

# Department of Chemical Engineering

## Minor-I Exam CHL 727 Heterogeneous catalysis and Catalytic Reactors

Time : 2:30-3:30 pm

Date: 07 Jan., 2014

M.M 20

1. What are the assumptions of Langmuir adsorption Isotherm? The surface area of the boron-doped carbon catalyst was determined by measuring  $N_2$  adsorption at 77 K. The equilibrium  $N_2$  uptakes versus the pressure are listed in the table below. Using **Langmuir** adsorption isotherm, calculate the number of molecule of gas adsorbed and monolayer surface area of this catalyst? The saturation pressure value for  $N_2$  at the actual temperature measured as  $P_0 = 732$  Torr (760 Torr = 1 atm). (Density of liquid  $N_2$  at the condensation temperature:  $0.81 \text{ g/cm}^3$ )

Table:  $N_2$  physisorption on carbon

P (Torr)	36	96	130	200	240
Uptake, $N_2$ (mmole $N_2 \text{ g}^{-1}$ )	1170	1286	1395	1511	1600

2. In the following figure (1), the surface has been completely saturated with hydrogen atoms and we plan to estimate the desorption energy of the hydrogen molecules by recording a TPD spectra. It can be assumed that the desorption curve is completely symmetrical and that the desorption rate has maximum at 408 K. Under the assumption that the pre factor is  $k_0 = 1 \times 10^{13} \text{ s}^{-1}$  and rate of heating ( $\beta$ ) = 2 K/s estimate the activation energy for the desorption assuming that rate is independent of fractional coverage. (7)

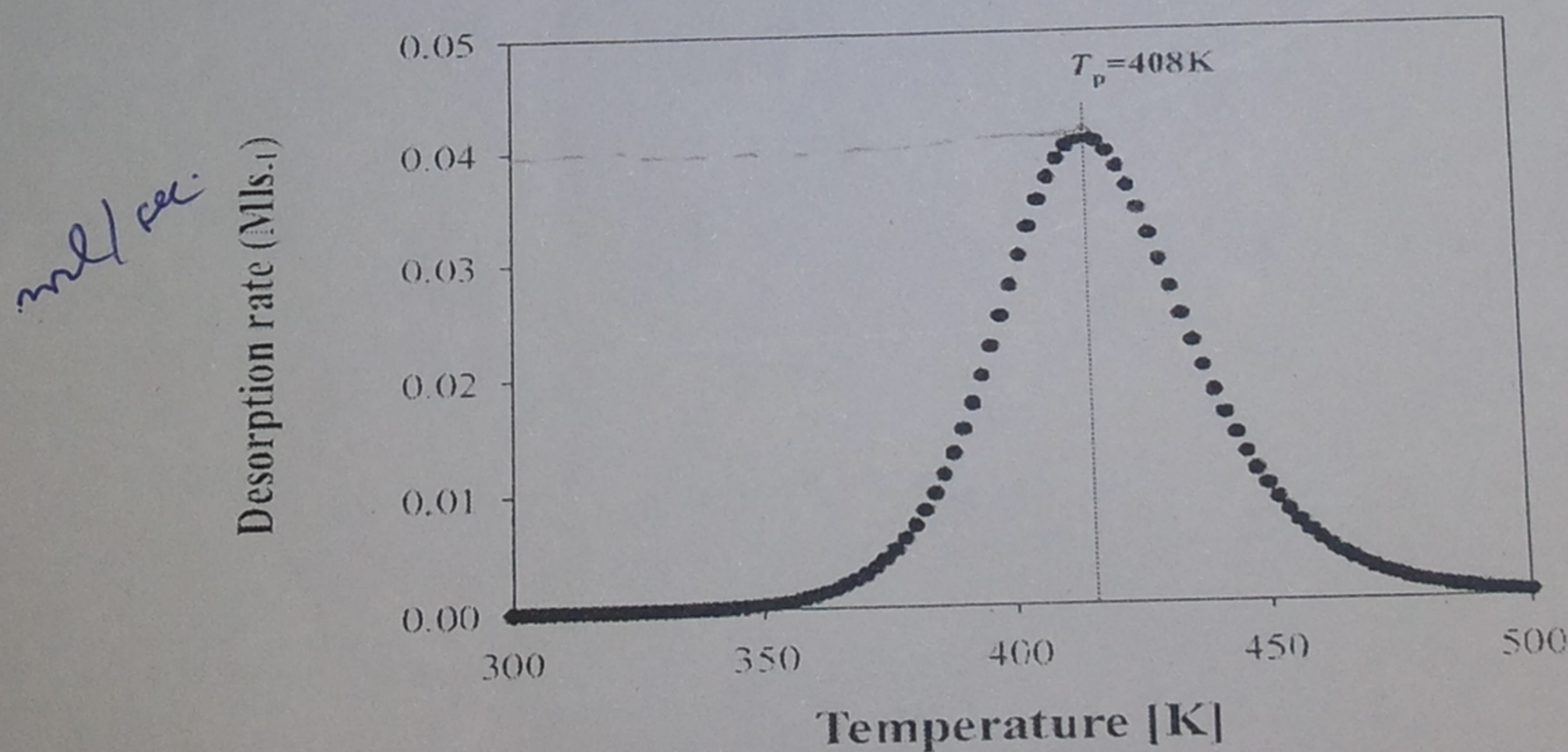


Fig. 1

- Why heterogeneous catalysts are preferred in industrial processes.
- What is meant by activation energy of a reaction and how is it different from the Gibbs free energy. Can the activation energy of a catalytic reaction have a negative value? If so, under what conditions?
- Explain the concepts of Lewis and Brønsted acidity in catalysis.

(6)