Oregon State University Material Science Seminar, 5/25/23
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Futile to Utile: Waste Plastics to Diesel Fuel in a Low-Cost Pyrolysis Reactor Abstract

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Non-OSU Partners:
Ocean Plastics Recovery Project (Scott Farling and Captain Andy Schroeder, Kodiak AK)
Clean Oceans International (Captain Jim (Homer) Holmes, Santa Cruz, CA)
PDO Tech (Kevin DeWhitt, Founder and CEO, Brooks, OR)

The Plastics to Fuel project utilizes pyrolysis to mitigate the burden of plastics pollution in rural and island communities. In 2018, only 8-10% of post-consumer plastic waste was recycled. By employing a chemical recycling process (pyrolysis), a variety of commodity plastics can be converted into a usable diesel additive in a single step with no additional processing. Prior to loading in the reactor, plastics are characterized for plastic types and any potential fillers using Differential Scanning Calorimetry (DSC) and Thermogravimetric Analysis (TGA). Mixed plastic streams can be loaded in the reactor but PVC (chlorine release) and PETE (high mechanical recycling value) are not used at this time. The majority of our studies have focused on HDPE, LDPE, PP, and PS, the largest group of commodity plastics encountered in waste streams.

A 1 kg capacity pyrolysis reactor PTF 1.0 (Niblerator) was designed and constructed at OSU in 2019. It was a Schedule 40 carbon steel pipe with two chambers (plastic and packed bed) heated with three 4" high resistance heater bands. To improve accessibility in the target communities, **PTF 2.0 (Helenator)** was constructed in Spring 2022 by a **MIME Capstone Design Group that was awarded the Sustainability Prize at the 2022 COE Expo.** It is a kiln with heating of air surrounding a Schedule 10 SS single-chamber reactor to heat the plastics. Several other improvements were made, such as changing packing from Raschig rings to stone pebbles and powering at 120 V instead of 240V. Solar panels to provide electricity are planned in the future.

Studies with the Helenator on a wide variety of plastic streams have focused on creating campus waste plastics circularity and ocean plastics. Campus circularity has involved working with OSU Campus recycling to do "dumpster diving" for waste plastics and a pilot project with a local coffee shop (Dutch Bros.) to collect their cups which are primarily PP. Ocean plastics were recovered from a beach clean-up in summer 2022 on the Katmai Reserve in Alaska with our partners Ocean Plastics Recovery Project (Kodiak AK). Each of these plastic streams, and several others, have been run in the Helenator to produce a quality "diesel-like" fuel which could readily be blended into commercial diesel. Future work will focus on increasing the diversity of plastic waste streams to study the effects ocean salt, biomass, grease and grime have on product yield and hydrocarbon distribution. In addition, we have developed and are testing a rapid GC analysis technique for the diesel product.