Enhanced Waste-to-Energy Conversion Solution for Application in a Municipal Wastewater Plant

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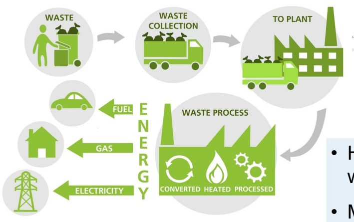
Challenges and Opportunities

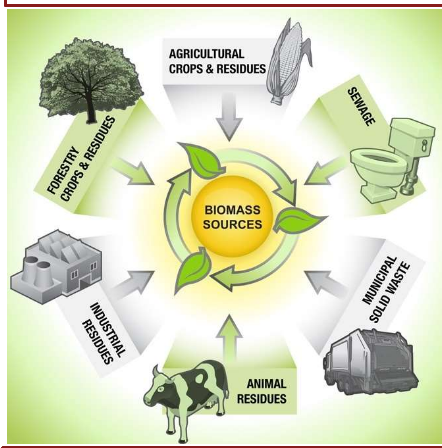
- Millions of tons of waste are generated every year and the numbers increase with each passing year

or a Resource?



- Hydrothermal Liquefaction uses wet feedstocks to produce energy
- Meeting SDG 6&7

Different Forms and Sources of Waste



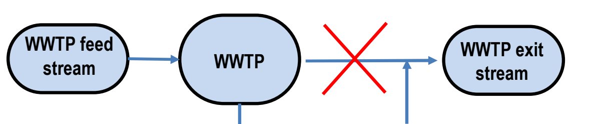
Sources of Waste

- Municipal Solid Waste, and sewage from homes and industry
- Animal Residue
- Agricultural Waste (e.g., from farms or forestry)

Some Forms of Waste

- Plastics
- Food waste
- Sewage Sludge (by-product of wastewater treatment)
- Agricultural Waste (Manure from animals, residue from harvested crops)

Proposed Option and Goal

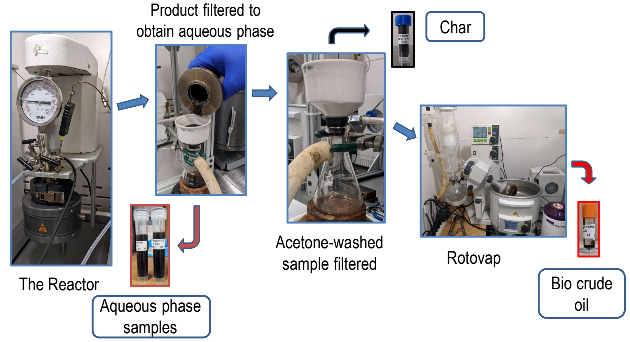


Wastewater Treatment Plant (WWTP)

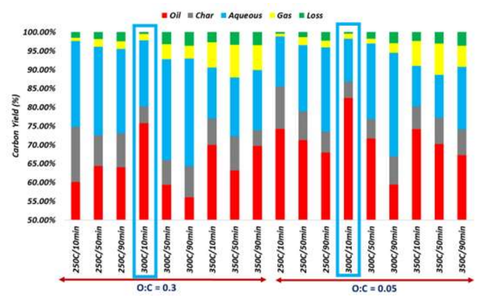
- Research has shown that the energy content dissolved in WWTP feed streams can be up to 5 times that consumed in treatment.

- Opportunity to recover energy content while reducing solids to be landfilled

Basic Hydrothermal Liquefaction Process



Enhanced Thermal Experiments



This chart shows Carbon yields for experiments conducted for two different concentrations of the radical initiator used at varying values of temperature (250^0C, 300^0C, and 350^0C) for varying values of time (10 minutes, 50 minutes and 90 minutes)

Radical Experiments

Carbon Yields

Two sets of Experiments were conducted first at 300^0C for 10 minutes (Fig.1), and then at 300^0C for 90 minutes (Fig. 2) using the following species:

1. Sewage sludge without a radical initiator (HTL)
2. Sewage sludge with a radical initiator (HTL+)

Fig. 1

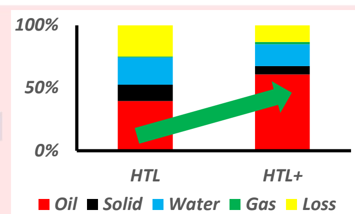
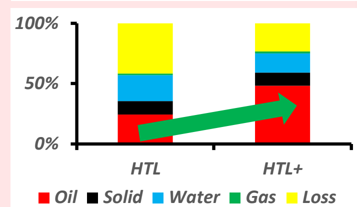


Fig. 2



Hypothesis: HTL+ increases biocrude yield by increasing the pool of radicals available for reaction.

Mechanism

Radical initiators produce radical species under mild temperature conditions. The resulting unpaired valence electron, however, make the radical species highly chemically reactive. The chosen radical decomposes or breaks homolytically when heated into two –oxyl radicals which readily initiates the reaction.

$$R-O-O-R \longrightarrow 2\ \cdot OR$$

$$R-O-O-R \longrightarrow OR^{+} + OR^{-}$$

To confirm this, a different initiator will be used to test the initiator hypothesis

Results and Analysis

- **Regardless of the time duration of the reaction, the radicalized hydrothermal liquefaction process led to higher carbon yields in the biocrude than the basic hydrothermal liquefaction process.**
- **Organic reactions almost always involve the breaking and making of covalent bonds with varying degrees of polarity or ionic character. When that bond is broken, electrons may be shared out in one of two ways, homolytic fission which involves equal sharing of the electrons, and heterolytic fission where there is unequal sharing of electrons.**

Conclusions

- The experiments showed that more biocrude can be produced from reactant species upon initiation, with introduction of a radical initiator
- Running the reaction at a temperature of 300^0C gives higher biocrude yields than running it at 250^0C or 350^0C
- Generally, higher biocrude yields and less char are obtained when the reaction is run for 10 minutes than when it is run for 50 minutes or 90 minutes

References

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Acknowledgments

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