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Optimization of Batch Distillation Involving Hydrolysis System

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In this work optimization of batch reactive distillation involving hydrolysis reaction of methyl lactate with excess water to produce pure lactic acid and methanol is studied. Lactic acid product amount and purity are used as constraints; reflux ratio profile (piecewise constant) is utilized to the optimization problem. Different values of product purity ranging from 0.8 to 0.999 mole fraction are investigated and the impact of time dependant reflux ratio policy on the product quality and batch time is analyzed.
The optimization results indicate that highly purified lactic acid (0.999 mole fraction) can be achieved directly from hydrolysis of methyl lactate in the presence of catalyst using batch reactive distillation process. Moreover it is noticed that, the column operated with single time interval for reflux ratio could not produce lactic acid at high purity (> 0.925 mole fraction). The multi-reflux interval strategies (2 and 3 time intervals) have been found to be better to produce products with higher purity specifications with shorter batch time. Also it is found to be more effective to operate the column with excess water in the feed to produce high purity of lactic acid.

1. Introduction

Lactic acid (LA) is used in many applications such as in the food, flavor as preservative, in cosmetics, leather processing and pharmaceuticals industries. High purity of LA is required for polymerization and it can be produced by chemical synthesis or by fermentation of renewable carbohydrates. About 90 % of LA was produced by the fermentation routes and carried out in batch mode (Joglekar et al., 2006). Many processes for recovery and purifying LA from fermentation broth has been considered and studied in the past, adsorption process (Lee et al., 2004). An alternative technique beyond these processes have also been suggested where esterification of LA followed by hydrolysis of ester lactate is considered to produce pure LA. Experimentally, purification of LA was considered by several authors (Kim et al., 2000; Kim et al., 2002). The process setup consists of two columns for separation of reactant from products and two reboilers for esterification and hydrolysis reactions. Seo et al., (1999) considered the esterification of LA with methanol followed hydrolysis of methyl lactate in the presence of cation exchange resin (Dowex 50) as catalyst in batch reactive distillation to achieve pure LA (90 %). Sun et al., (2006) used two reactors with a

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