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Environmentally Friendly Epoxidation of Styrene to Styrene Oxide using Hydrogen Peroxide under Liquid-Liquid Phase Transfer Catalysis

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Abstract : Phase transfer catalysis (PTC) is an attractive technique for synthesis of organic chemicals from two immiscible reactants existing in two different phases, which otherwise normally cannot react with each other due to their low mutual solubility in other phase and hence their low interaction. In this research work, an environmentally friendly catalytic epoxidation system is developed for the synthesis of styrene oxide from styrene using hydrogen peroxide as the oxidizing agent under liquid-liquid phase transfer catalytic conditions by using tetra-butyl ammonium bromide (TBAB) as the phase transfer catalyst and sodium tungstate as the co-catalyst. The use of co-catalyst with PTC has proven to be advantageous in intensifying the rate of oxidation reactions with H_2O_2. The kinetics of epoxidation of styrene to styrene oxide under liquid-liquid phase transfer catalysis was studied. Styrene was converted quantitatively to styrene oxide with about 75% conversion of styrene to styrene oxide in ethyl acetate as the solvent at 50°C. The reaction takes place to a significant extent in 30 minutes at 50°C and at a speed of agitation of 1200 rpm. Thermal decomposition of hydrogen peroxide may become significant at temperatures of 70°C and above, and also beyond 60°C, thermal oligomerisation of styrene sets in; hence, all the experiments were carried out at 50°C. An apparent activation energy of 2.5 kcal/gmol was found from the Arrhenius plot for the temperature range of 30°C-50°C. The effect of various parameters such as speed of agitation, temperature, concentration of styrene, concentration of H_2O_2, concentration of phase transfer catalyst such as TBAB and concentration of co-catalyst such as sodium tungstate on the conversion of styrene was studied. A suitable reaction mechanism and kinetic model for the above-mentioned environmentally friendly catalytic epoxidation system was also developed.

Key-words : Phase Transfer Catalysis; Styrene Oxide; Styrene; Hydrogen Peroxide; Environmentally Friendly Epoxidation; Kinetic Model.

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