RETASTE Conference Abstracts
Vol. 1 RETASTE-W2E-139
Athens, Greece, 6-8 May, 2021

Biofuels from Hydrothermal Liquefaction of Food Waste: The Impact of Feedstock Composition on Process Economics

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Abstract

Energy recovery from wet wastes via Hydrothermal Treatments (HTs) is an emerging alternative to traditional conversion and nutrient recycling by Anaerobic Digestion (AD). In particular, Hydrothermal Liquefaction (HTL) seeks the production of a bio-oil that can be further upgraded to transportation biofuels. Together with bio-oil, an aqueous phase, rich in soluble organics, a solid (hydrochar) and gas (mostly CO_2) are generated. Experimental results show the relative yields of these products are sensitive to the operating conditions of the HTL reaction (Tzanetis et al., 2017) and the composition of the input feedstock (Li et al., 2021). Consequently, such variations are expected to have a non-negligible impact on the economics of the overall waste-to-fuel process. In this work, we intend to show the impact of Food Waste (FW) composition on the estimated Minimum Fuel Selling Price (MFSP) of renewable gasoline and diesel produced via HTL. The assessment is based on a process simulation model built on Aspen Plus® V10, which further integrates an AD stage of the aqueous phase. The production of biogas is conceptualised to diminish the external purchase of natural gas, utilised in the plant to produce hydrogen (required in bio-oil upgrading) and to fulfil the internal energy demand, which is reported to be the most significant contribution to variable costs in this kind of facilities. We are assessing different combinations of FWs described in the literature, with different contents in lipids (13-35 w%, daf) and proteins (13-25 w%, daf), the most influential parameters on the bio-oil/aqueous yield ratio, so we can elucidate the optimal ratio in economic terms. Our preliminary results indicate the bio-oil yield varies 45-52%, while the aqueous phase is between 22-26%. Our initial estimations for a high-protein, low-lipid feedstock have shown a calculated MFSP of 0.036 € MJ^{-1} produced fuel.

Keywords: food waste, hydrothermal liquefaction, process simulation, techno-economic assessment

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Acknowledgments: The authors thank financial support from the Spanish Ministry of Science, Innovation and Universities through the REDEFINERY project (RTI2018-097227-B-I00, AEI-FEDER/Retos Investigación 2018), and the Government of the Community of Madrid through the BIO3 project (S2018/EMT-4344).