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Integrated two stage processing of biomass conversion to HMF esters using ionic liquid as green solvent and catalyst: Synthesis of mono esters

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PURPOSE OF THE ABSTRACT

In this study a two stage process were established for the synthesis of HMF esters using ionic liquid acid catalyst. Ionic liquid catalyst with different strength of the Bronsted acidity was prepared in laboratory and characterized using 1H NMR, FT-IR and 13C NMR spectroscopy. Solid acid catalyst from the ionic liquid catalyst was prepared using co-polymerization method. The acidity of the synthesized acid catalyst was measured using Hammett function and titration method. Catalytic performance was evaluated for the biomass conversion to 5-hydroxymethylfurfural (5-HMF) and levulinic acid (LA) in methyl isobutyl ketone (MIBK)-water biphasic system. Good yield of 5-HMF and LA was found at the different composition of MIBK: Water. In case of MIBK: Water ratio 10:1, good yield of 5-HMF was observed at ambient temperature 150 ?C. Upgrading of 5-HMF into mono esters from the reaction of 5-HMF and reactants using biomass derived mono acid were performed. Ionic liquid catalyst with -SO3H functional group was found to be best efficient in comparative of solid acid catalyst for the esterification reaction and biomass conversion. A good yield of 5-HMF esters with high 5-HMF conversion was found to be at 105 ?C using the best active catalyst. In this process, process A was the hydrothermal conversion of cellulose and monomer into 5-HMF and LA using acid catalyst. And the process B was the esterification followed by using similar acid catalyst. All mono esters of 5-HMF synthesized here can be used in chemical, cross linker for adhesive or coatings and pharmaceutical industry. A theoretical density functional theory (DFT) study for the optimization of the ionic liquid structure were performed using Gaussian 09 program to find out the minimum energy configuration of ionic liquid catalyst.

FIGURES

Catalyst	Product	Product Yield (%)	Product Selectivity (%)
Blank	HMF levulinate	0.62	4.02
[1-MeIm-SO_3H][Cl]	HMF levulinate	82.62	82.89
[1-ViIm-SO_3H][Cl]	HMF levulinate	77.08	79.85
[EGDMA-SO_3H][Cl]	HMF levulinate	54.5	62.78
[PDVB-SO_3H][Cl]	HMF levulinate	57.3	63.45

FIGURE 1

Catalyst screening

Effect of the catalyst on the conversion and product yield

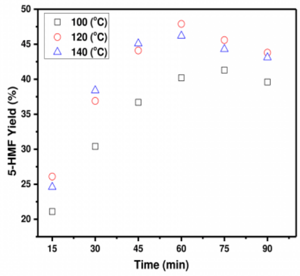

FIGURE 2

Effect of Time and Temperature

Effect of Time and Temperature on the biomass conversion to HMF

KEYWORDS

Biomass Conversion | Ionic liquid | HMF | HMF levulinate

BIBLIOGRAPHY

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