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Liquid transportation fuels from sugar derivatives

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Abstract

ABSTRACT –Conversion of lignocellulose-derived sugars in the biorefinery would result in the production of second generation liquid biofuels. This process requires removal of almost all the oxygen atoms and other chemical steps to form branched hydrocarbons and to increase the molecular weight. The first step of the sugar transformation gives the so called "platform molecules" (C4-C6 oxygenates) which can be further transformed into C9-C18+ alkanes to be used as liquid transportation fuels.
The gas-phase upgrading of 2-hexanol, a model molecule of the primary conversion of sugars, was investigated on Cu-M_I-M_{II} mixed oxides (M_I, M_{II}: Mg^{2+}, Al^{3+}, Ce^{4+}) to obtain higher molecular weight compounds of application as jet fuels (1).
The bifunctional metal-base catalytic process occurs through a series of sequential steps comprising dehydrogenation, C-C coupling, dehydration and hydrogenation reactions. Nano-sized Cu^0 particles promote dehydrogenation and hydrogenation steps whereas acid-base sites provided by $M_I(M_{II})$-O pairs participate in the C-C coupling reaction. In general, main products were C9-C12 compounds that represented ~60% of the product pool. Branched C9-C24 compounds such as ketones, alcohols and alkanes were obtained with yields of up to 91% on a Cu-Mg-Al mixed oxide with 8wt.% Cu (catalyst 8.0CuMgAl). This catalyst presented well dispersed Cu^0 particles and a high number of base sites with moderate basic properties as well as a low number of acid sites. The rate-limiting step (r.l.s) of the bifunctional process leading to C9-C24 products on catalyst 8.0CuMgAl was the metal-promoted hydrogenation step, but the reaction can be controlled by the C-C bond formation step on less basic catalysts with similar copper content. A reaction pathway leading to formation of odd carbon atom number products (C9, C15 and C21) was postulated in contrast to the conventional aldol condensation pathway toward even carbon atom number products (C12, C18 and C24). The former prevails under conditions at which the catalyst surface is deprived of hydrogen atoms. The Cu content notoriously affects the catalyst basicity, metal dispersion, activity, product distribution and r.l.s.

Keywords: 2-hexanol; aldol condensation; dehydrogenation; hydrogenation; copper; mixed oxides

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References

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