113e Hydrogentation of Alpha-Methylstyrene to Cumene Via an Electrochemical Route

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Phenol is an important organic chemical since it serves as a precursor to several important industrial chemicals. The phenol production in the United States has increased in the last 15 years. It is generally manufactured via the cumene peroxidation process. However, in this process, a significant proportion may be lost as the by product alpha-methylstyrene (AMS). While AMS by itself serves as a monomer for development of industrial polymers, in a phenol production plant, the primary aim is to maximize the yield of phenol. In addition, the separation and purification of AMS from the by-product stream is an added cost. Therefore, in order to increase the profitability of phenol plant, several manufacturers, have found it beneficial to hydrogenate AMS back to cumene and reintroduce it as the feed to the peroxidation process. In general, the hydrogenation of AMS is achieved via catalytic hydrogenation. However, this process requires the use of highly explosive hydrogen under high pressures. In addition, this reaction is limited by the diffusion of the gaseous hydrogen into the liquid phase and to the catalyst surface.

A mediator-assisted electrochemical pathway for reduction of alpha-methyl styrene to cumene is investigated. Ambient pressure and low temperature hydrogenation is carried out in a emulsion of the reactant, an organic solvent and water, to which a suitable surfactant is added. The mediator employed in the study hydrogenates alpha-methylstyrene via a chemical step on the solid catalyst while the former is regenerated electrochemically at the cathode.

Alpha-methylstyrene was successfully hydrogenated to cumene using both catalytic transfer hydrogenation and mediator assisted electrochemical hydrogenation. Complete conversion was achieved at a mediator concentration of 0.5M and at an applied potential of -1.3V vs. SCE at 60°C. The influence of the applied current density, concentration and the type of electrode on the rate of hydrogenation is investigated. A mathematical model that takes into consideration the reaction chemistry is proposed and validated using the experimental data.