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Refinement of Production Grade Biodiesel

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BACKGROUND

Hydrocracking is a method of synthesizing biodiesel from peanut oil. As a result, the long hydrocarbon chains of peanut oil are broken down into shorter hydrocarbon chains characteristic of biodiesel, and the triester bond present in peanut oil is reduced. The experimental method being used has been modeled after the Burton method which was invented by William Burton in 1913 and utilizes high pressure and high-temperature features. Modifications of this method include hydrogen and nickel catalyst. Byproducts associated with this process include water and propane. The hydrocracking reaction is illustrated in Figure 1.

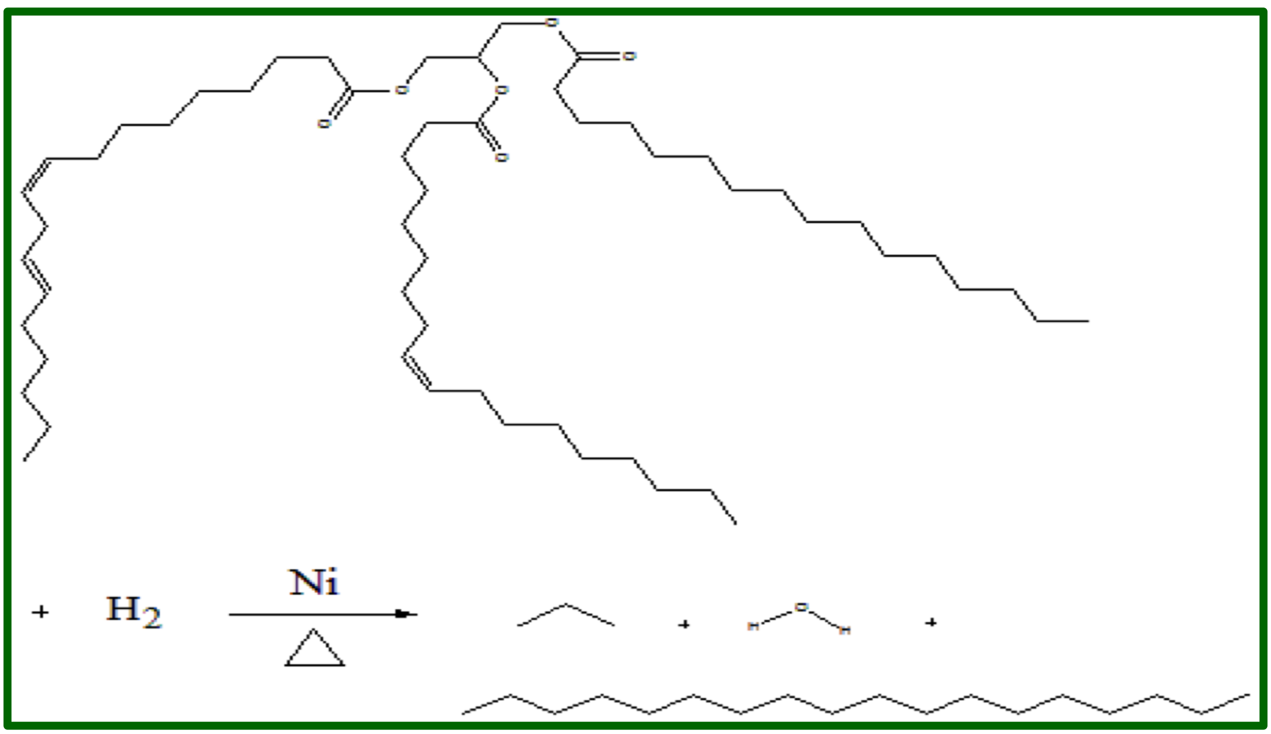

Figure 1. Hydrocracking Reaction

APPARATUS SET-UP

The assembled apparatus for hydrocracking is shown in Figure 2. The reflux chamber is where the major reaction takes place, which is shown in Figures 3. The metal cylinder shown in Figure 3 is the bomb-calorimeter, which is filled with a nickel catalyst. The catalyst is also shown in Figure 3 as nickel balls. Peanut oil is pumped into the reflux column along with hydrogen gas. Under the conditions of elevated temperature and pressure, the peanut oil begins reacting with the nickel and hydrogen gas. This usually occurs around 225°C, which is the boiling point of peanut oil. As shown in Figure 2, there are three separate traps that the product travels to. The main biodiesel trap is kept at room temperature.

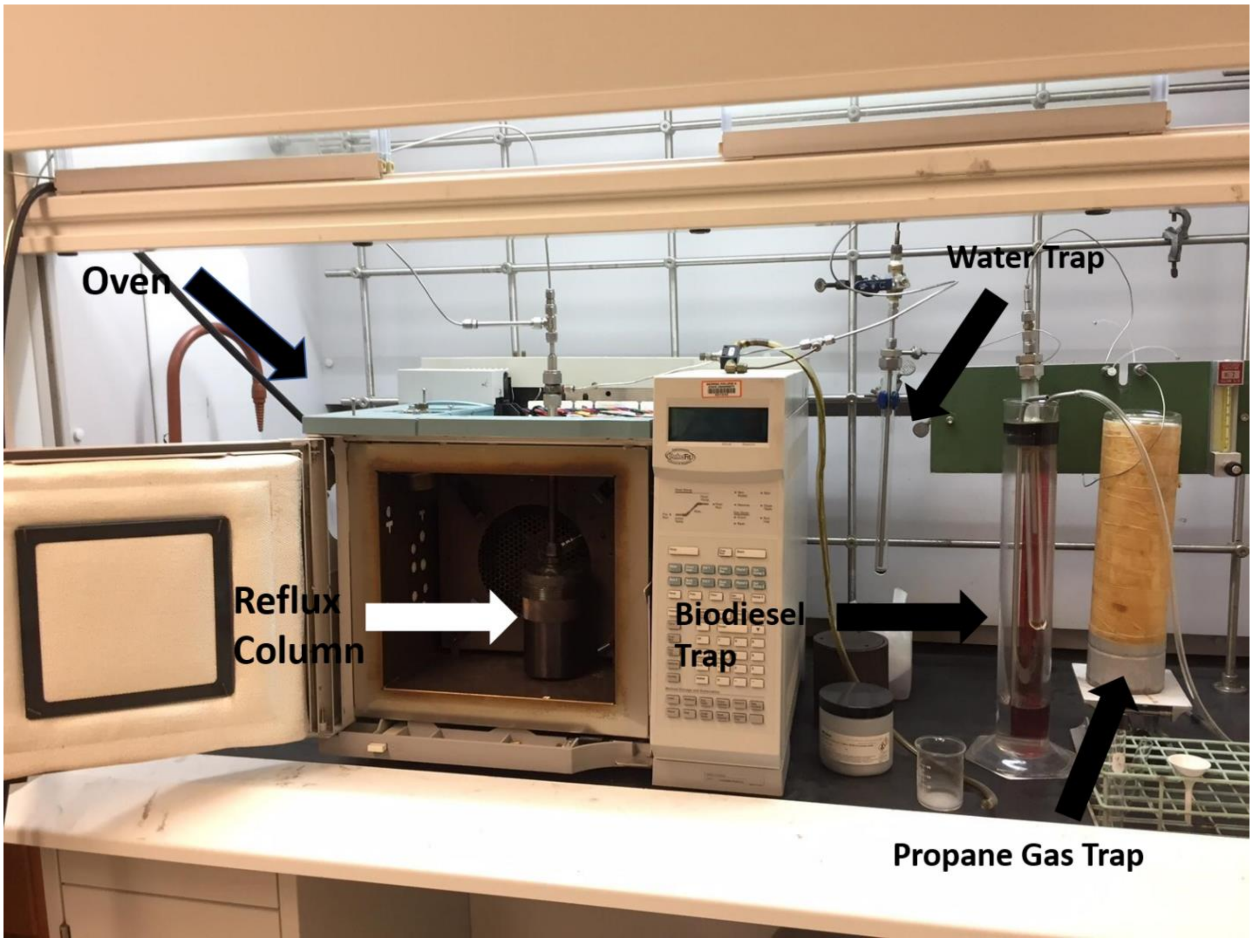

Figure 2. Hydrocracking Apparatus

The second trap is maintained in a cold-water bath, which usually traps any water vapor that passes past the room temperature trap before condensing. The third and final trap is maintained by liquid Nitrogen. The trap is made of copper and was designed to trap the propane gas that is produced by this reaction. The end goal of this experiment is to determine the efficiency of our experiment in reducing the triglyceride molecule into water and propane molecules.

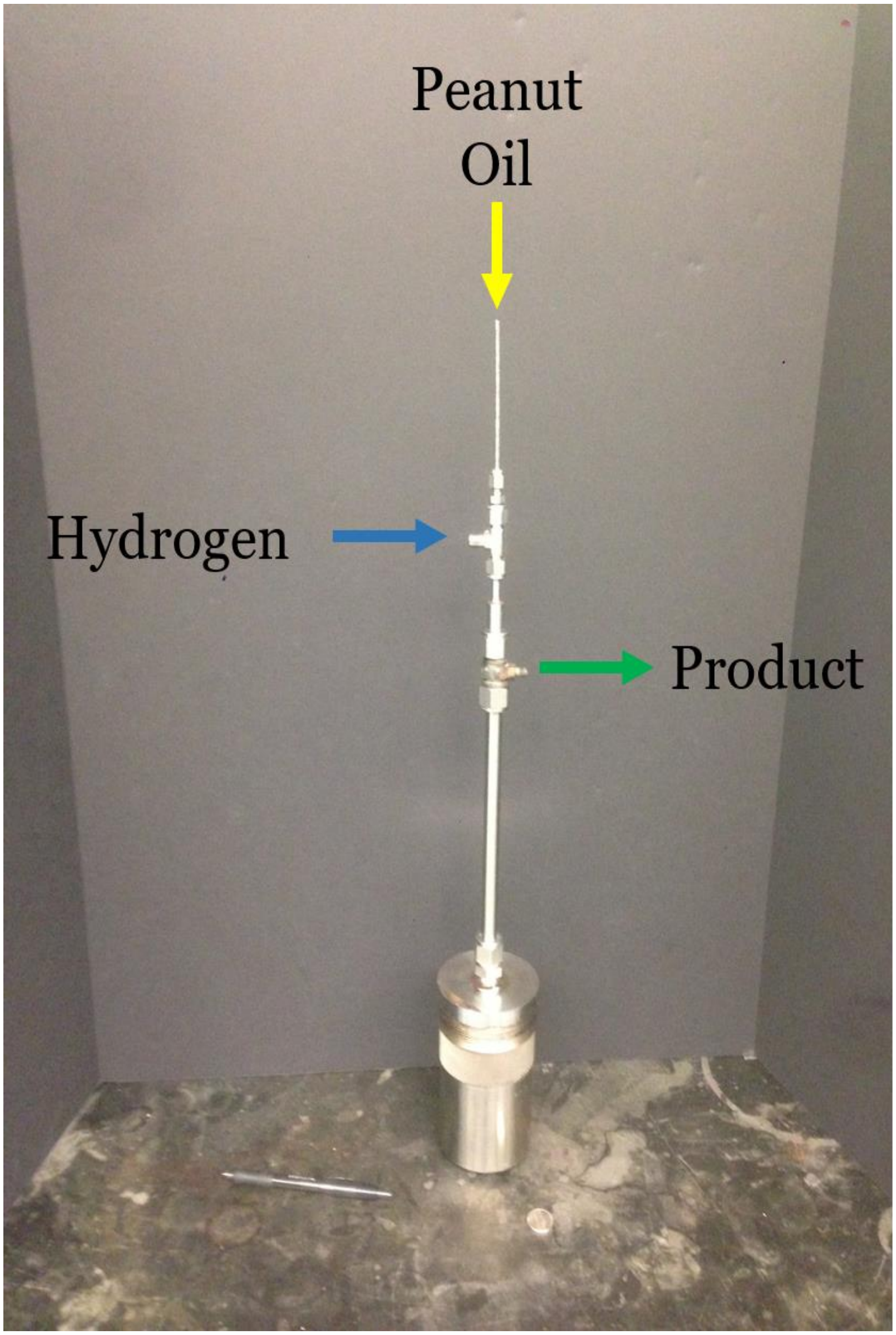

Figure 3. Reflux Column

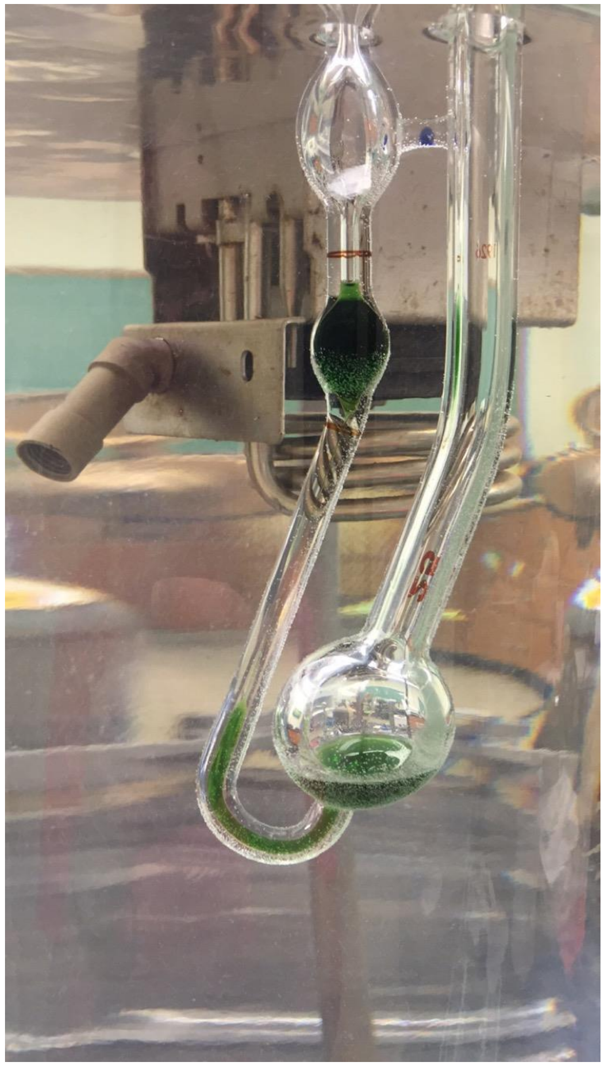

Figure 4. Viscometer

$$\eta = \frac{\pi r^4 (p_1 - p_2)}{8AL^2} t$$

Formula 1: Poiseuille's Law

The main biodiesel product contains water as seen in Figure 1. To remove water, the product was placed in a centrifuge and the water was extracted. The product was then analyzed by viscosity tests. The Ostwald Viscometer is shown above in Figure 4. From Poiseuille's Law, the viscosity is proportional to how much time it takes the liquid to pass through the viscometer. The product was tested as well as a sample of diesel, in order to see how similar the results were to one another. The data is shown above in Table 1.

Production Grade Diesel is not just one compound that we use to fill our gas tanks every day, but rather a mixture of compounds that can be used to run a diesel engine. The viscosity of our product is much less than the viscosity of production grade diesel, and the viscosity of peanut oil is much higher than Production Grade Diesel. It should be possible to identify a mixture of peanut oil and our product that has a viscosity of Production Grade Diesel. To determine the correct mixture of peanut oil and our product we created a standard curve by employing the Eyring mixing equation of viscosities.

$$log\ (\eta_{Diesel}) = \chi_{product}\ log\ (\eta_{product})\ +\ \chi_{peanut\ oil}\ log\ (\eta_{peanut\ oil})$$

Equation 1. Eyring's Viscosity Equation

Since the moles of the product is so much larger than the moles of peanut oil, $\chi_{product} \approx 1$. Our calibration can be developed as shown in equation 2 where *a* and *b* are the calibration constants.

$$log\ (\eta_{Diesel}) = b + am_{percent\ peanut\ oil}$$

Equation 2. Calibration Equation

The viscosity of diesel is known as well as the viscosity of our product (see table 1 below). This equation can be utilized to determine the mass percent of peanut oil and product that has the same viscosity of Production Grade Diesel.

DATA AND RESULTS

Viscometer Flow Time of Product	950 s
Viscometer Flow Time of Diesel	1780 s

Table 1. Viscosity Data

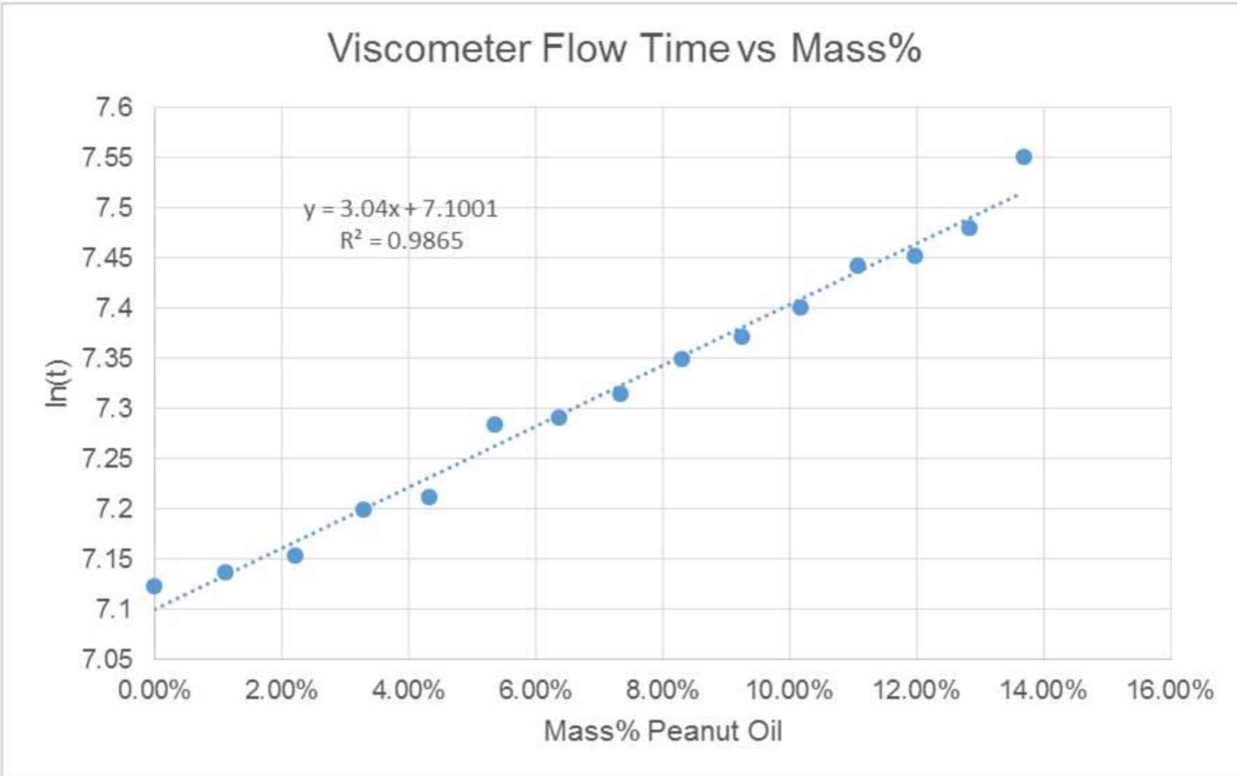

Figure 6. Viscosity Calibration

CONCLUSION

Production Grade Diesel has a flow time of 1780 *s*. Employing the calibration data above, 12.6% mass percent of peanut oil and product will have the same viscosity as Production Grade Diesel.