Hydrotreatment of high oleic sunflower oil: optimization of diesel fraction yield

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INTRODUCTION

By catalytic hydrotreatment, vegetable oils exposed to high temperature and high H_2 pressure can be efficiently converted into mixtures of paraffins and isoparaffins. It has proved to be an effective pathway for processing vegetable oils into a wide range of hydrocarbons, including chain length from C15 to C20, suitable for Green Diesel.

OBJECTIVE

Study the effect of the main parameters of the hydrotreatment of high oleic sunflower oil (temperature, pressure, % catalyst) using Pd/Al2O3 as catalyst, on the yield of green diesel fraction (C15-C20) by a response surface methodology (RSM).

MATERIALS AND METHODS

SURFACE RESPONSE:

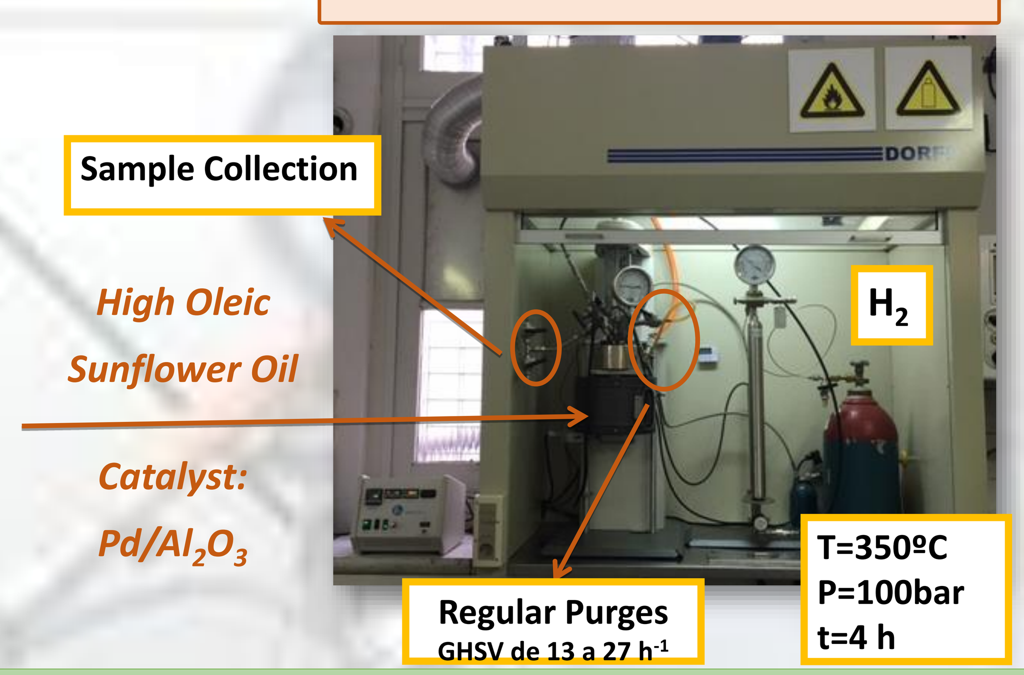
Response surface methodology was applied by using Boxe-Behnken Design (BBD). The study was conducted using Statistica Software Version 10 for generating and evaluating the statistical experimental design in order to obtain a good model equation.
There were chosen three independent parameters: temperature (°C), H2 pressure (bar) and catalyst percentage. Final reaction time was 4 hours. The independent variables were set in a range between low and high levels, coded as -1, 0 and +1.

COMERCIAL OIL:
-High Oleic Sunflower Oil (HOSFO)

COMERCIAL CATALYSTS:
-Pd/Al_2O_3

REACTOR PARR HP/HT 250 mL

PRODUCTS



RESULTS

The regression coefficient R^2 achieved was 0.719, which indicates that the regression model represented 71.9% of the experimental results and 28.1% of the total variations was not explained by this model.

The three-dimensional (3D) response surface and two-dimensional (2D) contour plot of Green Diesel yield towards independent variables are shown in Fig. 1-3. The 3D plots ilustrate the effects of varying two independent variables while keeping the third constant at the zero level.

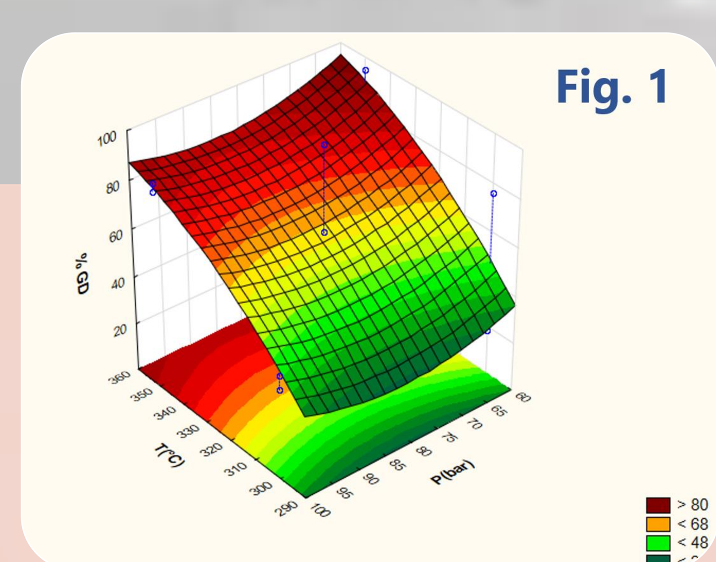


Fig. 1 represents the 3D plot and 2D contour plot for the percentage of green diesel as a function of pressure and temperature. Results suggested that green diesel yield increseed when increasing temperature, while the effect of hydrogen pressure appears moderate.

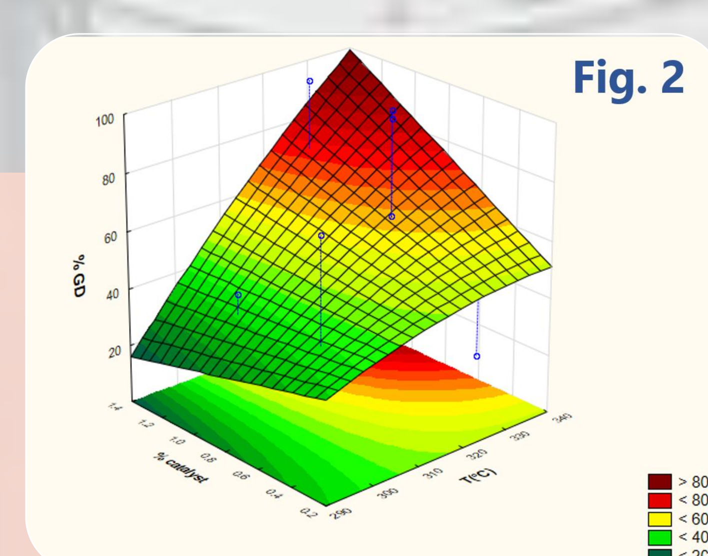
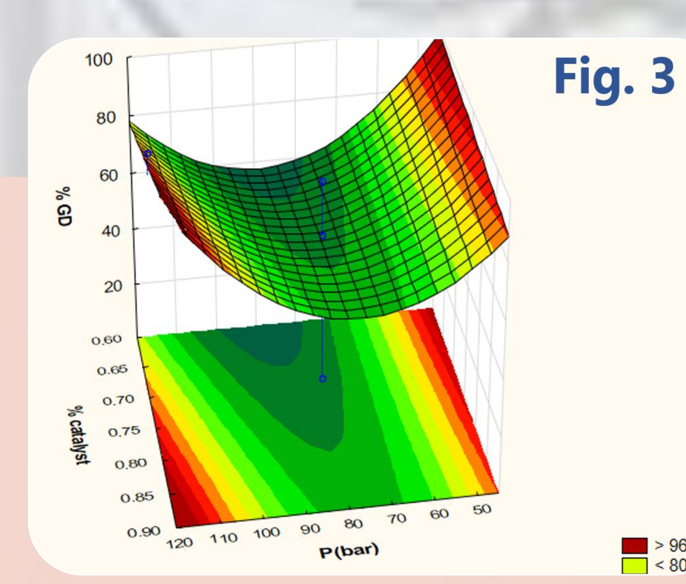


Fig. 2 represents the 3D plot and 2D contour plot for the percentage of green diesel as a function of temperature and percentage of catalyst.

The 3D plot shows that the temperature has a strong effect on the efficiency of the process and when the percetage of catalyst increase the yield of GD was favored.



The effect of pressure and percentage of catalyst on green diesel yield is shown in 3D surface and 2D contour plot in Fig.3. Yield was favored by high pressures and high percentage of catalyst. Although an unexpected region with high yields was observed at low catalyst percentage and low pressure.

CONCLUSIONS

It can be concluded that the temperatue of the reaction was the determinant parameter on green diesel yield, followed by the percentage of catalyst, while pressure had a moderate effect. Thus by conveniently controlling presure and catalyst percentage a high yield can be achieved in a relatively short reaction period of 4hs.

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