

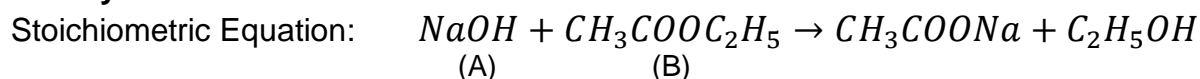
## EXPERIMENT No. 3

### Rate Study in a Plug Flow Reactor

#### Objective:

- (1) To determine the order of reaction between sodium hydroxide and ethyle acetate using a Plug Flow Reactor
- (2) To find the rate constant at a particular temperature

#### Theory:



Mole Balances: 
$$\frac{V_R}{F_{A_0}} = \int_0^{X_A} \frac{dX_A}{-r_A}$$

Rate Equation: 
$$-r_A = k_1 C_{A_0}^2 (1 - X_A)(M - X_A)$$

Assuming 2<sup>nd</sup> Order reaction,

Where  $M = \frac{C_{B_0}}{C_{A_0}}$ ,  $X_A$  = Conversion of A,  $k_2$  = rate constant

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

Where  $v_0 = v_A + v_B$  and  $\tau = V_R/v_0$

#### Apparatus:

- (1) Stainless Steel Reactor in a constant temperature water bath
- (2) Stop Watch

#### Dimension of the reactor:

Length of the coil: 609.6 cm; inside dia. Of the tube = 1.23 cm;

Volume of the reactor (volume of tube) : 0.724 liter

#### Chemicals:

- (i) Succinic Acid (N/50), (ii) NaOH (N/20), (iii)  $CH_3COOC_2H_5$  (N/10) and
- (iv) Phenolphthalein indicator

#### Procedure:

- (i) Fill both the storage tanks of ethyl acetate and NaOH and calibrate the flow meters.
- (ii) Adjust the control valves to set the flow rates. Try to keep both flow rates equal.
- (iii) After attaining steady state, collect the sample in a flask from the outlet.
- (iv) Take 5 ml of this sample and titrate with the standard succinic acid solution with phenolphthalein as indicator.
- (v) Take 5 ml of supplied NaOH and titrate with the standard succinic acid solution to get  $C'_{A_0}$  gmol/lit

(vi) Calculate  $X_A$  from  $C_A$  for various  $\tau = V_R/v_0$

(vii) Plot  $f(X_A)$  against  $\tau$  and determine the rate constant from the slope.

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