HYDROTHERMAL LIQUEFACTION OF FOOD WASTE: OPTIMAZION AND KINETIC MODELLING

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As food waste generation is increasing, alternative solutions to valorize it and avoid landfilling are necessary. Among the possibilities, hydrothermal liquefaction (HTL) can be a viable option [1]. HTL can convert various feedstock into an organic phase, which after upgrading can be used as fuel. It works in subcritical water condition (250-374 °C, 5-25 MPa) with a solid content of 10-25 %. The use of HTL can both improve food waste management and produce a sustainable fuel while recovering the valuable nutrient phosphorus.

In this work hydrothermal liquefaction of food waste is studied: tests were carried out in batch between 300 and 360 C for 5 to 35 minutes to find the optimum conditions in terms of oil yield. Additional tests were performed to determine the kinetics. Finally, the food waste was fed to a continuous pilot plant (Aarhus University, Foulum, Denmark) [2] with different flow rates to validate the model and calculate energy efficiency. For HTL tests in batch conditions, 20 mL custom built reactors made of tube fittings were used at desired temperature with 20% solid loading.

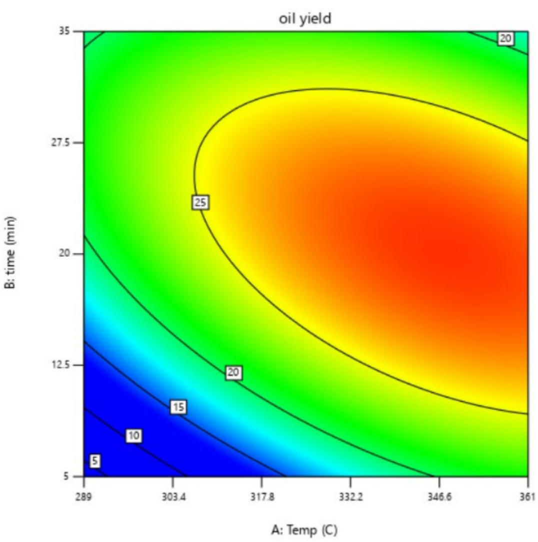

Figure 1 – contour plot for oil yield

In figure 1 the oil yield is showed. From these data it is possible to optimize the operative conditions in terms of oil yield. Keeping constant the reaction time (between 5 to 28 minutes) the oil yield increases with temperature. Instead at constant temperature there is a maximum in the oil yield with the time. The optimization predicted the optimum point at 347 °C and 20 minutes with oil yield of 28.4%. The highest solid yield (28%) was found at 290 °C for 20 minutes, probably due to the presence of unconverted food waste. The gas yield increased with temperature from 12% at 290 °C to 22 % at 350 °C; residence time had a lower impact on the gas production. A slurry, containing food waste at 26 % of solid content, was prepared and subjected to HTL in the continuous plant. The temperature was set at 325 °C and the flow rate at 24 kg/h (equivalent to 45 min of residence time). The biocrude yield reached 24%, value comparable with the batch tests. Energy analysis indicated energy recovery of 40.2% and an energy return of investment (EROI) of 1.8.

In conclusion, HTL has succeeded in converting food waste into valuable bio-crude. Stream with high solid loading (26%) was also successfully valorized in a continuous pilot plant, confirming the industrial application of HTL for food waste valorization.

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