Accepted Manuscript

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PII: S1004-9541(17)31451-9
DOI: https://doi.org/10.1016/j.cjche.2018.01.004
Reference: CJCHE 1006

To appear in:

Received date: 25 October 2017
Revised date: 10 January 2018
Accepted date: 11 January 2018

Please cite this article as: Wenpeng Li, Suohe Yang, Xiaoyan Guo, Guangxiang He, Haibo Jin , The effect of operating conditions on acylation of 2-methylnaphthalene in a microchannel reactor. The address for the corresponding author was captured as affiliation for all authors. Please check if appropriate. Cjche(2018), https://doi.org/10.1016/j.cjche.2018.01.004

Fluid Dynamics and Transport Phenomena

The effect of operating conditions on acylation of 2-methylnaphthalene in a microchannel reactor☆

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Abstract Acylation of 2-methylnaphthalene (2-MN) is a very important reaction in organic synthesis; but the batch method is not efficient. Considering that the Friedel–Crafts acylation is a rapid exothermic reaction, in this study we perform the acylation of 2-MN in a stainless steel microchannel flow reactor, which is characterized by high mass and heat transfer rates. The effect of reactant ratio, mixing temperature, reaction temperature, and reaction time on product yield and selectivity were investigated. Under the optimal conditions, 2-methyl-6-propionylnaphthalene (2,6-MPN) was obtained in 85.8% yield with 87.5% selectivity. Compared with the conventional batch system, the continuous flow microchannel reactor provides a more efficient method for the synthesis of 2,6-MPN.

Keywords: acylation, microchannel reactor, 2-methylnaphthalene, 2-methyl-6-propionylnaphthalene

☆Supported by the National Natural Science Foundation of China (91634101) and The Project of Construction of Innovative Teams and Teacher Career Development for Universities and Colleges under Beijing Municipality (IDHT20180508).

1 INTRODUCTION

In recent time, microchannel reactors are being widely used for manufacturing various products such as fine chemicals, biochemical, and pharmaceuticals [1-4]. Compared to conventional reaction devices, microchannel reactors have several advantages: (i) precise control of reactant ratio, (ii) fast and direct scale-up, (iii) high specific surface area and heat transfer rate, (iv) short residence time and little byproduct formation, and (v) safe operation and low pollution. The microreactor technology has been discussed in detail elsewhere, and different types of reactions have been investigated in continuous flow systems [5]. Friedel–Crafts reactions were found to be particularly suitable for microchannel reactors.

Friedel–Crafts alkylation in microchannel reactor has been studied by several researchers [6,7]. In particular, Freidel–Crafts acylation reaction plays an important role in organic synthesis. For instance, acylation is a key step in the continuous-flow microreactor synthesis of an aminonaphthalene derivative [8], resulting in 100% yield compared to the 86-96% yield of the corresponding batch reaction. Moreover, a safe and efficient continuous-flow synthesis of 1,3,4-oxadiazoles via acylation of 5-substituted tetrazoles has been developed by Reichart and Kappe [9], who reported that the reaction in a FlowSyn microreactor (Uniqsis Ltd.) afforded the target product with yield and selectivity much higher than those obtained in batch processes. The synthesis of sugar 6-monoesters by acylation of sugars with vinyl carboxylates in a microchannel flow reactor has also been developed [10]. In addition, Jamison studied the synthesis of

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