Biocrude Potential from Hydrothermal Liquefaction of Wastewater treatment residues and Food waste

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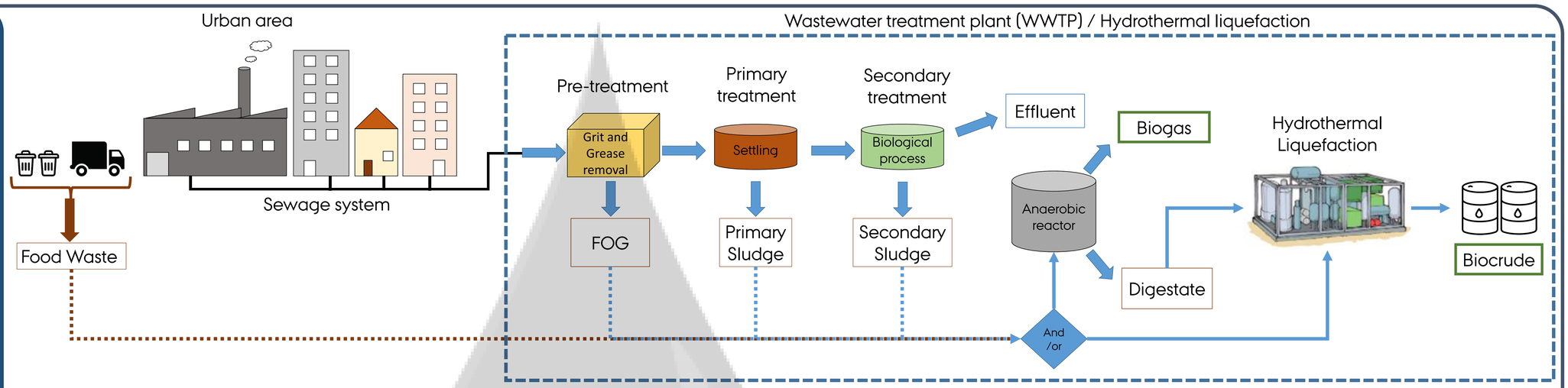
BACKGROUND

- Hydrothermal Liquefaction (HTL) is a promising technology to convert wet biomass/residues into biocrude that can be further upgraded to Biofuels.
- In 2017, the US generated around 14 MT of dry sludge [1], and in 2010, in the EU27 around 11.5 MT [2], which gives great potential for biocrude production from WWTPs.



METHODS

- **HTL Batch Experiments**
  - 2 WWTPs investigated
  - Single feedstock and mix in the production proportion;
  - 20mL reactor;
  - 3 temperatures: 300, 325 and 350°C;
  - Residence time 20 min.
- **HTL Continuous Experiments**
  - Food waste and Primary sludge from Randers;
  - ~20L reactor;
  - 325°C;
  - Single and Mixed biomass (30%primary sludge + 70% Food waste);
  - Low, medium and High flow rates.

Table 1: Annual dry matter residue production

Biomass	Fredericia (ton/year)	Randers (ton/year)
Fat, oil and grease (FOG)	133	-
Food Waste	-	1900
Primary Sludge	1372	1600
Secondary Sludge	3366	1100
Digestate	1705	1580

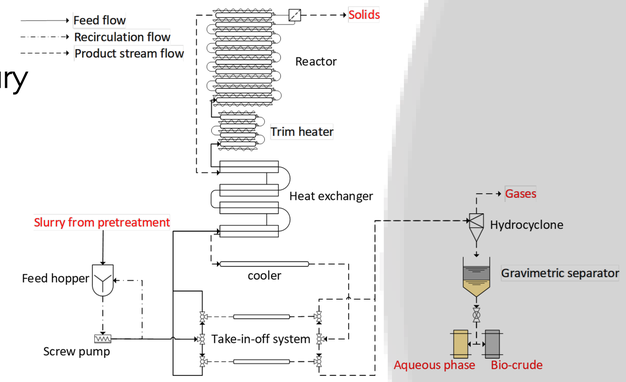


Figure 1: HTL pilot plant flow diagram (Aarhus University)

KEY FINDINGS

- **Batch Experiments**
  - Highest biocrude yield at 325°C for all feedstock;
  - Higher than expect biocrude yield when mixing 33% instead of 30% for Fredericia and 42% instead of 40% for Randers. (Positive synergetic effect)
- **Continuous Experiments**
  - Low flow results in higher biocrude yields for primary sludge 44.4%;
  - Medium flow for Food waste results in biocrude yield of 37.9%
  - High flow results in higher biocrude yield for the Mixture (36.4%).

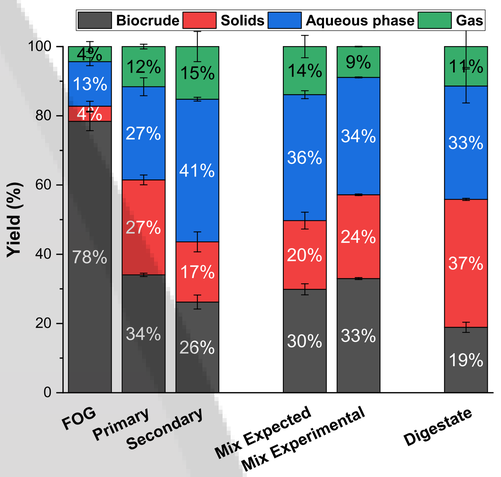


Figure 2: Fredericia HTL yields

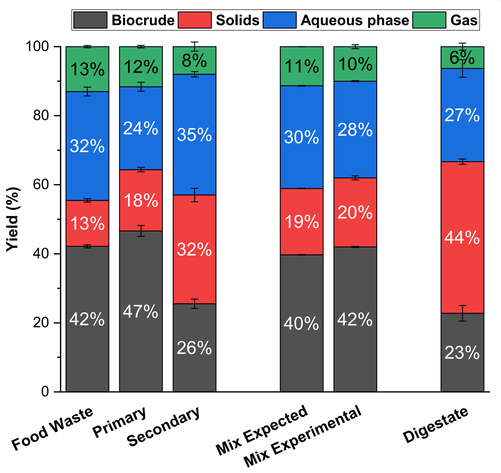


Figure 3: Randers HTL yields

Table 2: Continuous HTL conditions and Biocrude yield

Feedstock	Dry matter (%)	Flow Low-med-high	flow (kg/h)	Filtered biocrude yield (%)
Primary sludge	2.76	Low	26.8	44.4
Primary sludge	3.10	Medium	34.3	39.9
Primary sludge	4.80	High	45.4	15.3
Food waste	12.00	Low	21.9	19.6
Food waste	10.13	Medium	32.2	37.9
Food waste	12.00	High	33.9	32.8
Mix	9.80	Low	23.1	23.7
Mix	9.34	Medium	29.1	35.3
Mix	9.14	High	36.4	36.4

TAKE-AWAY

- HTL Batch Experiments
  - Fredericia: 1608 tons of biocrude per year by using FOG, Primary and Secondary sludges. From digestate 324 tons.
  - Randers: 1932 tons of biocrude per year by using Food Waste, Primary and Secondary sludges. From digestate 363 tons.

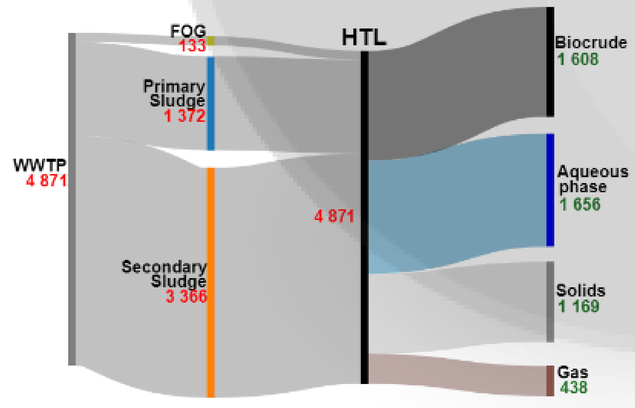


Figure 4: Fredericia feedstock pathway through HTL

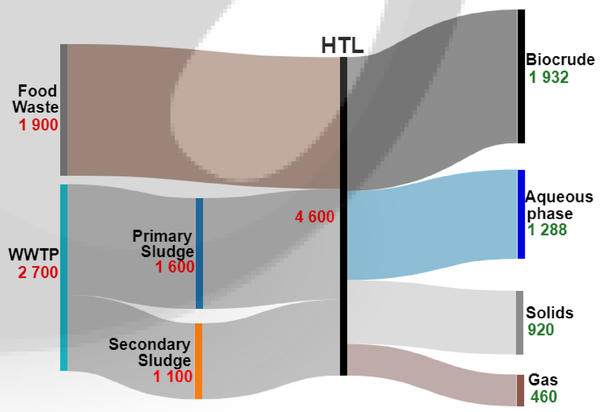


Figure 5: Randers feedstock pathway through HTL

TAKE-AWAY

- HTL continuous Experiments
  - Biocrude yields are highly affect by the flow rate;
  - Mixing Food waste and Primary sludge results in higher biocrude yields than expected (36.4% instead of 30.3%)

REFERENCES

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[2] Verlicchi P, et al. Pharmaceuticals and personal care products in untreated and treated sewage sludge: occurrence and environmental risk in the case of application on soil—a critical review. Science of the Total Environment. 2015;538:750-67..

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