Assignment 2

The due date for submitting this assignment has passed. Due on 2019-02-13, 23:59 IST.
As per our records you have not submitted this assignment.

1) A steam pipe of 0.12m outside diameter is insulated with a layer of calcium silicate \( k = 0.089 \text{ W/mK} \). The inner surface temperature fixed at \( T_{s,1} = 800 \text{ K} \). The outer surface is exposed to an airflow \( (T_{\infty} = 25^\circ \text{C}) \) that maintains a convection coefficient of \( h = 25 \text{ W/m}^2 \text{K} \) and to large surroundings for which \( T_{\text{sur}} = T_{\infty} = 25^\circ \text{C} \). The surface emissivity of calcium silicate is approximately 0.8. Calculate the heat loss and the outer surface temperature for the 20 mm thick insulation.

Given: Radiation coefficient \( h_r = \sigma(T_s,2 + T_{\text{sur}})(T_{s,2}^2 + T_{\text{sur}}^2), q_{\text{radiation}} = 2\pi r h_r(T_s,2 - T_{\infty}), \sigma = 5.67 \times 10^{-8} \text{ W/K}^4 \)

Hint: The convection and radiation happening simultaneously.

\[ T_s,2 = 353.2^\circ \text{C}, q' = 845.24 \text{ W/m}^2 \]
\[ T_s,2 = 353.2 \text{ K}, q' = 868.52 \text{ W/m}^2 \]
\[ T_s,2 = 303.7^\circ \text{K}, q' = 1305.41 \text{ W/m}^2 \]
\[ T_s,2 = 303.7^\circ \text{C}, q' = -1779.1 \text{ W/m}^2 \]

No, the answer is incorrect.
Score: 0

Accepted Answers:
\[ T_s,2 = 353.2 \text{ K}, q' = 868.52 \text{ W/m}^2 \]

2) A S.S. tube \( (k_{ss} = 14.2 \text{ W/mK}) \) used to transport a chilled pharmaceutical has 3 points an inner diameter of 36 mm and a wall thickness of 2 mm. The pharmaceutical and ambient air are at temperatures of \( 6^\circ \text{C} \) and \( 23^\circ \text{C} \), respectively, while the corresponding inner and outer convection coefficients are \( 400 \text{ W/m}^2 \text{K} \) and \( 6 \text{ W/m}^2 \text{K} \), respectively. What is heat gain per unit tube length? What is heat gain per unit tube length if a 10 mm thick layer of calcium silicate insulation \( (k_{ins} = 0.050 \text{ W/mK}) \) is applied to the tube?
3) Consider one-dimensional conduction in a plane composite wall. The outer surfaces are exposed to a fluid at 25°C and a convection heat transfer coefficient of 1000 W/m²K. The middle wall B experiences uniform heat generation $q_B$ while there is no generation in walls A and C. The temperatures at the interfaces are $T_1 = 261°C$ and $T_2 = 211°C$. Assuming negligible contact resistance at the interfaces determine the volumetric heat generation $q_B$ and the thermal conductivity $k_B$.

$$q' = 11.98 \text{ W/m}, \quad q'_{\text{ins}} = 9.08 \text{ W/m}$$

No, the answer is incorrect.
Score: 0
Accepted Answers:
$q' = 12.6 \text{ W/m}, \quad q'_{\text{ins}} = 7.73 \text{ W/m}$

$q_B = 4.0 \times 10^6 \text{ W/m}^3, \quad k_B = 15.3 \text{ W/mK}$
$q_B = 1.0 \times 10^3 \text{ W/m}^3, \quad k_B = 10.2 \text{ W/mK}$
$q_B = 1.3 \times 10^6 \text{ W/m}^3, \quad k_B = 20.5 \text{ W/mK}$
$q_B = 7.5 \times 10^6 \text{ W/m}^3, \quad k_B = 5.1 \text{ W/mK}$

No, the answer is incorrect.
Score: 0
Accepted Answers:
$q_B = 4.0 \times 10^6 \text{ W/m}^3, \quad k_B = 15.3 \text{ W/mK}$