The Benefits of Thermophilic Digesters during the Process of Anaerobic Digestion in Wastewater Treatment

Zain Glover, Gawthaman Senthilvelan

Dept. of Applied Science and Engineering, University of Toronto

Toronto, ON

z.glover@mail.utoronto.ca, gawthaman.senthilvelan@mail.utoronto.ca

Minimising the amount of solids during water treatment is pivotal to reducing pollutant waste. The existing approach employed by global wastewater treatment facilities for managing solids through anaerobic digestion has a significant drawback. Anaerobic digestion is a biological process where microorganisms break down organic matter in wastewater [1]. Presently, mesophilic digesters, widely utilised for anaerobic digestion on a global scale, fall short of optimal solutions [2].

To remove the greatest percentage of pathogens, this process should be conducted at thermophilic conditions. Not only does conducting at these elevated temperatures remove a greater amount of organic matter, but it also increases the biogas production, which as the City of Toronto states, “is used as a supplementary fuel for plant needs, including process and space heating, thereby reducing the plant's operating costs and carbon footprint” [3]. Specifically, a study by the Department of Environmental Biotechnology at the University of Warmia and Mazury determined a biogas production of 0.25-0.32 L CH_4/g and 0.56–0.70 L CH_4/g for mesophilic and thermophilic temperatures respectively [4]. As stated in the paper, “the process carried out under thermophilic conditions (55 °C) was characterised by higher biogas productivity, …, and higher efficiency of organic compounds removal.” [4].

In order to sustain thermophilic conditions, the generation of biogas will serve as a fuel to heat the water throughout the digestion process, rendering this solution renewable. To convert biogas to heat energy, we can use biogas combined heat and power engines (CHPs). CHPs send biogas through several processes but ultimately output high-grade heat as exhaust gas, which can be used in waste heat boilers to sustain thermophilic temperatures [5]. While biogas can be used as a partial energy source throughout the process, external energy outputs will likely be necessary to power the system. To keep this solution renewable, solar panels will be used to generate any remaining necessary energy.

Furthermore, biogas is more environmentally sustainable compared to more common forms of fuel such as fossil fuels [6]. Therefore, an increase in the production of biogas would be an environmental improvement for wastewater plants worldwide. Additionally, the process of using anaerobic digestion to create biogas may be considered inefficient, however as explained, performing this process at elevated temperatures will increase this efficiency by over double the amount of L CH_4/ g [4]. In regards to the economic impacts, however, implementing a method where the plant performs this process at thermophilic temperatures would undoubtedly be costly, which can be a significant flaw of our proposed model. However, because we will reuse biogas to maintain these conditions, thermophilic temperatures will prove more economical long-term.

Evidently, water treatments worldwide would benefit from conducting anaerobic digestion with thermophilic digesters, as it would increase the production of biogas (which can be used as fuel to lower costs), while also increasing the efficacy of the removal of organic compounds.

References

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