Department of Chemical Engineering

MInor II – CHL221 **CRE -II**
Time: 1:00-2:00 pm Date: 4th Oct., 2013
M.M 20

1. Discuss the concept of temperature –time trajectory for the slow catalyst deactivation. The vapor phase cracking of a vacuum gas oil (A),

A (g) ---------→ P (g) + coke (s), is to be carried out in a Moving bed reactor containing 100 kg of silica-alumina catalyst that decays due to coke deposition. The reaction is carried out at 600° C. The feed A enters at a concentration of 0.004 mol/L and at volumetric flow rate of 4.0 L/s. The catalyst particles are moving in the bed at the rate of 10.0 kg/s. The kinetics of the reaction is given by

$-r'_A = (kC_A/ 1+ K_A C_A). a(t)$, with $K_A = 3$ L/mol and $k= 8.0$ L/g. s^{-1}.

At 600° C, the catalyst decay rate for vacuum gas oil over this catalyst is given by a second order kinetics, with $k_d = 0.5\ s^{-1}$. Calculate the conversion of A at the exit of the reactor. (8)

2. A plant is removing a trace of SO_2 from a waste gas stream by passing it over a solid granular adsorbent in a tubular packed bed. At present, 60.0 % removal is being accomplished, but it is believed that higher removal could be achieved if the flow rate were increased by a factor of 2, the particle diameter were decreased by a factor of 2, and the packed tube length is doubled. What percentage of SO_2 would be removed under the scheme proposed? Assume that SO_2 transferring to the adsorbent is removed by an instantaneous chemical reaction. Use the following correlation for the calculation of mass transfer coefficient:

(7)

$$Sh= (Re)^{1/2}(Sc)^{1/3}$$

3. The solid density of silica particle is 3.8 g/cm^3, the catalyst pellet density is 1.2 g/cm^3, and the internal surface area of the catalyst is 150 m^2/g. 12 g of this catalyst is packed in a reactor of volume 15 cm^3. Compute the pore volume per gram, the catalyst porosity, and the mean pore radius and bed porosity. (5)