Modelling and analysis of green energy production from sewage sludge using Aspen Plus

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Introduction

- Sewage sludge contains significant organic matter, which can be converted into valuable products such as biogas, bio-oil, or syngas.
- Some wastewater treatment plants (WWTPs) use anaerobic digestion to convert organic matter in sewage sludge into biogas.
- Thermo-chemical processes like pyrolysis or gasification can be alternative methods for sewage sludge treatment due to their faster processing and operational benefits.
- Gasification partially oxidizes at high temperatures (around 800-1000 °C) and produces char, tar, and a combustible gas called syngas.
- Pyrolysis is a thermal decomposition process that occurs at high temperatures (around 250-600 °C) without oxygen and produces gaseous by-products, pyrolysis oil/bio-oil, and biochar.

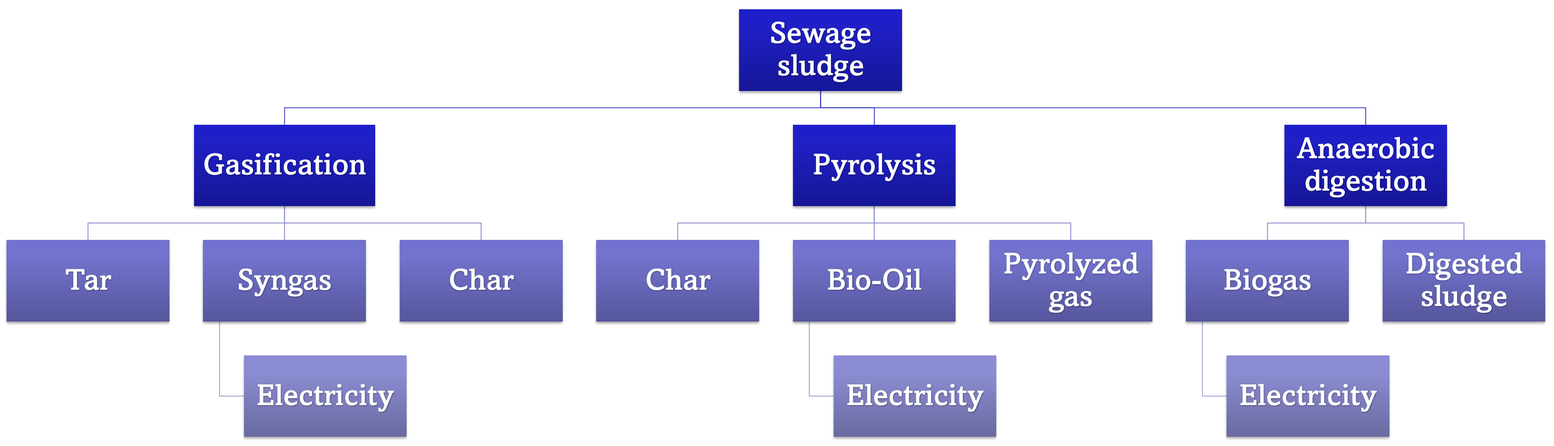

Figure 1: Routes of energy generation from sewage sludge

Results & Discussion

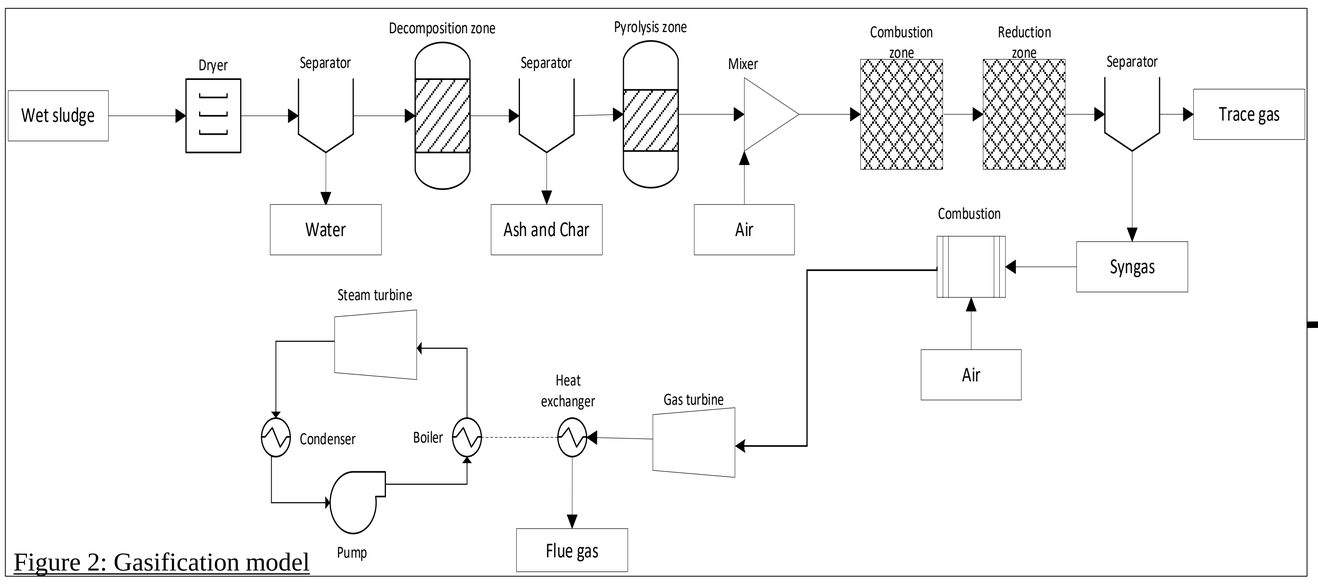

Figure 2: Gasification model

800°C
ER 0.3

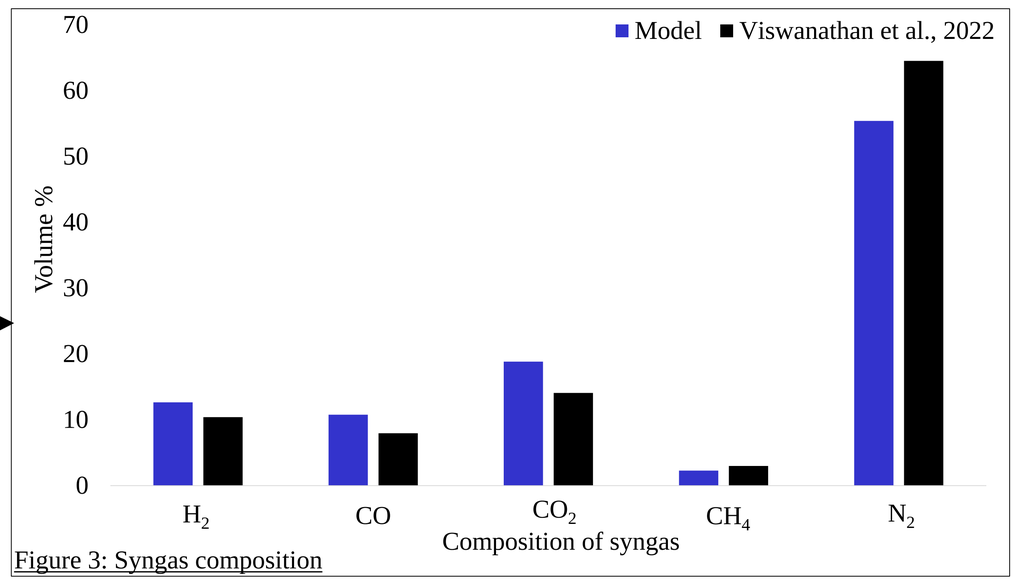

Figure 3: Syngas composition

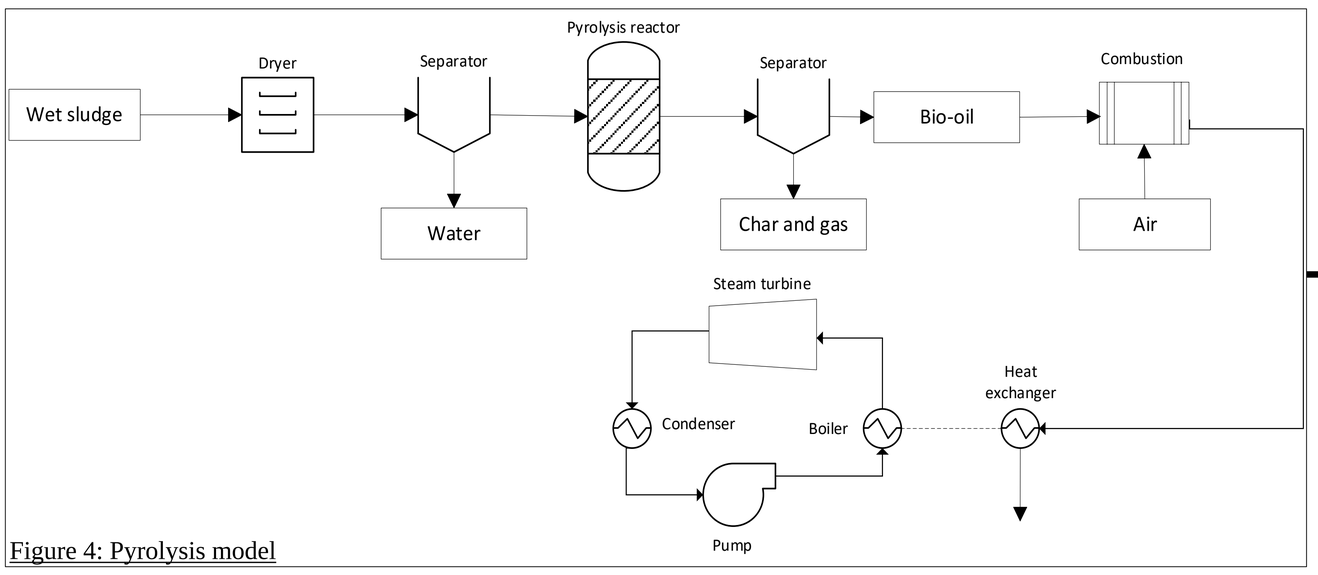

Figure 4: Pyrolysis model

500°C

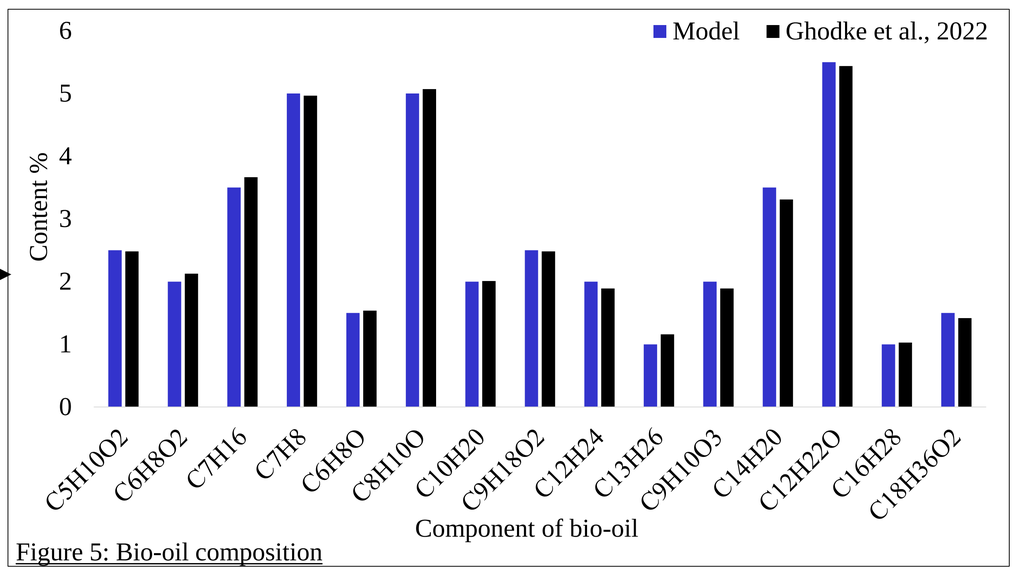

Figure 5: Bio-oil composition

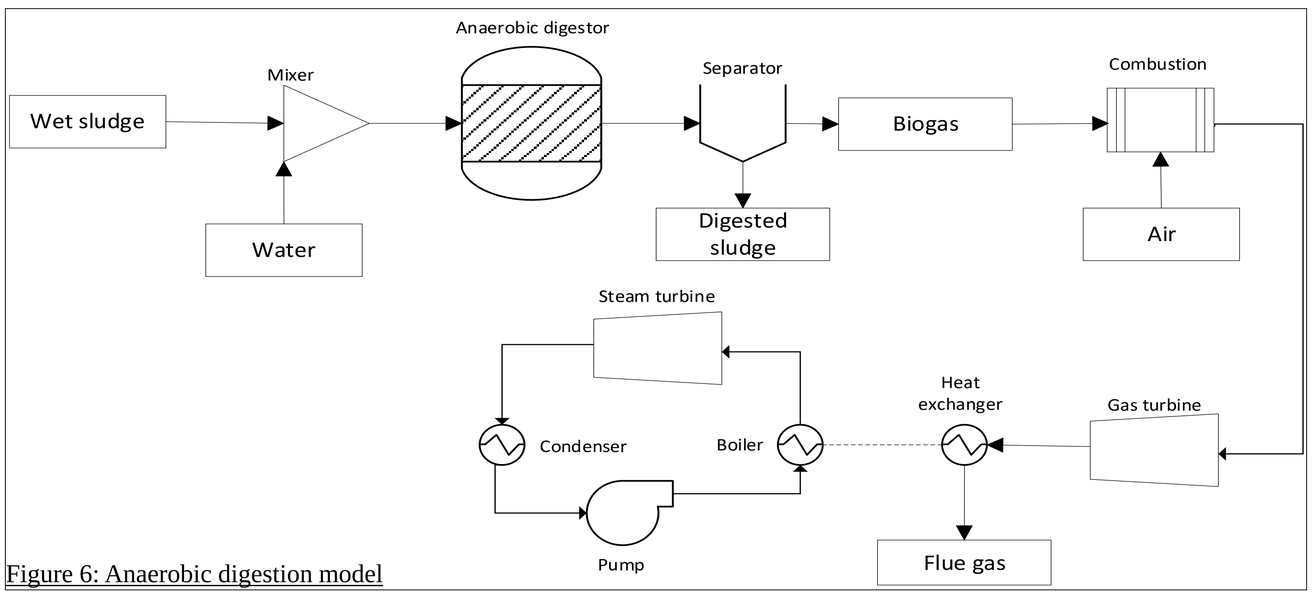

Figure 6: Anaerobic digestion model

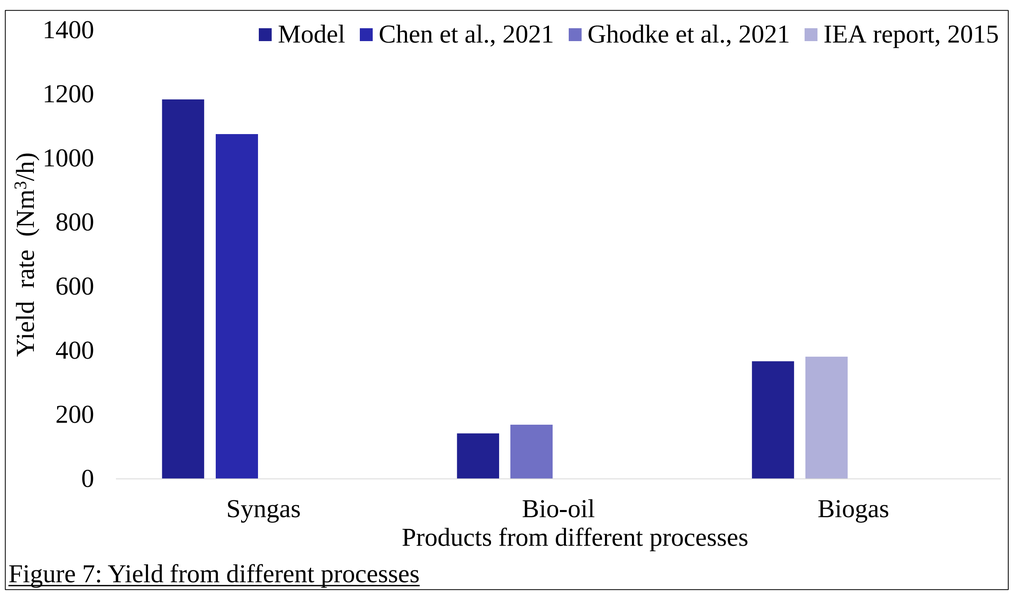

Figure 7: Yield from different processes

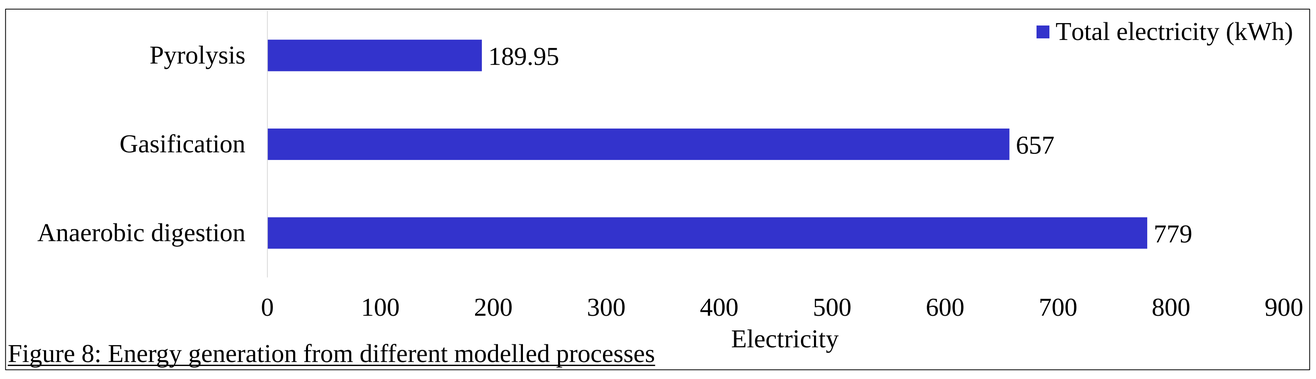

Figure 8: Energy generation from different modelled processes

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Conclusions

- Sewage sludge production on a large scale is challenging to manage, and this difficulty will only increase over the course of time. Before placing sewage sludge in landfills or on agricultural fields, one possible alternative would be to use it to generate electricity first.
- Using a model approach, the authors made an effort to mimic both the creation of green energy from sewage sludge and the process of producing that energy. The electricity produced through anaerobic digestion, gasification, and pyrolysis is 778.26 kWh, 656.31 kWh, and 189.95 kWh, respectively.
- There is a need for additional research to assess the cumulative impacts of the processes considering the net energy, efficiency and economics of the wastewater treatment system with sludge handling.
- The study also contributes to sustainable development goal 7 by generating electricity through waste to energy.

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