Hydrothermal Liquefaction of Polyethylene with Algae

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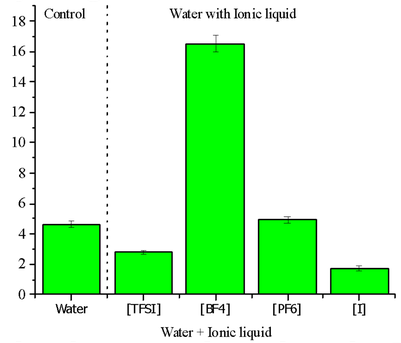
Research Objective

To utilize the hydrothermal liquefaction (HTL) of polyethylene (PE) from waste electrical cables to produce a crude oil product. Polyethylene will be mixed with algae in different proportions to investigate the effect of reaction composition on product composition.

Background

Plastic does not degrade easily, and making plastic utilizes finite petroleum resources. Polyethylene makes up the largest portion of the plastic waste stream, making it vital to find a viable recycling method for PE.



Research has been conducted on the HTL of PE using ionic liquids and acid catalysts to increase oil product yield. Experiments with BF4 showed the highest oil yield. Current work looked into the effect of using algae in the HTL of PE to increase the oil yield.

Research Methods

PE and algae samples were weighed in proportions of 25, 50, and 75 percent for various experiments. The samples were placed into a 100 mL PARR reactor with a 4843 controller. Experiments for each composition were conducted at 350 °C and 375 °C. Products were separated gravimetrically with dichloromethane, and the solids left over on the filtrate side will be used for mass balance and product yield calculations. The composition of oil and gas products will be characterized using gas chromatography/mass spectrometer, elemental analyzer, bomb calorimeter, and FT-IR spectroscopy.

HTL yields of SRP waste with Ionic liquid

SRP: Water	Ionic Liquid	Temperature, °C	Residence time, min	Oil yield, %	Solid yield, %	Gas yield, %	HHV (MJ/kg)
1:20	-NA-	350	90	4.64	42.32	53.03	37.74
1: 20	BMIM [TFSI], 3 ml	350	90	2.8	70.0	27.2	37.94
1:20	BMIM [BF_4], 3 ml	350	90	16.5	50.0	33.5	32.88
1:20	BMIM [PF_6], 3 ml	350	90	4.92	65.02	30.06	35.62
1:20	BMIM [I], 3 ml	350	90	1.73	80.14	18.13	23.23

Product yield of HTL with ionic liquids

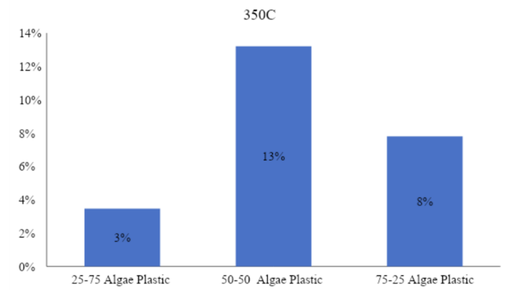
Acknowledgments

This research was conducted in conjunction with Dr. Shuguang Deng's SRP-ASU Joint Research Project.

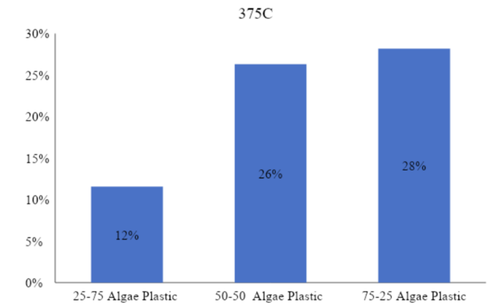
Results

The best oil yield came from the 75:25 algae to plastic ratio over a 375 °C reaction. The 50:50 and 75:25 reactions at 375 °C performed better than the reactions done with ionic liquids.

Oil yields from 350°C



Oil yields from 375°C



Future Work

Continued research will be focused on using solid catalysts to continue optimizing the oil yield. Literature suggests that HZN, FSM, and K3PO4 could be good catalysts for the HTL of polyethylene. Experiments with catalysts will be conducted purely with polyethylene to start, and reaction composition can be varied at a later time.

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