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Villigen, July 2018

Energy Storage System – a driver of the future of energy

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The efforts to find alternatives to coal and oil are resulting in a rising demand for green energy sources. Organic waste could be one of them. However, many organic residues are mixed with a great deal of water. This dilution makes the energetic valorization of such "wet" residues inefficient and economically unviable with most technologies. The reason is the large energy demand for evaporating the water. Researchers from the Paul Scherrer Institute (PSI) have found a solution to this problem.

The so-called hydrothermal gasification technology (HTG) developed at PSI works with diluted organic residues – wet waste. There is no need to remove the water. At high pressures and temperatures, water becomes an aggressive chemical that decomposes most organic substances to liquids and gases. When used in a proper way, such in a hydrothermal environment, it can serve to produce green gas very efficiently from almost any organic residue or waste.

Two key elements for high-efficient process

There are two key ingredients that make PSI's process unique: a catalyst and a salt separator. The catalyst is a solid material in granular form, doped with small amounts of the noble metal ruthenium. When the hot liquid water and the organics flow by the catalyst granules, they react on the ruthenium particles, forming only gases. This gas mixture consists mainly of carbon dioxide and methane, with some amounts of hydrogen. It resembles natural gas but is free of impurities normally encountered in natural gas. This gas mixture rich in methane (up to 60 vol%) can be used to produce electricity in a gas engine or as a fuel in a CNG (Compressed Natural Gas) car. Another application is to wash out the CO2 and feed the gas into the natural gas grid. The second key feature of the process, the salt separator, takes salts and other minerals out of the process to protect the catalyst. Furthermore, these minerals are valuable nutrients and can be upgraded to a fertilizer. The water leaving the HTG process usually contains only very low levels of organics and some ammonia, which can also be used as fertilizer.

Therefore, the HTG process is very energy-efficient. It is designed to work without any external supply of thermal energy. Only a small amount of electrical energy is needed to power the feed pump and some other auxiliary devices. The net energy recovered in the gas mixture makes up between 60 to 70% of the energy contained in the organic feedstock. This is higher than what can be obtained by any other thermal process from a wet waste. The typical water content of the feed mixture should be around 80% or less. Only the pump capability sets the limit. The HTG has been shown to work well on sewage sludge, manure, spent coffee grounds, digestate, concentrated waste waters, algae slurries, and other non-digestible feedstock.

Ecological benefit and market potential

There is a large ecological benefit with the HTG when wastes are used as feedstock. Luterbacher et al.[1] have performed a life cycle assessment of HTG and found significant advantages vis-à-vis other uses of the wet feedstocks. Cost estimations have shown that sewage sludge valorization using HTG can be profitable in Switzerland for a gate fee of 133 CHF/t of dewatered sludge[2]. This is lower than what most wastewater treatment plants have to pay today.

PSI's HTG process is also well suited for "power-to-gas" applications: hydrogen from a high-pressure water electrolyzer can be fed directly into the HTG process. The result is a boost in methane concentration up to 86 vol%[3].

References

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