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RESPONSE SURFACE FOR BIODIESEL PRODUCTION FROM SOYBEAN OIL BY ETHYLIC ROUTE

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Introduction

Petroleum has been the most consumed energy source in the world, but it tends to run out due its non-renewable character. Among biofuels, biodiesel has emerged as the main candidate to substitute petroleum diesel. According to Ambat et al. (2018), as it is derived from renewable raw materials, such as vegetable oils and animal fats, biodiesel promotes sustainable development through energy savings, reduces the need to import diesel oil, in addition to presenting characteristics such as low toxicity and low emission of polluting gases.

Aiming to optimize biodiesel production by ethylic route from soybean oil, the present work intends to determine the biodiesel production process with the best yield using the response surface methodology (RSM) by varying the production factors (molar ratio, reaction time and temperature).

Materials and Methods

Biodiesel production and analysis were performed at the School of Engineering at the Federal Fluminense University (UFF).

Biodiesel was produced through the transesterification process in the presence of a basic catalyst. Table 1 shows the factors that were evaluated.

Table 1. Variation sources used in the work

Oil	Soybean		
Molar ratio (Ethanol:Oil)	6:1	9:1	12:1
Reaction Temperature (°C)	30	40	50
Reaction Time (min)	30	60	120
[mbo] Oil Mass (g)	100	100	100
Catalyst Mass (NaOH) (g)	1	1	1
[mba] Ethanol Mass (g)	31.588	47.381	63.175

Initially, the necessary quantities of raw materials were weighed according to the treatment. The oil was preheated to the treatment temperature. Meanwhile, NaOH was diluted in ethanol at a temperature of 45°C, producing sodium ethoxide. As soon as sodium ethoxide became homogeneous and the oil reached the preheating temperature, it was slowly placed in sodium ethoxide and the treatment temperature was controlled.

After the transesterification process, the mixture was placed in a separating hopper, remaining for 24 hours. At the end of the separation phase, the glycerin was removed and the biodiesel needed to go through purification steps. Distilled water at a temperature of 50°C and hydrochloric acid were used to wash biodiesel, allowing it to rest for 20 minutes before removing the washing liquid. This procedure was performed three times, following the proportions of 30 mL of distilled water and 3 drops of hydrochloric acid (HCL) for each 100 mL of biodiesel. After was placed in an oven at a temperature of 105°C ± 3°C for 2 hours. In the last stage, the biodiesel was slowly inserted into a funnel with filter paper, in order to remove the last residues present in the fluid, thus obtaining clean biodiesel.

Results and Discussion

It is possible to observe, from the results of the physicochemical analyses, that specific mass at 20ºC and kinematic viscosity at 40ºC are in accordance with Brazilian, American and European specifications, varying between 877.46 $Kg.m^{-3}$ and 879.64 $Kg.m^{-3}$ and 4.49 $mm^2.s^{-1}$ and 4.82 $mm^2.s^{-1}$, respectively. The acid value obtained did not vary within the limits established by the standards. Values between 0.54 and 2.74 mg of $KOH.g^{-1}$ were observed.

Figures 1 and 2 present the behavior of the variables manipulated in this work, as well as their interactions with the biodiesel production yield from soybean oil. Figure 3 shows the normalized distribution of production yields, and it is possible to notice that for the 12:1 molar ratio, few values reached yields of 92% to 95%, and these refer to the region of maximum yield observed in Figure 2. On the other hand, the 9:1 molar ratio showed a significantly greater amount of values between 90% and 93%.

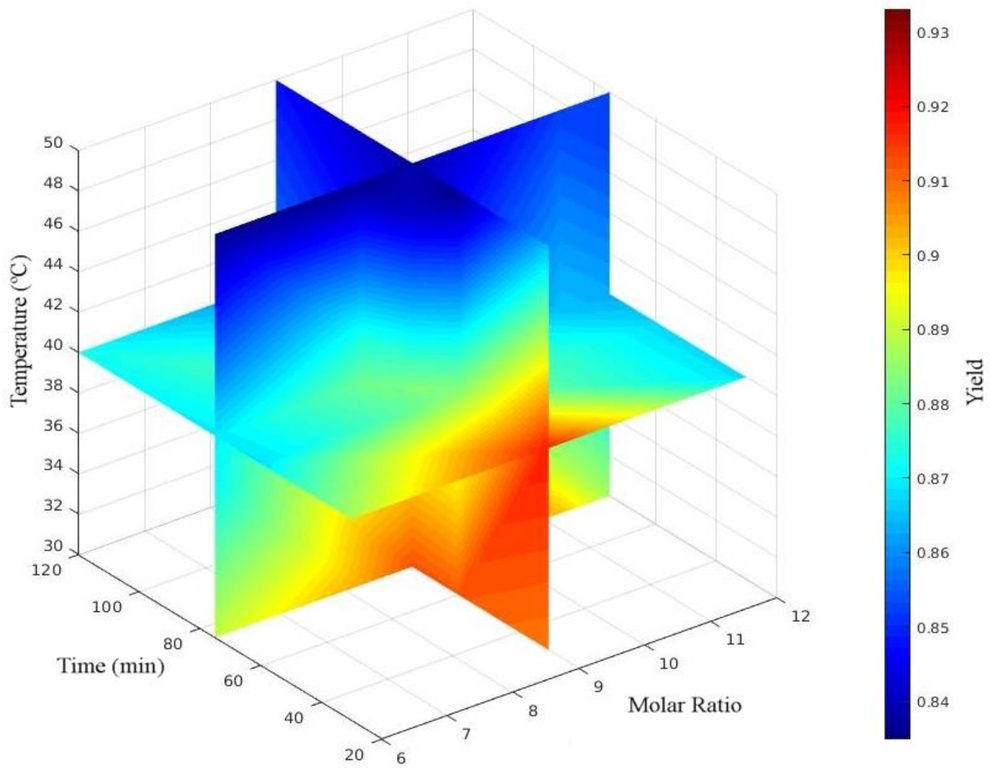

Figure 1. Response Surface

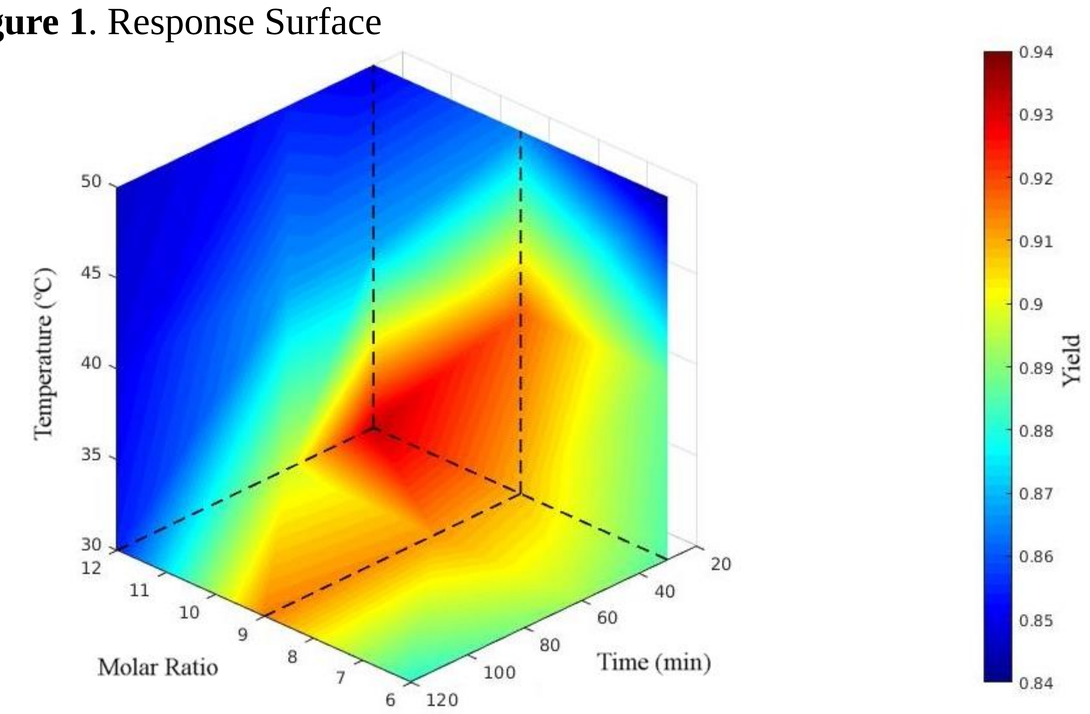

Figure 2. Response Surface - another perspective

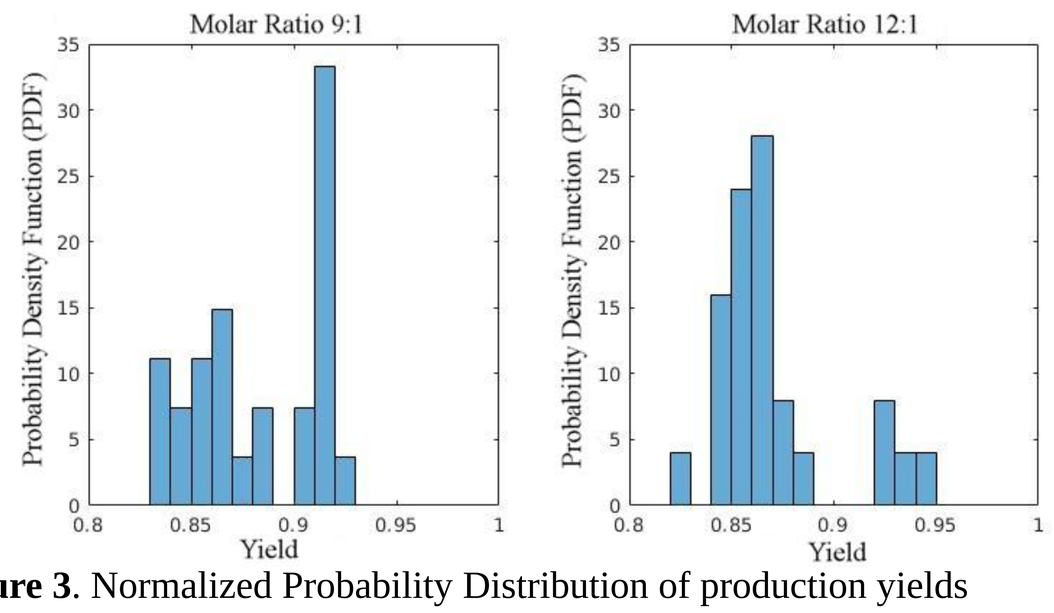

Figure 3. Normalized Probability Distribution of production yields

Conclusions

It was possible to conclude that the configuration that results in maximum yield of 93.30% is a 12:1 molar ratio, temperature of 30ºC and reaction time of 30 minutes.

According to the results of the physicochemical analyses, specific mass at 20ºC and kinematic viscosity at 40ºC are in accordance with Brazilian, American and European specifications, that was supposed to be between 850 to 900 $Kg.m^{-3}$ and 3 to 6 $mm^2.s^{-1}$, respectively. The acid value obtained did not vary within the limits established by the standards. Values between 0.54 and 2.74 mg of $KOH.g^{-1}$ were observed, this value could not exceed the maximum limit of 0.5 mg of $KOH.g^{-1}$.

Acknowledgements