Minor I – CLL 727 Heterogeneous catalysis and Catalytic Reactors

Time: 11:00-12:00 pm **Date: 7, Feb., 2019**
M.M 20 LH 308

1. Give thermodynamic analysis for evaluating the composition of the chemical reaction taking the example of steam reforming of ethanol. Assume that Steam reforming, Water gas shift and CO_2 methanation reactions are prevailed during the reaction. 6

2. (i) Explain the Sabatier principle of heterogeneous catalysis. How volcano curve is generated and what is its importance in catalysis. 3

(ii) Define Atom efficiency and E-factor and their importance in the concept of Green Catalysis. 2

(iii) Derive an expression for correlating pore volume and surface area of the catalyst in terms of average pore radius, pore length and pore volume. 2

3. A methanol forming reaction was investigated on a commercial supported catalyst 15.0% Cu/Al_2O_3. The degree of dispersion (D) of the catalyst was found to be 20 % by means of chemisorption measurements with H_2. At 75 bar and 150^{0}C a catalyst turn over frequency (TOF) of 0.25 s^{-1} was determined for methanol. Calculate the rate of formation of methanol (r_{CH3OH}) in mol/ s. /g (cat.) (metal + support).

$$CO + 2\,H_2 \longrightarrow CH_3OH$$ 3

4. The reaction rate kinetics of isobutene oligomerization on macroporous polystyrene sulfonic acid is described as follows:

At low concentrations of isobutene (IB) rate is given by,

$r = K_1 P_{IB}^2$,

and at high concentrations it is,

$r = K_2 P_{IB}$, Which simple model can be used to explain this? Justify. 4