Optimization of a batch CaO-catalyzed transesterification of used domestic waste oil with methanol and elucidation of a mathematical correlation between biodiesel yield and percent conversion

Ismail, A.R.[a], El-Henawy, S.B.[a], Younis, S.A.[a], Betiha, M.H.[a], Abu Amr, S.S.[b], El-Gendy, N.S. [a]Azab, M.S.[c], Sedky, N.M.[d]

Abstract

The major drawback of the wide applicability of biodiesel is its price compared to the conventional petro-diesel. The feedstock and the applied catalyst in the transesterification reaction are the main contributor for the overall cost of the biodiesel production. Thus, this study summarizes the optimization of a batch transesterification reaction of used domestic waste oil (UDWO) with methanol using CaO, which can be easily prepared from different cheap and readily available natural sources. Quadratic model equations were elucidated describing the effect of methanol:oil molar ratio, CaO concentration wt.%, reaction temperature °C, reaction time h, and mixing rate rpm on biodiesel yield and conversion percentage. The optimum operating conditions were found to be competitive with those of the high-cost immobilized enzyme Novozym435. An overall acceptable agreement was achieved between the produced biodiesel, its blends with petro-diesel and the available commercial petro-diesel, and the international fuel standards. A precise and reliable logarithmic mathematical model was predicted correlating the production of pure high-quality biodiesel yield with the conversion percentage which were measured based on the fatty acid methylester content and decrease in viscosity, respectively.

Author keywords

Biodiesel, heterogeneous CaO catalyst, mathematical modeling, optimization, transesterification, used domestic waste oil

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