Hydrothermal Carbonization (HTC) – A technology for the treatment of organic sludge

Written by Dr. Tammo Rebling

Tammo Rebling, born in 1985, graduated 2011 in Environmental Sciences at the Carl von Ossietzky University Oldenburg (degree M. Sc.). Subsequent he was until 2015 research fellow in the project "hydrothermal carbonization in Lower Saxony – development, improvement and simulating a continuous pilot plant" at the University of Applied Sciences Osnabrück and worked as assistant lecturer for basic principles of bioprocess engineering. In April 2016 he received his doctorate in technical chemistry at the TU Braunschweig. Since then he is working for umwelttechnik & ingenieure GmbH.

As a biomass conversion technology, Hydrothermal Carbonization (HTC) converts wet biomass-waste (feedstock) into coal-like products with new properties (e. g. better dewatering property or a higher heating value) [1]. Implied by the name of HTC, the process needs hydrothermal conditions, which means that the feedstock is in a sealed reactor in contact with water, whereas the temperature is around 200 °C. Due to this conditions, HTC is suitable as a (pre-)treatment technology for different kinds of organic waste, digestate or sewage sludge with high moisture contents [2].

First hydrothermal approaches to produce coal-like products were performed in Hannover (Germany) about 100 years ago by the Nobel Prize winner Friedrich Bergius. His aim was to simulate the natural formation of coal on a technical way. Other works followed on this research field, but without great response and success. Due to rising interests of sustainable technologies in the context of climate and resource protection, the hydrothermal process got new attention. The following activities on hydrothermal conversion technologies were mostly performed under the keyword of HTC – last but not least by umwelttechnik & ingenieure GmbH in Hannover [2].

Since the rediscovery in the year 2006, a substantial progress has been made in the development of HTC. This can be seen in developed business models, the variety of successful accomplished research projects or the number of pilot plants, which were constructed. Now, there are different plant engineers and constructors on the market. All of them use different process engineering concepts. Due to the fact, that long-term experiences of these HTC-plants are missing and legal foundations of the usage of sludge are changing (e. g. in Germany), the different concepts and HTC-plants are hard to compare and assess.
Therefore, this short article describes properties and potentials of HTC.

For the process of HTC, the water-bathed feedstock is heated up to a temperature of about 200 °C in a sealed reactor. Thereby, a saturation pressure is generated. At these conditions, the properties of the used feedstock are changing [1] – which can be seen in the darker colour of the dried products (s. Figure 1). Simultaneously to the increase in darkness of colour, carbon content and higher heating value of products increase.

One important characteristic for the process of HTC is its controllability: Due to adjusted time (usually < 5 h) and temperature (usually 180 - 240 °C) the aspired product quality is achieved. Furthermore, overall it is an exothermic process, which means that a small amount of the energy which was stored in the feedstock is released during the process. Therefore, the energy input for the process can be reduced [1].

After carbonization, the mechanical dewaterability is increased significantly, as it is shown in Figure 2. For example, non-stabilized sewage sludge is dewatered before HTC up to a maximum dry matter content of 30 %, the maximum dry matter content of HTC-product is about 70 % [5]. This obtained solid product is versatile but due to the reduced water content, an energetic use is mostly practicable [2].
Figure 2  Example of HTC-process for sludge treatment: Reduction of solid mass on about 1/3 (0.28 t instead of 1 t); depending on feedstock and process properties.

Because the process water contains soluble compounds, it is suited for a fermentation. Thus, the chemical oxygen demand (COD) of the wastewater is reduced and simultaneously methane as an energy source is generated [2]. Particular for the sewage sludge treatment a phosphorus recovery is possible [4].

Since the "rediscovery" of HTC the umwelttechnik & ingenieure GmbH is working on the field of HTC. At present, u&i has a broad data base of more than 900 articles, combined with practical experience and data. Merged with the knowledge, which is accumulated over 24 years engineering services, we will guide customers from concept through to final commissioning and also provide feasibility studies. For more details about HTC-process, please do not hesitate to contact us.

In this context are our core competences:

- feasibility study
- project appraisal
- preparation of expert assessments/reports
- valuation reports/due diligence
Literature


