketing of heated surface in a pressurized water reactor?

(a) dryout (b) DNB (c) DNBR (d) none of the above

6. In which of the following regime, the rate of heat removal from a heated surface is highest?

(a) single-phase heat transfer (b) subcooled nucleate boiling
(c) saturated nucleate boiling (d) dryout

1.2 *Answers*

1. (b) radiation

2. For the purpose of easiness, the thermal conductivity may be determined separately at 200 and 300 °C and their arithmetic average may be taken as the average thermal conductivity.

Thermal conductivity at 200 °C = 10.5+0.005*200 = 11.5 W/mK
Thermal conductivity at 300 C° = 10.5+0.005*200 = 12 W/mK

3. Using Eq. (4),

$$\frac{Q}{A} = -\frac{1}{L}\int_{T1}^{T2} k(T)dT$$

$$Q = -\frac{1}{L}\int_{T1}^{T2} (10.5 + 0.005T)dT$$

$Q = -\frac{1}{L}(10.5T + 0.0025T^2)_{300}^{200} = 1175$ W/m^2

We may also utilize the average thermal conductivity determined in the previous problem as follows:

$Q=k_{avg}dT/dx = 11.75*100/1 = 1175$ W/m^2

4. (c) heat transfer is maximum

5. (b) DNB

6. (c) saturated nucleate boiling