Abd El-Hafid Boussouf University Center – Mila
Institute Of Sciences & Technology
Department of Process Engineering

May 2024

Notions of Transport Phenomena

Final Exam - correction

Closed Notes, Show All Work

Exercise 01 (08 Marks): "About heat transfer"

1- There are: THREE (3) main ways of heat transfer. 0,25
- Conduction HT; 0,25
- Convection HT, and; 0,25
- Radiation. 0,25

2- Fourier's law. 1

3- $q''_x = -k\frac{dT}{dx}$ (heat flux) or, $q_x = -kA\frac{dT}{dx}$ (heat transfer rate) 1

The thermal conductivity of most solids varies with temperature. In general:

$$k = \frac{\vec{q}_x}{\partial T/\partial x}$$ 1

Most materials are very nearly homogeneous, therefore we can usually write k = k (T).
As temperature increases, both the number of free electrons and lattice vibrations increase. However, the thermal conductivity of metals decreases slightly with increasing temperature.

Part 01:

4- $q''_x = h.(T_s - T_{surr})$ (heat flux) or, $q_x = h.A.(T_s - T_{surr})$ (heat transfer rate) 1

5- [**h**] : $W/m^2.K$ 1

6- $q''_{conduction} = q''_{convection}$ then, $-k\frac{dT}{dx} = .(T_s - T_{surr})$ so, $T_s = -k\frac{dT}{dx} + T_{surr}$ … 1

Part 02:

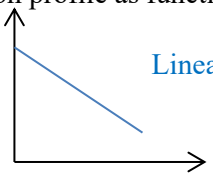
$q''_{conduction} = q''_{radiation}$ Then, $-k\frac{dT}{dx} = \sigma.(T_s^4 - T_{surr}^4)$ so… 1

Exercise 02 (07 Marks): "About mass transfer"

1- Gradient of concentration : $\frac{dC}{dx}$ 1

2- $J_{AB} = -D_{AB}.\frac{dC}{dx}$; called: Fick's first law of diffusion 2

3- Concentration profile as function of (x):



1

4- The negative sign of the equation indicates that diffusion occurs in a direction opposite to that of the increasing concentration. Hence, diffusion occurs in the direction of decreasing concentration of the diffusing substance, and thus, the diffusion flux is a positive quantity. 1

5- If we change the spices (A) and (B) by two **gases**, the new rate of diffusional mass transfer **increase**. 1

6- There is two main types of mass transfer, the first one is molecular diffusion, and the second one is: **convection mass transfer**. 1

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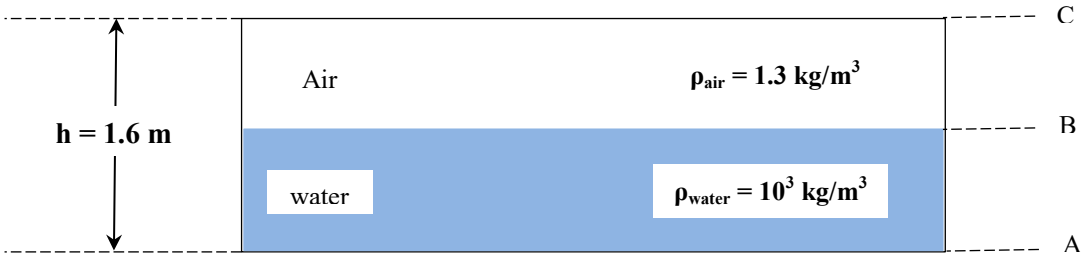
Exercise 03 (05 Marks): "About momentum transfer"

The tank shown in **figure 03** is half filled water.



1- Calculate the pressure difference between points **A** and **B**.

$\Delta P_{AB} = \rho_{water}.g.h$ then, $\Delta P_{AB} = 10^3.9{,}81.(\frac{1{,}6}{2})$, so $\Delta P_{AB} = 7\,848\ Pa$ 0,25 x 4

2- Calculate the pressure difference between points **B** and **C**.

$\Delta P_{BC} = \rho_{air}.g.h$ then, $\Delta P_{BC} = 1{,}3.9{,}81.(\frac{1{,}6}{2})$, so $\Delta P_{BC} = 10{,}2\ Pa$ 0,25 x 4

3- Compare these results.

$\Delta P_{AB} \gg \Delta P_{BC}$ (The pressure differential in water is much greater than in air.)
This is due to the volumetric mass of matter. 1

Good Luck,
Dr. BOUTI .M