RSCE 2012

PROCEEDING
19th Regional Symposium on Chemical Engineering

ISBN: 978-602-9494-30-3

Optimization of Hydroxylation Reaction For Synthesis of Polyol From Epoxidized Palm Oil Methyl Ester

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Abstract

The utilization of vegetable oils as a feedstock for synthesis of polyol become more desirable. In particular, polyol synthesized from epoxidized oil derived from palm oil methyl ester (EPOME). Polyol can be utilized as a raw material to produce polyurethane that has many applications especially foam. Response surface methodology was performed to determine the optimum condition in the hydroxylation step. The influence of input variables temperature and reaction time on hydroxyl value and viscosity was quantified and optimal condition (high hydroxyl value) was determined. The hydroxylation reaction was conducted in a batch reactor equipped with reflux condensor. A central composite design with two independent variables and two response variables was performed to determine the influence of independent variables. The hydroxyl value of polyol increases with temperature and reaction time until achieves optimum point then decreases. The effect of independent variables on the viscosity of polyol products also shows similar result. The optimal operating condition was achieved with a temperature of 48°C and a reaction time of 3 hours.

Keywords: Epoxidation; Hydroxylation; Polyol; Methyl Ester; Epoxidized; Palm Oil

1. Introduction

Polyurethanes have many applications in our daily life as coatings, thermoset and thermoplastics materials, rigid and non-rigid foams and adhesives [Lligadas et al., 2006; Wang et al., 2009]. Polyurethanes are normally produced from the reaction between polyols and diisocyanate [Pechar et al., 2006]. Hence, the polyol demand is predicted to increase each year as the amount of petroleum is declining. Basically, polyol is derived from petroleum and petroleum is non-renewable resource therefore effort is needed to find out an alternative raw material for polyol synthesis [Tu et al., 2007]. Palm oil is an alternative feed stock for polyol synthesis with various viscosity of polyol produced in particular polyol derived from palm oil methyl ester.

Polyol can be produced through two sequential reactions called epoxidation and hydroxylation reactions [Petrovic et al., 2003]. In the epoxidation step, double bonds in the oil are converted to epoxidized oil where oxirane ring is produced. Then in the hydroxylation step, oxirane ring is converted to hydroxyl groups more than one namely polyol.

Palm oil is very potential to develop as a raw material for polyol synthesis in Indonesia as Indonesia is the second biggest countries produces palm oil after Malaysia and it is predicted over-stock. Another consideration that palm oil contains unsaturated fatty acid in high amount about 50% (oleic, linoleic and linolenic acid) indicated by iodine value in the range of 52 – 58 g I_2/100 g oil [Bailey, 1951]. High content of unsaturated fatty acid will produce polyol with high quality indicated by hydroxyl value since polyol produced from the conversion of double bond to hydroxyl groups.

The key goal of this research is to determine the optimal operating condition for synthesis of polyol focused on the hydroxylation step from epoxidized palm oil methyl ester (EPOME).

2. Theory

Nowadays, polyol plays an important aspect as a raw material to produce polyurethanes which have been widely used in polymer applications (Guo et al., 2000, Hu et al., 2002, Lligadas et al., 2006, Wang et al., 2007). The demand for polyol worldwide is projected to increase each year.