GALEGO PORTUGUÉS DE QUÍMICA

XXV ENCONTRO

Study of the performance of alkaline ionic liquids for the catalysis of biodiesel production from waste cooking oil

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BACKGROUND AND LITERATURE REVIEW

BIODIESEL

- Fatty Acid Alkyl Esters Mixtures
- Biodegradable and non-toxic
- Similar characteristics to petroleum diesel
- Can be blended to diesel in any proportion for the transport sector

WASTE COOKING OILS

- Low cost
- High availability
- Possible alternatives to overcome the disadvantages of the traditional production processes of biodiesel

CATALYSTS

- Homogeneous Basic catalysts
- Homogeneous Acid catalysts
- Ionic liquids

IONIC LIQUIDS

- Near-zero vapor pressure
- Low volatility
- High thermal and chemical stability
- Can be recovered and reused in new reaction cycles

Bis-(3-methyl-1-imidazole)-ethylene dihydroxide (IMC_2OH) proved to be an efficient catalyst for the preparation of biodiesel, as can be seen in Table 1.

Table 1. Summary of some experimental conditions found in the literature for biodiesel production.

Reaction	Feedstock	Catalyst	Molar Ratio alcohol:oil	Catalyst Dosage (%wt)	Temperature (°C)	Reaction Time (h)	Conversion (%)	REF
Esterif.	Palm Oil	[BMIM][HSO_4]	12:1	4.4	160	2	91.2	[4]
Trans.	Seed Oil	[BSO_3HMIM] HSO_4-$Fe_2(SO_4)_3$	5:1	4	60	1	95.7	[5]
Esterif.	Waste Cooking Oil	[BMIM][HSO_4]	15:1	5	160	1	95.65	[6]
Esterif.	Waste Cooking Oil	[BSMBIM] [CF_3SO_3]	12:1	4	120	4	78.13	[7]
Trans.	Cottonseed Oil	IMC_2OH*	12:1	0.4	55	4	98.5	[8]
Trans.	Soybean Oil	BNPs-CCH	11:1	4.13	60	4.4	95.2	[9]

*Studies with IMC_2OH ionic liquid performed by Liang *et al.* (2010) [8].
[BMIM][HSO_4]: 1-butyl-3-methyl-imidazolium hydrogensulfate
[BSMBIM][CF_3SO_3]: 3-methyl-1-(4-sulfo-butyl)-benzimidazolium trifluoromethanesulfonate
BNPs-CCH: chlorocholine hydroxide on the boehmite nanoparticles

IMC_2OH SYNTHESIS

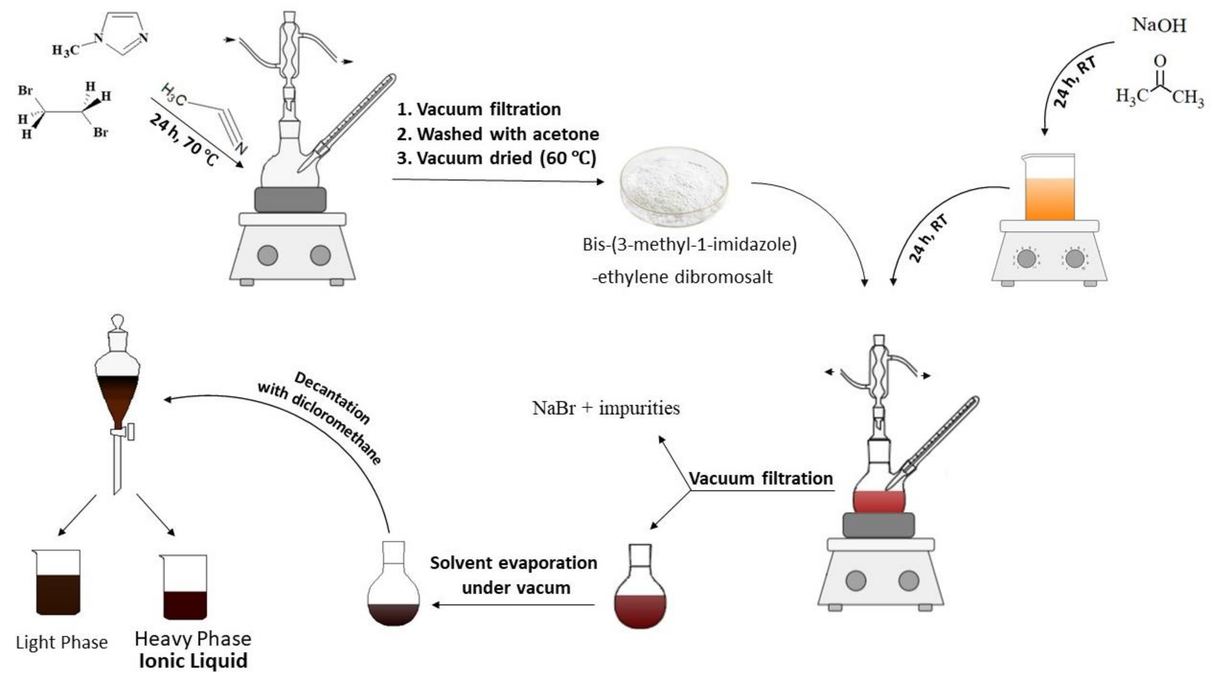

Figure 1. Scheme for the synthesis of bis-(3-methyl-1-imidazole)-ethylene dihydroxide.

EXPERIMENTAL RESULTS

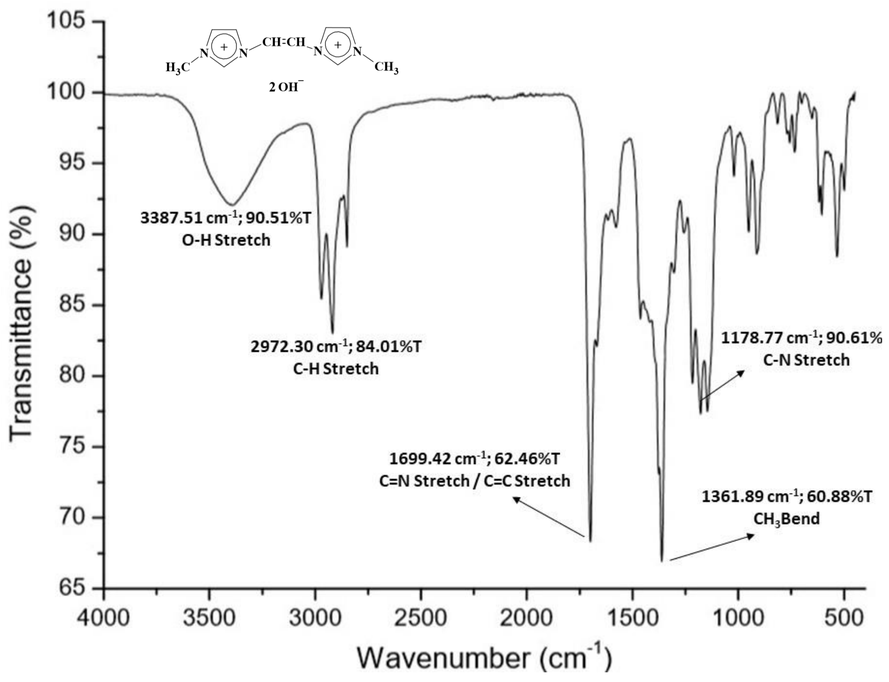

Figure 2. FTIR spectrum of bis-(3-methyl-1-imidazole)-ethylene dihydroxide and its structure.

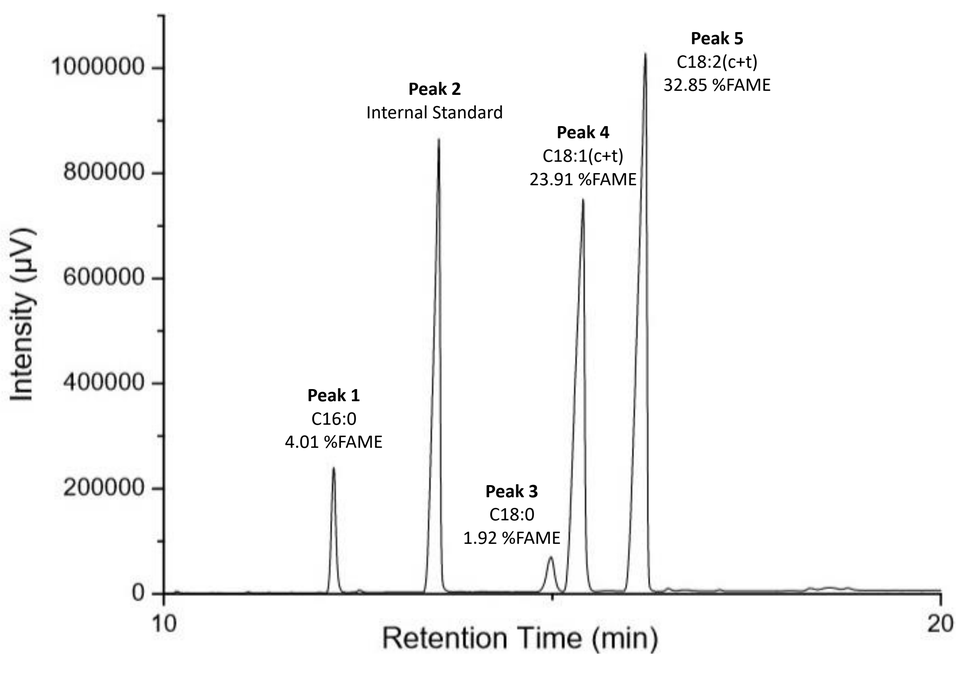

Figure 3. Chromatographic analysis obtained by GC-FID for biodiesel sample produced with sunflower oil catalyzed by IMC_2OH.

FTIR Analysis

- The spectrum confirms the existence of -OH vibration denoted by peak of 3387.51 cm^{-1}
- The skeleton vibrations of imidazole ring were observed at around 1699.42 cm^{-1}
- Bands 1217.36, 1178.77, 1146.42 cm^{-1} can be associated with C-N type vibrations which are characteristic at 1350-1000 cm^{-1}

GC Analysis

- Total %FAMEs: 62.68 %wt.
- Chromatographic analysis confirms IMC_2OH was capable of catalyze the transesterification reaction

CONCLUSIONS AND FUTURE WORK

- Synthesis of IL IMC_2OH was successfully performed
- IL showed good catalytic character with sunflower oil used as raw material
- Apply the IL in transesterification of waste oil
- Optimize operational parameters such as reaction time, reaction temperature, alcohol/oil molar ratio and catalyst dosage

REFERENCES

[1] I. Ambat, V. Srivastava, and M. Sillanpää, 'Recent advancement in biodiesel production methodologies using various feedstock: A review', *Renew. Sustain. Energy Rev.*, vol. 90, 2018.
[2] Y. Zhang, M. A. Dubé, D. D. McLean, and M. Kates, 'Biodiesel production from waste cooking oil: 2. Economic assessment and sensitivity analysis', *Bioresour. Technol.*, vol. 90, no. 3, 2003..
[3] A. H. Mohammad Fauzi and N. A. S. Amin, 'An overview of ionic liquids as solvents in biodiesel synthesis', *Renew. Sustain. Energy Rev.*, vol. 16, no. 8, 2012.
[4] Y. . Elsheikh, Z. Man, S. Yusup, M. A. Bustam, and C. D. Wilfred, 'Brønsted imidazolium ionic liquids: Synthesis and comparison of their catalytic activities as pre-catalyst for biodiesel production through two stage process', *Energy Convers. Manag.*, vol. 52, no. 2, 2011.
[5] Li, J., Peng, X., Luo, M., Zhao, C. J., Gu, C. B., Zu, Y. G., and Fu, Y. J. 'Biodiesel Production from Camptotheca Acuminata Seed Oil Catalyzed by Novel Brönsted-Lewis Acidic Ionic Liquid'. *Applied Energy*, Vol. 115, 2014.
[6] Z. Ullah, M. A. Bustam, and Z. Man, 'Biodiesel production from waste cooking oil by acidic ionic liquid as a catalyst', *Renew. Energy*, vol. 77, 2015.
[7] Z. Ullah, M. A. Bustam, Z. Man, A. S. Khan, N. Muhammad, and A. Sarwono, 'Preparation and kinetics study of biodiesel production from waste cooking oil using new functionalized ionic liquids as catalysts', *Renew. Energy*, vol. 114, 2017.
[8] J. Liang, J. Wang, X. Ren, Z. Li, and M. Jinag, 'Preparation of biodiesel by transesterification from cottonseed oil using the basic dication ionic liquids as catalysts', *J. Fuel Chem. Technol.*, vol. 38, no. 3, 2010.
[9] S. Hosseini, G. R. Moradi, and K. Bahrami, 'Synthesis of a novel stabilized basic ionic liquid through immobilization on boehmite nanoparticles: A robust nanocatalyst for biodiesel production from soybean oil', *Renew. Energy*, vol. 138, 2019.

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