ENERGETIC AND MATERIAL VALORIZATION OF DIGESTATE VIA HYDROTHERMAL LIQUEFACTION

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Among the options for biomass to energy schemes, anaerobic digestion to produce biomethane is one of the most established routes, with applications ranging from wastewater management to agricultural biomass. The project "Pilot-SBG - Bioresources and Hydrogen to Methane as Fuel - Conceptual Design and Realization of a Pilot Scale Plant ", which is financed by the Federal Ministry of Digital and Transport (BMDV), aims to investigate the possibilities of increasing the yield and flexibility of anaerobic digestion of biogenic wastes and residues by introducing additional processes such as catalytic methanation. The biogas is to be provided as renewable methane for the transport sector. The side product, commonly known as digestate, requires further treatment due to pathogenic and zoonotic agent loadings. Established schemes involve energy intensive drying and hygienization prior to its use as a fertilizer, neglecting the energy content of the biomass. Furthermore, application to land is limited depending on the local legal framework, leading to costly storage and transportation. This constitutes a waste management problem, which requires novel solutions. Hydrothermal liquefaction (HTL) can be used as an alternative technology for increased value creation. At conditions close to the critical point of water (647 K, 22 MPa) the biomass breaks down and recombines to form an energy-dense biocrude oil, which has received attention as a potential precursor for aviation and transportation fuels, an aqueous phase rich in organic compounds, and a nutrient rich hydrochar. In this study, HTL of digested sewage sludge (DSS), straw/manure digestate (SMD), and digested biogenic waste (DBW) is performed in a mini-batch (20 mL) setup. Response surface methodology is applied to investigate the influence of the biochemical composition of the input material, temperature and reaction time on product yield and composition, energy recovery, as well as the mobility of nutrients among the product phases. The experimental data highlights a variety of differences in the behavior of the digestates in HTL. The feedstock analysis reveals differences between the digestates in terms of elemental and biochemical composition, in particular carbon, ash, protein and carbohydrate content. Quantity and quality of biocrude produced varies between the digestates, as do the processing conditions at which maximum yield is achieved. For each digestate, models to describe product yields are developed, which reveal further differences in the influence and significance of temperature and time. As a consequence, the optimal processing conditions with regards to maximum biocrude yield and energy recovery differ for each digestate (see *Figure 1*). In terms of biochemical composition, modelling suggests high carbohydrate, medium fat and low protein and lignin content to favor biocrude formation. ICP-OES analysis shows, that Al, Ca, Fe, Mg and P were primarily found in the solid residue, enabling recycling of said nutrients. GC-MS of the biocrude oil reveals differences on the molecular level, inter alia higher concentration of N-heterocyclic compounds for the high protein feedstock DSS.

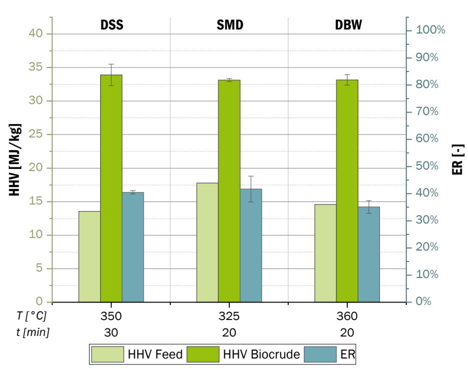

Figure 1 – Comparison of digestates in terms of energy recovery and biocrude HHV at top condition