Production of biodiesel from linseeds via direct esterification of seeds using a cosolvent

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Introduction

There are many methods for biodiesel production but transesterification process is the most applicable and economical methods in industrial scale. Transesterification reaction is performed between fatty acids or triglycerides and an alcohol in the presence of a catalyst. The main product is methyl ester known as biodiesel and the byproduct is glycerin (used in soaps). In-situ transesterification differs from the conventional method in which the original material is used directly instead of purified oil to produce biodiesel. That is, extraction and transesterification proceed in one step. This could reduce the long production sequence associated with pre-extracted oil and maximize alkyl ester yield.

The objective of this study was to investigate in-situ transesterification of linseed, a non edible seed with methanol in the present of potassium hydroxide (KOH) and diethylether (DEE) as a cosolvernt for the production of biodiesel. Experimental runs have been conducted using milled linseeds, methanol as a solvent and potassium hydroxide as a catalyst. The influence of molar ratio of DEE to methanol (0.5-2.0), methanol to oil molar ratio (1~15), catalyst concentration (1~13 %wt. oil content), agitation rate (600~900 rpm), reaction temperature (30~50 °C) and reaction time (90~150 min) was examined to define optimum biodiesel yield.

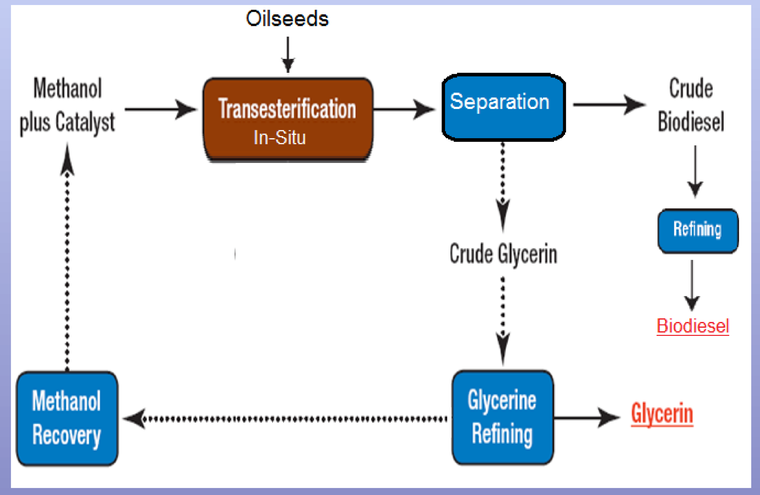


Fig 1. Transesterification steps

Materials and Methods

Materials

Linseed was purchased from the local market in Tehran (Iran). Potassium hydroxide 85% was supplied by Ghatran Shimi Co. in Tehran (Iran), Methanol with 99.6% purity and n-hexane with 99.6% purity were purchased from Dr. Mojalali Co. in Tehran (Iran).

Seed Moisture Calculation

First, a certain amount of seeds is poured into the glass and then put it in the oven at 100 °C for 6 hours for drying process and then the dried seeds weight was obtained. The seeds moisture was calculated using equation (1).

$$\%M = \frac{Wb}{Wb-Wa} * 100 \qquad (1)$$

where M is moisture, Wb is seeds weight before drying, Wa is weight after drying . The moisture percentage of the seeds was calculated to be 5.79%wt.

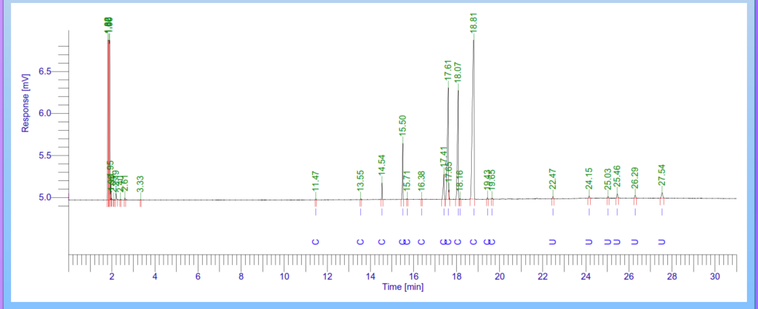


Fig. 2. GC results of linseed oil

Experimental Setup



Fig. 3. Experimental Setup and biodiesel separation

Results

To obtain the optimum conditions for the biodiesel production, the transesterification of linseed oil with methanol was conducted in the presence of KOH as a catalyst. The effects of the main reaction parameters, such as SSR, wt.% of catalyst, agitation rate, reaction temperature, reaction time and their interactions on the fatty acid methyl esters (FAME) yield were investigated.

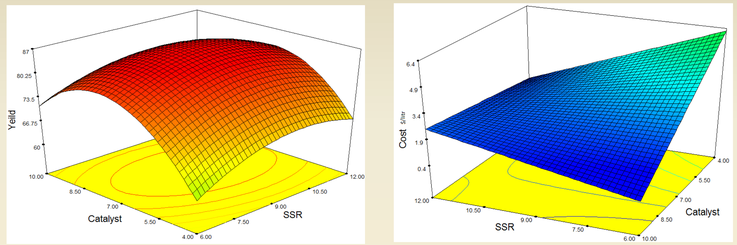


Fig. 4a,b. 3D plot of interaction parameters on biodiesel yield

Effect of interaction between main parameters was investigated and the result was shown as 3D plots. Fig.4 represents a 3D plot of the effect of integration between the SSR and catalyst on yield and cost of biodiesel production. Fig.6 was shown that model for designing of the experiment was significant. Fig. 4.a shows that catalyst has more influence on the yield than SSR. As can be seen from the figure, in the constant SSR i.e. 6 with increasing catalyst from 4 to 7, the yield was increased from 58% to 75% but in the constant catalyst as 4 with increasing SSR from 6 to 9, the yield was increased from 58% to 68%. Fig. 4.b represents that catalyst has more effect on cost than SSR. This is due to the fact that methanol can be recovered easily and used again in the reaction.

Conclusions

Linseed has a great potential for biodiesel production due to its high oil content, high unsaturated fatty acids, being non-edible, and low price of the seeds in comparison to other oily seeds. Linseed biodiesel is also a suitable fuel for cold climate due to its low cloud point of -7°C and pour point of -17°C. The highest and economical methyl ester yields of 82.15% were achieved with 8.95 wt.% of KOH, 7.89 of SSR, 750 rpm and 50°C of reaction temperature with 120 minutes of reaction time.