PRODUCTION OF ETHYL ACETATE USING CATALYTIC REACTION METHOD

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DECLARATION OF THE CANDIDATE & SUPERVISOR

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ABSTRACT

Chemical industries drive towards heterogeneous catalysts which meet generation of nearly zero waste chemicals and less energy utilization. Ethyl acetate synthesis by esterification of acetic acid with ethyl alcohol occurs very slowly in the absence of catalyst. In order to make the reaction faster, both homogeneous and heterogeneous catalysts can be employed.

In this work ethyl acetate production using homogeneous and heterogeneous catalysts are studied. Two types of inexpensive cation exchange resins locally available in the market are used for the heterogeneous reaction. The homogeneous catalyst study for the ethyl acetate production is done using sulphuric acid catalyst.

The study of esterification reaction over heterogeneous catalysts showed maximum conversions of acetic acid in the range 62% to 58% at varying reaction conditions. The heterogeneous reaction experiments carried out within the temperature range 325K to 355K showed second order reversible reaction kinetics. Low activation energy values are observed in the heterogeneous catalyst reactions compared to that of homogeneous experiments. Heterogeneous reaction kinetics study done by examining the effect of initial concentration of acetic acid, ethanol and water on initial reaction rate indicated that the reaction follows Eley-Rideal mechanism. The reusability of the solid catalyst and the reactive distillation of ethyl acetate are also looked at briefly.

Keywords: Esterification, Ethyl acetate, acid catalyst, cation exchange resin

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NOMENCLATURE

A- Carboxilic acid

B- Alcohol

E - Ester

W - Water

C_{A0} – Initial concentration of carboxylic acid

C_{B0} - Initial concentration of alcohol

C_{E0} - Initial concentration of ester

C_{W0} - Initial concentration of water

X_A - Equilibrium conversion of carboxilic acid

k1 – Forward reaction rate ,l/mol/min

k2 – Backward reaction rate, l/mol/min

K_{eq}-Equilibrium constant

C_{Ae} – Concentration of carboxylic acid at equilibrium

C_{Be} - Concentration of alcohol at equilibrium

C_{Ee} - Concentration of ester at equilibrium

C_{We} -Concentration of water at equilibrium

X_{Ae} – Conversion of carboxylic acid at equilibrium

t – Time

E – Activation energy

k_0- Pre-exponential factor

R – Real gas constant

T- Reaction temperature

θ_A – Fractional coverage of component A

θ_B – Fractional coverage of component B

θ_C – Fractional coverage of component C

θ_D – Fractional coverage of component D

θ_V – Fraction of vacant adsorption sites on resin surface

r – Reaction rate

r_{ads} – Rate of adsorption

r_{des} – Rate of desorption

K_{SA} – Adsorption equilibrium constant of reactant A