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ORIGINAL PAPER

A comparative study on direct production of ethyl levulinate from glucose in ethanol media catalysed by different acid catalysts

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Direct production of ethyl levulinate (EL) from glucose catalysed by a liquid acid catalyst (sulfuric acid) and a solid acid zeolite catalyst USY NKF-7 (USY) in ethanol media was investigated in this study. Effects of the initial glucose concentration (C_{G0}), reaction temperature (T), amount of acid catalyst, and water addition on the yields of EL were compared, respectively. The results show that higher yield of EL can be obtained at lower C_{G0}. Higher temperature and acid concentration can accelerate the reaction rate, but the formation rate of the by-products increases more quickly than that of EL. Water addition also can result in the decrease of the yield of EL. Although sulfuric acid is efficient in the production of EL, the USY is more efficient in converting glucose to 5-ethoxymethyl-2-furaldehyde. Moreover, the use of USY can limit the diethyl ether production, and it can be reused for multiple times.

Keywords: glucose, ethanol, ethyl levulinate, catalyst

Introduction

Utilisation of biomass as chemical feedstock can decrease the dependence on fossil resources and it has thus attracted much attention in recent years. Therefore, a substantial amount of research activities worldwide is currently undertaken to identify attractive chemical transformations converting biomass into bulk chemicals (Dharne & Bokade, 2011; Murat Sen et al., 2012). Among various chemicals that can be transformed from biomass, levulinic acid is one of the most promising building blocks of a biomass refinery, and it is also selected as one of the "Top 10" platform chemicals (Bozell & Petersen, 2010). As a derivative of levulinic acid, ethyl levulinate (EL) has recently drawn much attention due to its numerous potential industrial applications. EL can be used in the flavouring industry and as a solvent and plasticiser (Mascal & Nikitin, 2010a). In addition, it can be used as an additive in gasoline and diesel (Gürbüz et al., 2011; Joshi et al., 2011; Lange et al., 2009).

Up to now, two different conversion routes for the EL production from biomass have been developed. As shown in Fig. 1, it can be produced from cellulosic biomass through two reaction steps. Firstly, levulinic acid is obtained from biomass, then EL is synthesised through esterification in the presence of ethanol and a catalyst (Lee et al., 2010). The other route is direct production of EL from cellulosic biomass by an acid catalysed reaction in ethanol media. In this process, cellulosic biomass can be depolymerised and degraded into glucose in ethanol, the glycosidic hydroxyl

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