Hydrothermal Liquefaction as a Tool to Enable Plastic Circularity

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Background/Objectives. As a result of the growing environmental consequences of plastic use, there is both a societal and self-imposed pressure to enable plastic circularity. Global plastic consumption, production, and waste generation has more than doubled since 2000. Currently 70% of plastic waste is disposed of by traditional methods, while only 15% of plastic waste is collected for recycling, and just 9% is recycled successfully. The remaining eludes waste management systems and ends up burned in open pits, creating uncontrolled wasteyards, or being dumped in the ecosystem. The development of robust recycling methods that facilitate upcycling of waste will accelerate growth of plastic circularity by lowering waste accumulation, while simultaneously creating beneficial products. Hydrothermal liquefaction (HTP) is an energy-efficient emerging technology that transforms plastic into value-added products like lubricants, greases, fuels, and feedstocks for commodity chemicals.

Approach/Activities. Comprehensive understanding of reaction parameters and product control is necessary to effectively incorporate HTP into waste management infrastructure. To better understand the outcomes of HTP we evaluated liquefaction of polyethylene, nylon 6, nylon 6/6, polyethylene terephthalate, and cotton. Effect of reaction time, temperature, catalytic intervention, headspace composition, and pressure were assessed to optimize breakdown and facilitate reproducible product generation.

Results/Lessons Learned. Gas chromatography, NMR, and FTIR were used for determining the chemical compositions of the products. A mixture of paraffin and α-olefin waxes and oils, carboxylic acids, alcohols, and aromatics can be produced in high yield by varying reaction conditions and input. In future phases of development mixed waste inputs will be evaluated, outputs will be utilized in upstream processes, and HTP will be further optimized and scaled for commercial use.