Biodiesel Production from Waste Food Oil

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Summary

This study was completed in order to better understand homogeneous catalysis to produce biodiesel. This was done using transesterification double step process to produce biodiesel from a soybean oil source.Other process modifications include varying the concentrations of the catalyst, temperature variations, and different condensation methods. This process is only in its first stages and will continue to be studied. These are only preliminary findings of a multifaceted study that also includes heterogeneous catalysis and biodiesel from algae.

Motivation

Fossil diesel is a finite resource that will be exhausted. Due to the inevitable exhaustion of this resource, alternatives must be found. A reliable source of biodiesel would help improve air quality, assist environmental protection efforts, and increase energy security. Biodiesel achieves these goals by not only being a renewable resource, but also a clean burning replacement for petroleum diesel.

Research Question

Is this procedure feasible on this scale? How does the oil source affect the results of the given procedure?

Methods & Materials

The transesterification double step process method used in this experiment relied on potassium hydroxide as a base catalyst, and sulfuric acid as the secondary acid catalyst. These two substances were varied to see how the yield was affected. Other parameters to consider are the temperature and mixing intensity. For this experiment the Oil-Methanol ratio was maintained throughout the trials. The aforementioned parameters were used in the experimental procedure. The potassium hydroxide was dissolved in 80 ml of methanol. This was stirred and heated. This was then added to 200 ml of oil which was heated.This gives a molar ratio of 10:1 for the alcohol/oil. The outline that the process followed can be seen in Figure 1.

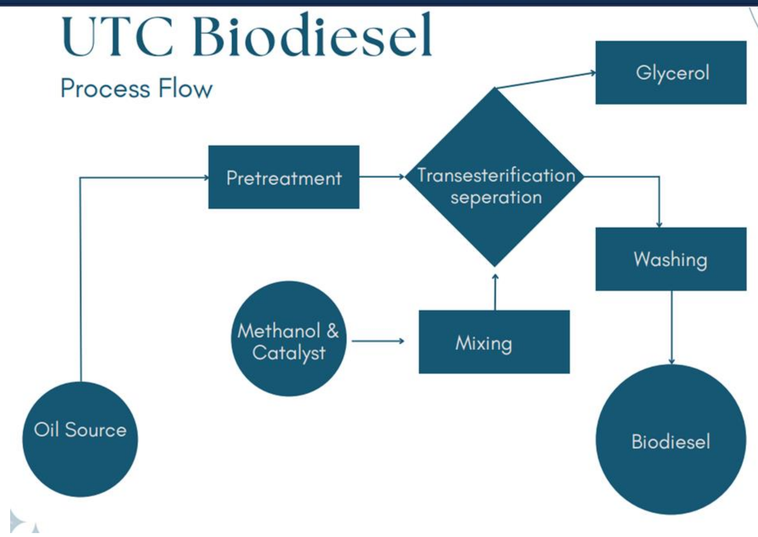

Figure 1

Results and Discussion

This process involved trials that are not included in the data below. There were many parameters that skewed the results. This project remains in the testing process and this is only preliminary findings. One struggle with the current lab capabilities is a lack of consistent temperature. 60°c was the ideal temperature to perform this experiment and it was found in literature that higher than 65°c would result in an increase in reaction rate which led to a lower yield in biodiesel. At times our reaction could exceed that temperature briefly before it could be cooled back to 60°c.
In Table 1 is a sample of some of the preliminary data collected. Some trials were not viable and more data is still being collected. At this time, these trials are untested for the viability of the diesel. The observed volume was higher than the volume calculated using the observed weight and biodiesel's approximate density indicating methanol or other pollutants could be present in these samples. We were unable to condense the methanol under a vacuum at this time which limited our efforts. Current testing of the product is only qualitative. Samples not included in the table below have passed a 3/27 conversion test and a copper strip test for biodiesel.

Table 1. Preliminary Findings with Virgin Oil

Trial	Volume of oil	Weight of oil (g)	Volume of product (ml)	Weight of product (g)	Volume of product using density (ml)	Percent Yield (%)
1	200	181.44	130	107.14	121.75	59
2	200	181.44	160	136.24	154.82	75
3	200	181.44	135	114.408	130.01	63

Figure 2. Separation Funnel Layers

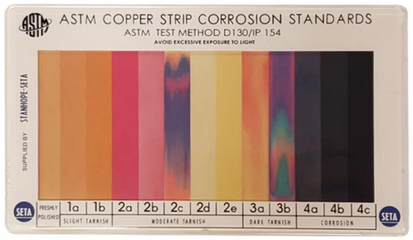

Figure 3. Corrosion Test Standard

Conclusion/Future Work

The aim of this project was to create a process that can produce biodiesel from waste oil using homogeneous catalysis. It was found that potassium hydroxide had an exceptional activity in mediating the transesterification process within the virgin oil process in the first step. In the second step, sulfuric acid was found to complete the transesterification of the free fatty acids. The preliminary findings showed adequate conversions and satisfactory yields were achieved. As the research continues, the catalyst amount, temperature, mixing rate, and reaction rate will be optimized to produce the highest yield. A final washing and drying procedure is being tested to ensure the quality of the product. Next steps beyond washing include quantitatively testing the product. It is currently passing several qualitative tests but no quantitative tests have been completed at this point in the project. Future testing of the product to determine if it meets biodiesel standards will require gas chromatography.

Acknowledgements

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