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Catalysis, Kinetics and Reaction Engineering

Polyethoxylation and polypropoxylation reactions: Kinetics, mass transfer and industrial reactor design

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Abstract

Ethoxylation and propoxylation reactions are performed in industry to produce mainly non ionic surfactants and ethylene oxide (EO) - propylene oxide (PO) copolymers. Both the reactions occur in gas-liquid reactors by feeding gaseous EO, PO or both into the reactor containing a solution of an alkaline catalyst (KOH or NaOH). Non-ionic surfactants are produced by using liquid starters like fatty alcohols, fatty acids or alkyl-phenols, while when the scope is to prepare EO-PO copolymers the starter can be a mono- or multi-functional alcohol of low molecular weight. Both reactions are strongly exothermic, and EO and PO, in some conditions, can give place to runaway and also to explosive side reactions. Therefore, the choice of a suitable reactor is a key factor for operating in safe conditions. A correct reactor design requires: (i) the knowledge of the kinetic laws governing the rates of the occurring reactions; (ii) the role of mass and heat transfer in affecting the reaction rate; (iii) the solubility of EO and PO in the reacting mixture with the non-ideality of the reacting solutions considered; (iv) the density of the reacting mixture. All these aspects have been studied by our research group for different starters of industrial interest, and the data collected by using semibatch well stirred laboratory reactors have been employed for the simulation of industrial reactors, in particular Gas-Liquid Spray Tower Loop Reactors.

Keywords: Ethoxylation, Propoxylation, Kinetics, Mass transfer, Spray tower loop reactor

1. Introduction

Polyethoxylation and polypropoxylation reactions are normally performed, in industry, for preparing non-ionic surfactant and polymers (1-3). Both the reactions are highly exothermic (~83.7 kJ/mol) and requires an efficient heat exchange to avoid the hazard of runaway that is particularly