Reg. No.										

Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)

INSPIRED BY LIFE

IV SEMESTER B.TECH (CHEMICAL ENGINEERING)

MAKE UP EXAMINATION, JUNE-2017

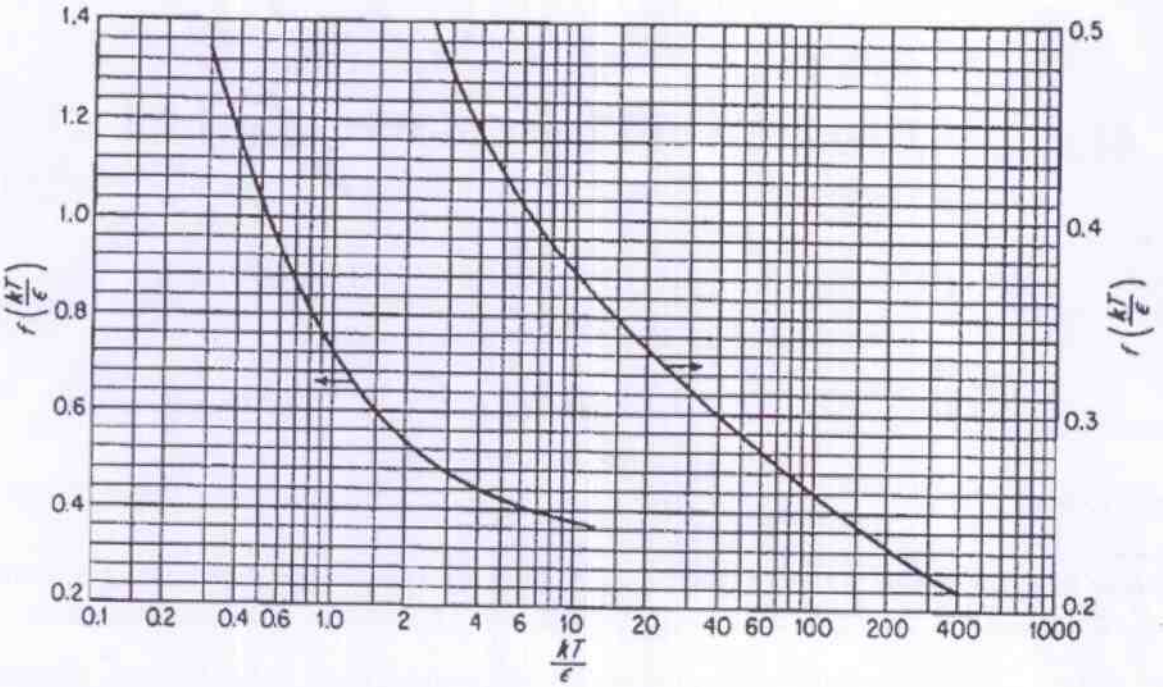
SUBJECT: MASS TRANSFER -I (CHE2203)

REVISED CREDIT SYSTEM

Time: 3 Hours MAX. MARKS: 100

Instructions to Candidates: Missing data may be suitably assume and answer all questions

1A	Ammonia is diffusing through a stagnant nitrogen. The total pressure is 206.8 kN/m^2 and the temperature 54 ^0C. Calculate the rate of diffusion of the ammonia through a film of gas 0.5 mm thick when the concentration change across the film is 10 to 5 % Ammonia by weight. Consider both extreme cases which can be solved. $D_{AB}= 1.98X10^{-5}$ m^2/s	07
1B	Estimate the diffusivity of Toluene vapor through air at 1 atm and 90^0C (BP of toluene is 80^0C) Data and charts provided at the end of questions/next page	13
2A	Porous Alumina spheres, 10 mm diameter, 25% voids were thoroughly impregnated with an aqueous potassium chloride, KCl solution, concentration 0.25 g/m^3. When immersed in pure running water, the spheres lost 80% of their salt content in 5 h. The temperature was 25 ^0C. At this temperature the average diffusivity of KCl in water over the indicated concentration range is $1.84x10^{-9}$ m^2/s. Estimate the time for removal of 99% of the dissolved solute if the spheres had been impregnated with Potassium chromate K_2CrO_4 solution at a concentration 0.2 g/cm^3, when immersed in a running stream of water which contains 0.02 g/cm^3 K_2CrO_4. The average diffusivity of K_2CrO_4 in water at 250C is $1.14x10^{-9}$ m^2/s.	16
2B	Define the Humid volume and humid heat?	4
3	Estimate the rate of absorption of pure oxygen at 10 atm and 24 ^0C into water flowing as a film down a vertical wall 1 m high and 6 cm width at a Reynolds number of 75 without ripples. Assume the diffusivity of oxygen in water $2.5x10^{-9}$ m^2/s and mole fraction of oxygen in water at that temperature and pressure is $2.3x10^{-4}$. Viscosity of water is 0.89 cp and density of water is 1000 kg/m^3. Assume the average density and molecular wt will not be effected by the soluble oxygen.	20
4	A coal gas is to be freed of its light oil by scrubbing with wash oil as an absorbent. Gas in 0.250 m^3/s at 26^0C and $P_t=1.07x10^5$ N/m^2 containing 2.0% by volume of light oil vapors. The light oil will be assumed to be entirely benzene and a 95% removal is required. The wash oil is to enter at 26 ^0C, containing 0.005 mole fraction benzene and has an average mol. Wt. 260. An oil circulation rate of 1.5 times minimum is to be used. Wash Oil and Benzene solutions are ideal solution and temperature is constant (P^S of benzene at this is 13330 N/m^2)	20
5A	Explain various properties and raw materials used for preparation of industrial adsorbents (atleast 6 adsorbents)	9
5B	i) Briefly explain the differences between chemisorption and physical adsorption	6
	ii) Explain the hysteresis phenomena in adsorption with the help of graph	2
	iii) Briefly explain following a) gas holdup b) slip velocity c) tray efficiency	3



Force constants of gases as determined from viscosity data

Gas	ε/k, K	r, nm
Air	78.6	0.3711
CCl_4	322.7	0.5947

Atomic and molecular volumes

Atomic volume, $m^3/1000$ atoms $\times 10^3$		Molecular volume, $m^3/kmol \times 10^3$		Atomic volume, $m^3/1000$ atoms $\times 10^3$		Molecular volume, $m^3/kmol \times 10^3$	
Carbon	14.8	H_2	14.3	Oxygen	7.4	NH_3	25.8
Hydrogen	3.7	O_2	25.6	In methyl esters	9.1	H_2O	18.9
Chlorine	24.6	N_2	31.2	In higher esters	11.0	H_2S	32.9
Bromine	27.0	Air	29.9	In acids	12.0	COS	51.5
Iodine	37.0	CO	30.7	In methyl ethers	9.9	Cl_2	48.4
Sulfur	25.6	CO_2	34.0	In higher ethers	11.0	Br_2	53.2
Nitrogen	15.6	SO_2	44.8	Benzene ring: subtract	15	I_2	71.5
In primary amines	10.5	NO	23.6	Naphthalene ring: subtract	30		
In secondary amines	12.0	N_2O	36.4				

Source: Mass Transfer Operations by R E Treybal, 3rd Edition, McGraw Hill Book Company