EXPERIMENT NO -2

Rate Study in a CSTR

Objective:

(1) To determine the order of reaction between sodium hydroxide and ethyl acetate using a CSTR reactor.
(2) To find the rate constant at a particular temperature.

Theory:

Stoichiometric Equation: $NaOH + CH_3COOC_2H_5 \rightarrow CH_3COONa + C_2H_5OH$

A B C D

Mole Balance: $$\frac{V_R}{F_{A_0}} = \frac{X_A}{-r_A} \quad (1)$$

Rate Equation: $$-r_A = k_2 C_{A_0}^2 (1 - X_A)(M - X_A) \quad (2)$$

Assuming 2nd order reaction

Where $= \frac{C_{B_0}}{C_{A_0}}$; X_A= conversation of A; k_2 = rate constant in lit/(mol) (min)

From eqn (1) & (2), $$\frac{V_R}{F_{A_0}} = \frac{V_R}{v_0 C_{A_0}} = \frac{\tau}{C_{A_0}} = \frac{X_A}{k_2^{\tau} C_{A_0}(1-X_A)(M-X_A)} = \frac{1}{k_2} f(X_A)$$

Where, total volumetric flow rate, $v_0 = v_A + v_B$ and $\tau = \frac{V_R}{v_0}$

Apparatus:

(1) S. S. reactor (volume of reactor = 2.815 lit.),

(2) Constant temperature water bath

(3) Stop watch and (4) Conical flasks

Chemicals:

(i) Succinic acid (N/50) (ii) NaOH (iii) $CH_3COOC_2H_5$ (N/10) and (iv)Phenolphthalein indicator

Procedure:

1. Fill both the storage tanks of ethyl acetate and NaOH and calibrate the flow meters.
2. Adjust the control valves to set the flow rates. Try to keep both the flow rates equal.
3. After attaining steady- state, collect the sample in a flux from the outlet.

4. Take 5 ml of sample and titrate with the standard succinic acid solution with phenolphathalein as indicator.
5. Take 5 ml of supplied NaOH solution by the standard succinic acid solution to get C'_{A_0} gmol/lit
6. Calculate X_A from C_A for various $\tau = \frac{V_R}{v_0}$
7. Plot $f(X_A)$ against τ and determine the rate constant from the slop.

N.B. $C_{A_0} = \frac{v_A}{v_A+v_B} C'_{A_0}$ and $C_{B_0} = \frac{v_A}{v_A+v_B} C'_{B_0}$