Organic waste exploitation *via* hydrothermal carbonization: the effect of liquid phase recirculation on the chemicals recovery

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The management of the enormous amount of waste produced nowadays is a crucial issue. In a circular economy concept, wastes represent a resource that can be used by reducing its environmental impact and aiding society on its dependence on fossil fuels. The optimal residues exploitation, and especially the organic fraction of municipal solid waste (OFMSW), is affected by the high heterogeneity and moisture of these substrates.

Hydrothermal carbonization (HTC), a relatively mild thermochemical process using water as a reaction medium, could improve the management and valorization of OFMSW. Typically, the HTC process takes place at temperatures around 180 - 250 °C, under autogenous pressure and ~~a~~ with water-biomass ratios between 3 and 10. The products obtained are a coal-like solid material, a liquid phase enriched in chemicals and a negligible amount of gaseous phase. The characteristics and distribution of the products obtained strongly depend on the reaction conditions.

The HTC process allows the confinement of the unwanted species of the treated biomass in the aqueous phase. For this reason, the process is widely recognized as a pre-treatment to obtain a solid material with improved characteristics that could make it suitable for processes such as gasification. However, a treatment plant based on the biorefinery concept cannot neglect the non-energy use of biomass. In particular, sustainable exploitation of biomass through HTC must take into account that the continuous supply of process water represents one of the main operational challenges. The correct use of the liquid phase could both reduce the use of water and allow the recovery of platform chemicals.

This work analyzes the effects of process water recirculation in the HTC of OFMSW. The experimental tests were carried out in a 3 L laboratory scale batch reactor at 200 °C with a residence time of 2 h and a water/biomass ratio equal to 4. Ten tests were carried out according to the scheme shown in Figure 1.

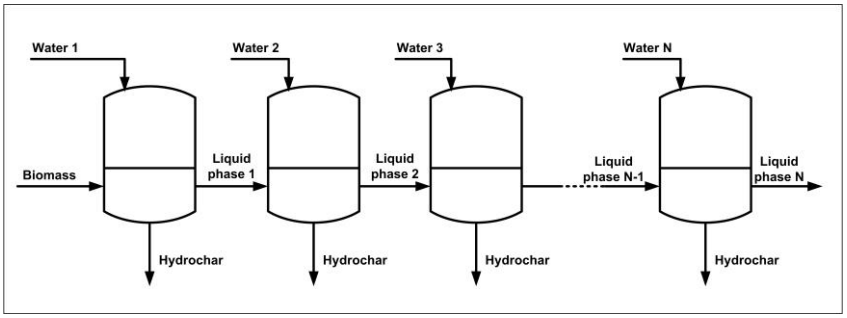

Figure 1 : *Experimental test scheme*

To evaluate the effect of the residence time on the characteristics of the process water, samples were taken at time 0 (when the reactor reaches the operating temperature) and after 1h. A further sample was taken at the end of the process from the liquid phase obtained after filtration. Experimental results show that residence time and recirculation affect the content of chemicals such as 5-HMF, furfural, fructose, acetic acid and lactic acid. As the number of recirculation cycles increases, hydrochar yield is observed to be higher due to the polymerization of the chemicals contained in the recirculated aqueous phase.

The experimental test results will be used for the development of process schemes to enhance biomass valorization in terms of chemicals recovery.