Biomass ethanolysis: process optimization and performances of ethyl levulinate as diesel blendstock

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Biomass represents a key asset for renewable energy production in the context of the more and more pressing energetic transition. Moreover, at the present, the issue of how to store a convenient amount of energy on board of electric vehicles is still a challenge and electric vehicles perspectives are limited to passenger cars and very small-range trucks, significant amount of time being necessary to define the eventual appropriate electric storage system to be employed in heavy transport, as well in aviation and shipping. In this context alkyl levulinates represent a concrete perspective for partial replacement of fossil fuel with renewable blendstocks. In particular ethyl levulinate (EL) production by direct acid-catalyzed biomass ethanolysis was studied in order to investigate and optimize this one-step process which involves only renewable starting materials (biomass and bioethanol) [1]. The significant potential of this innovative biofuel can contribute to energy and environmental objectives only if its production process is environmentally and economically sustainable. In this perspective the role of the main reaction parameters as the substrate nature (model sugars, papermill and agri-food wastes) and loading, type of the acid catalyst (proton acids, acid resins and zeolites) and its concentration, reaction temperature and duration were studied. Under the optimized reaction conditions yields up to 60 mol %, evaluated respect to the units of C6 sugars in the starting materials, were reached working with a high-gravity approach. Moreover the proper tuning of the reaction conditions allowed to significantly reduce up to suppress the formation of solid by-products and of diethyl ether by etherification of ethanol, their production representing a significant drawback for the industrial process.

EL was tested up to high concentrations (from 10 to 25 vol%) in a mixture with diesel fuel in a small single-cylinder air-cooled diesel engine, to verify the engine and emission performances of the different blend compositions respect to those ascertained with a conventional diesel fuel [2][3]. The evidenced good performances of these mixtures, able to significantly reduce the emissions of particulate and CO without significant increase of NO_x emissions or worsening of engine power and efficiency, and, above all, the sustainable and simple biomass conversion process open the way to EL application as advanced sustainable biofuel.

References (10 pt)

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