The effect of ultrasounds on enzymatic transesterification

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Abstract

The deficiency of fuel sources has become a universal problem in the world. It is open an opportunity to determine any renewable sources which are able to replace the fossil fuel. One of the approach is in production of biofuel such as biodiesel [1]. In this field, considerable attention has been dedicated in the last decade for the synthesis of fatty acid ethyl and methyl esters (FAEE and FAME). Traditionally, the transesterification reaction is carried out mixing an excess of an alcohol with an oil. Despite the high reactivity of methanol in this reaction the use of ethanol is a promising alternative due to its lower toxicity and the higher yield on a weight basis. It should also be considered the ethanol's renewable nature, and it is widely and prompt available [2]. The heterogeneous enzyme-catalyzed process is considered a green process and presents some advantages as: compatibility with various substrates, fewer process steps, easier product separation, minimal wastewater treatment needs, easy glycerol recovery, and no by-products formation (soaps). The main disadvantages are: the reaction time that is longer than the classical homogeneous process, enzymes cost and conversion efficiency [3]. The ultrasonic technique is a successful method for the intensification of transesterification in biodiesel production, increasing the conversion yield, reducing the reaction time and energy consumption [4].

This work presents the ultrasound assisted enzymatic transesterification of sunflower oil with ethanol using an immobilized lipase (Lipozyme 435). Ultrasound-assisted reactions were performed using a REUS bath in a batch transesterification process. The main parameters that affect the enzymatic transesterification process are: the applied ultrasonic power and the sonication mode (continuous and in pulses). In order to determine the total ultrasound power transferred using the REUS ultrasound bath, the calorimetric method for power determination was used. The measurements were performed with the fluid studied directly in the ultrasound bath, as well as in the glass reactor placed in the ultrasound bath. Three solvents were used for direct calorimetric determination in the REUS bath: polyethylene glycol (PEG 200), *n*-alkanes and distilled water, and ethanol was used as a solvent in the reactor. The best results were obtained for *n*-alkanes taking into account that the studied transesterification reaction is an enzymatic reaction, and it is known that a high ultrasound power leads to the degeneration of the enzymes. Regarding the sonication mode (continuous or in pulses), the best conversions were obtained for the sonication in pulses. In conclusion, by ultrasound-assisted enzymatic transesterification the conversion into biodiesel increased approximately 4-fold compared to the transesterification process in the absence of ultrasounds.

References

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