N°417 / PC
TOPIC(s) : Biomass conversion / Homogenous, heterogenous and biocatalysis

Synthesis of an innovative Ni Catalyst Supported on Highly Porous Carbon for the Continuous Flow HMF Conversion Toward DMF

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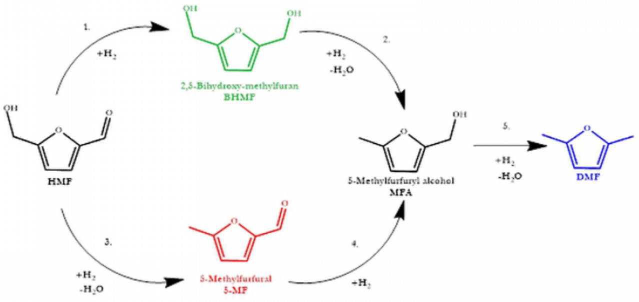
PURPOSE OF THE ABSTRACT

The scarcity of fossil oils and their effect on environment are the motivation for a transition from petrorefinery to biorefinery [1]. In this regard, lignocellulosic biomass (LCB) is suitable candidate to replace the product derived from fossil fuel. [2]. Among LCB derivatives, 5-hydroxymethylfuran (HMF) possesses a high potential for the production of fine chemicals and liquid transportation fuels. For instance, HMF can simply converted to 2,5-dimethylfuran (DMF), which can be used as a platform molecule in chemical industry, e.g. as an alternative monomer for polyethylene terephthalate (PET) [3]. Additionally, DMF can be used as a 3rd generation of biofuel, due to its high energy density (30 MJ L-1), comparable to petrol (32 MJ L-1) and noticeably higher than bioethanol (21 MJ L-1) [4].

In this context, this work presents a heterogeneously catalyzed process for DMF synthesis from LCB-derived HMF in a homemade / customized continuous-flow system (Scheme 1). For this purpose, a novel, efficient pelletized Ni catalyst supported on highly porous carbon was prepared. The mesopores carbon was prepared using hard-templating approach using a physical mixture of Semolina as carbon precursor and ZnO as porogen, followed by carbonization process at 1223 K. The prepared catalyst (16Ni/C) exhibit high catalytic activity with HMF conversion of 98 % and 54 % of DMF yield at 423 K, 2 MPa and space time 0.77 kgNi h kgHMF-1 (Fig. 2). This high activity can be correlated to the high specific surface area (661 m2 g-1), presence of mesopores (pore width 12 nm) and high Ni dispersion. Furthermore, increasing the space time, i.e., from 0.77 kgNi h kgHMF-1 to 3.0 kgNi h kgHMF-1; resulted in higher DMF yield (74 %) with (97 %) HMF conversion.

In conclusion the prepared pellets of 16 Ni/C catalyst exhibited a great activity for DMF production (yield 74 %) from HMF, which can be reproduced in large scale (kilograms scale). These findings can potentially drive the transition toward production of sustainable fine chemicals and liquid transportation fuels.

FIGURES



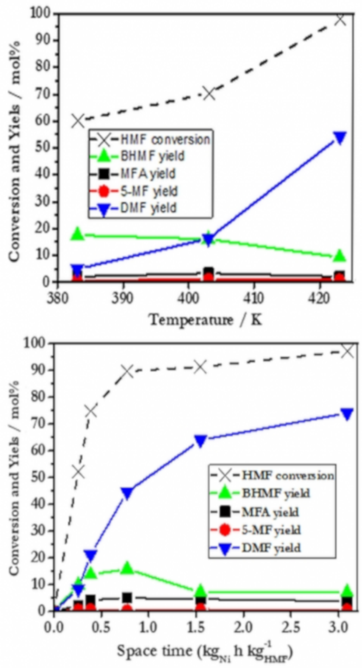


FIGURE 1

Scheme 1

Possible reaction pathway in 5-hydroxymethyl furfural (HMF) conversion toward 2,5 dimethylfuran (DMF)

FIGURE 2

Figure 1

HMF conversion and DMF and by-products yield as a function of reaction temperature (up) and space time (down).

KEYWORDS

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