## NA—164—2023

### FACULTY OF SCIENCE

**B.Sc. (First Year) (Second Semester) EXAMINATION**

**NOVEMBER/DECEMBER, 2023**

**(New Course)**

INDUSTRIAL CHEMISTRY

Paper-III

(Heat Transfer and Aspect of Industrial Chemistry)

| (Saturday, 23-12-2023) | Time : 10.00 a.m. to 12.00 noon |
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*Time—2 Hours* *Maximum Marks—40*

*N.B.* :— Use of log table and scientific calculator is allowed.

1. Explain convection in detail with suitable example and explain mathematical expression for individual and overall heat transfer coefficients. 15

*Or*

Solve problems on :

(*a*) Steam pipeline 150/160 mm in diameter is covered with a layer of insulating material of thickness 50 mm. The temperature inside the pipeline is 393 K (120ºC) and that of outside surface of insulation is 313 K (40ºC). Calculate the rate of heat loss of 1 m length pipeline.

Data for K for the pipe is 50 W/(m.K) and K for insulating material is 0.8 W (m.K). 8

P.T.O.

(*b*) A furnace is constructed with 225 mm thick of fibre brick, 120 mm of insulating brick and 225 mm of building brick. The inside temperature is 1200 K (927ºC) and the outside temperature is 330 K (57ºC). Find the loss per unit area and the temperature of junction of the fire brick and insulating brick.

Data K for fire brick = 1.4 W(m.K)

K for insulating brick = 0.2 W(m.K)

K for building brick = 0.7 W/(m.K). 7

2. Explain heat exchange equipment in detail. Give the example of double pipe heat exchanger, reboiler heat exchanger with neat labelled diagram and construction and working of it. 15

*Or*

Solve the problems on :

(*a*) Calculate the total length of a double pipe heat exchanger required to cool 5500 kg/h of ethylene glycol from 358 K (85ºC) to 341 K (68ºC) using toluene as a cooling medium which flows in a counter current fashion. Toluene enters at 303 K (30ºC) and leaves at 335 K (62ºC).

Data : Outside diameter of outside pipe = 70 mm

Outside diameter of inside pipe = 43 mm.

Wall thickness of both pipes = 3 mm.

Mean properties of two fluids are given as below : 8

| Property | Ethylene glycol | Toluene |
|----------|-----------------|---------|
| Density | 1080 kg/m$^3$ | 840 kg/m$^3$ |
| Specific heat | 2.680 KJ (kg. K) | 1.80 Kj/kg.K |
| Thermal conductivity | 0.248 W/(m.K.) | 0.146 W/(m.k) |
| Viscosity | 3.4 × 10$^{-3}$ Pa.s | 4.4 × 10$^{-4}$ Pa.s] |

Thermal conductivity of metal pipe is 46.52 W/(m.K) and ethylene glycol is flowing through the inner pipe.

(*b*) In a double pipe counter current flow heat exchanger, 1000 kg/h of on oil having a specific heat of 2095 J (kg.K) is cooled from 353 K (80ºC) to 323 K (50ºC) by 8000 kg/h of water entering at 298 K (25ºC). Calculate the heat exchanger area for an overall heat transfer coefficient of 300 W(m.K). Take Cp for water as 4180 J (kg.K). 7

3. Write short notes on any *two* : 10

(*a*) U-Tube heat exchanger

(*b*) Baffles in heat exchanger

(*c*) Planck's law

(*d*) LMTD.