Hydrothermal carbonization of digested sludge from wastewater treatment plants: processes, potential and key challenges

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Hydrothermal carbonization of digested sludge from wastewater treatment plants: Processes, potential and key challenges

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ABSTRACT

The presentation reviews hydrothermal carbonization of digested sludge as a complementary technology for sludge management at wastewater treatment plants. The motivation for expanding the knowledge of hydrothermal carbonization is the challenges of wastewater treatment plants: the increasing volume of sludge, high moisture content, the presence of organic and inorganic contaminants, rising disposal costs, and legislative amendments. Hydrothermal carbonization makes it possible to convert wet sludge under conditions (160–250 °C,10–30 bar) into hydrophobic hydrochars, but also liquids and gases, eliminating the need for drying. The process also offers heat recovery and integration into existing wastewater treatment plant infrastructure. A key aspect of implementing hydrothermal carbonization is understanding the impact of individual process parameters and their interactions on chemical reaction pathways, and optimizing operating conditions for specific applications. The presentation discusses two pathways for hydrochar utilization: as soil additives or as fuels in thermal processes, assessing their environmental and legal potential. Process liquids were evaluated as a source of valuable resources that can be recovered or used in situ. Despite the compatibility of hydrothermal carbonization with Green Deal policies, challenges related to energy efficiency, legislative compliance, public acceptance, and high investment costs for integrated thermal technologies still need to be addressed. Overcoming these barriers will enable the implementation of hydrothermal carbonization as a sustainable technology in a circular economy.

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Figures and Tables

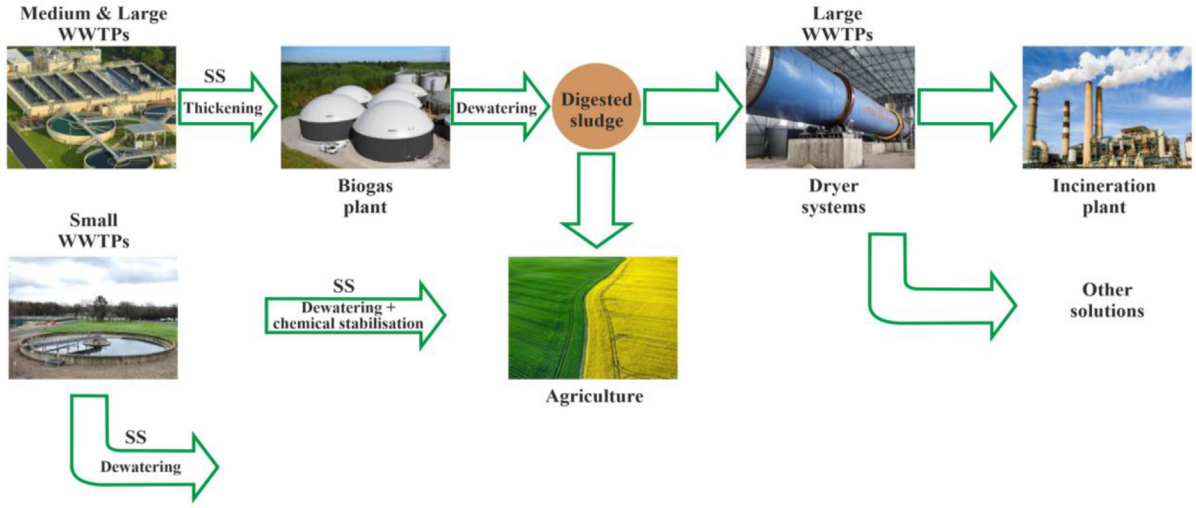

Fig. 1. Sewage Sludge Management System.

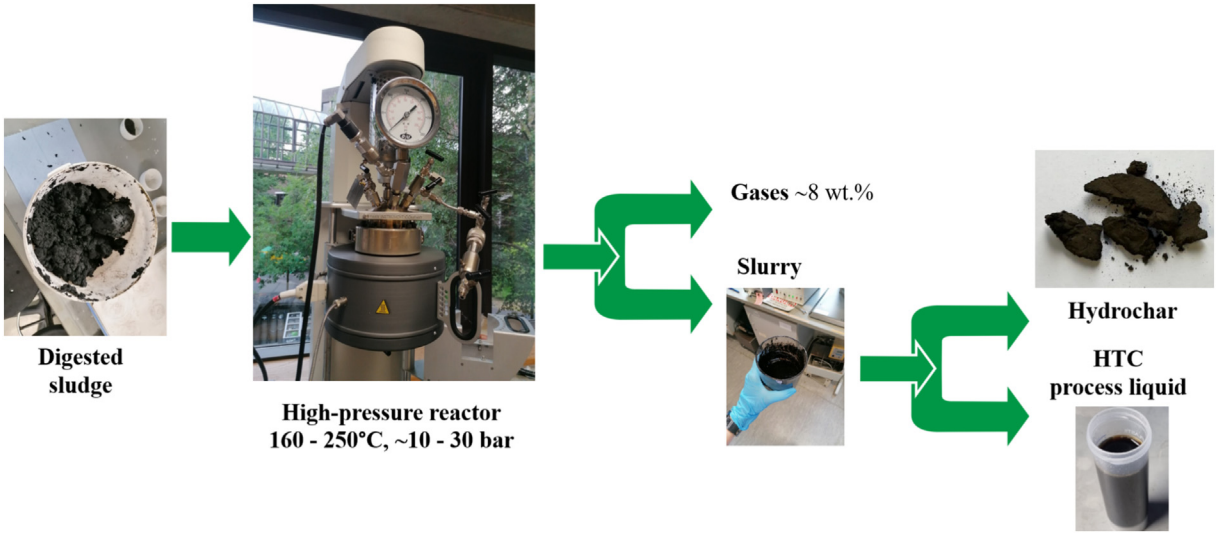

Fig. 2. Hydrothermal carbonization of digested sludge.

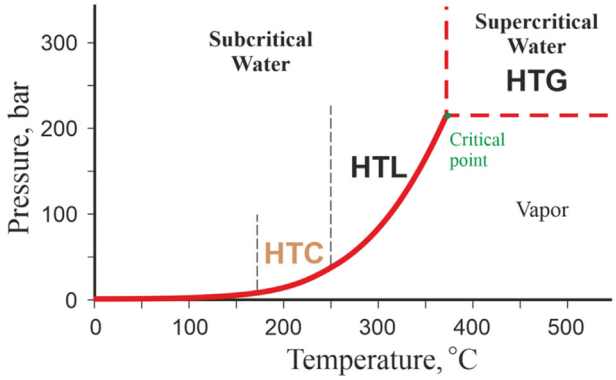

Fig. 3. Phase diagram of water under subcritical and supercritical conditions [1].

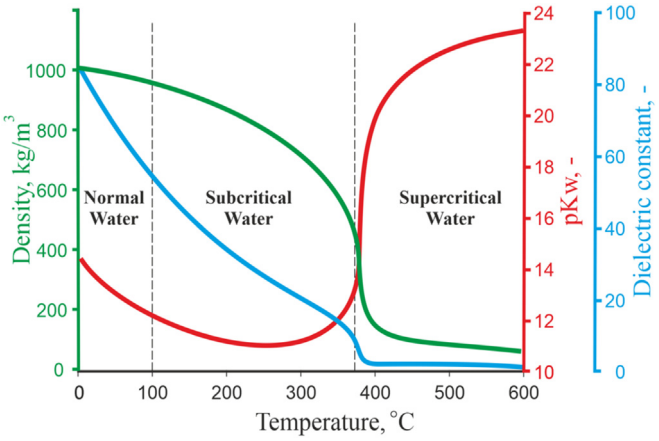

Fig. 4. Dependence of water properties on hydrothermal conditions [2].

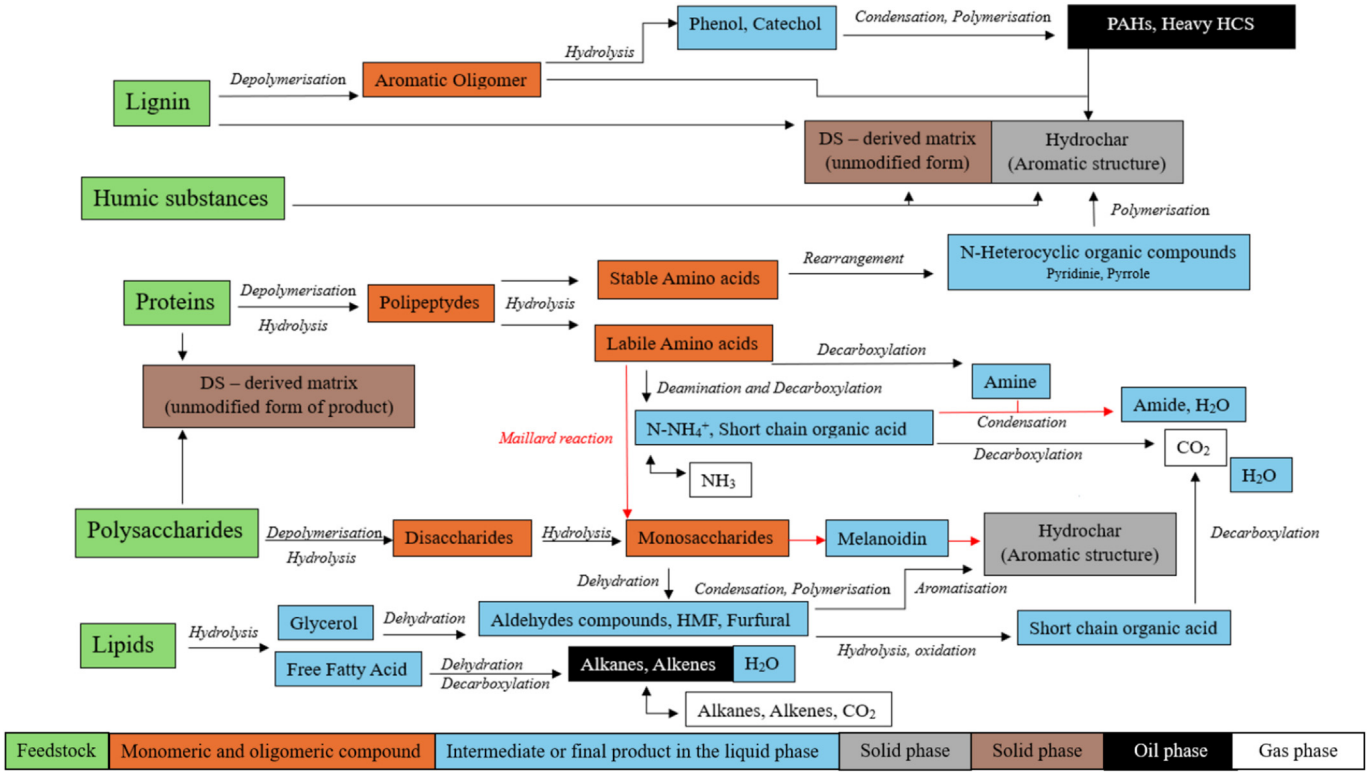

Fig. 5. HTC reaction mechanisms (160–250 °C).

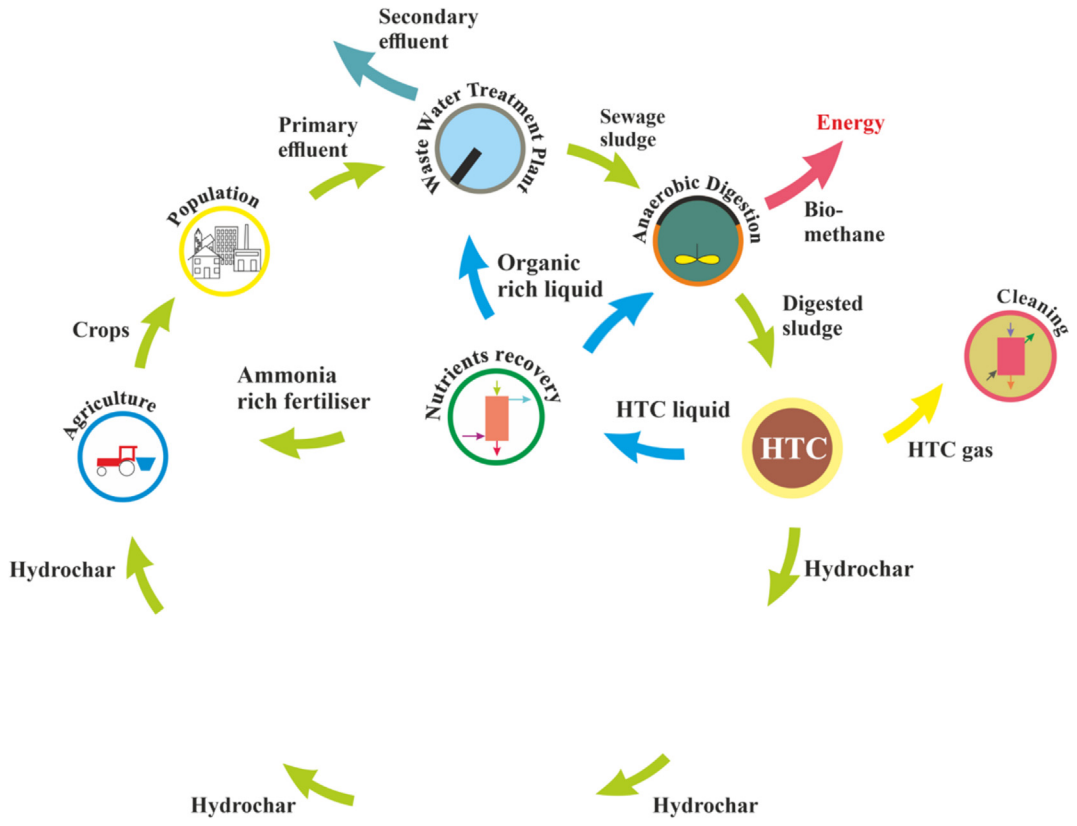

Fig. 6. Scenario 1: Circular economy with HTC process for direct hydrochar use in agriculture.

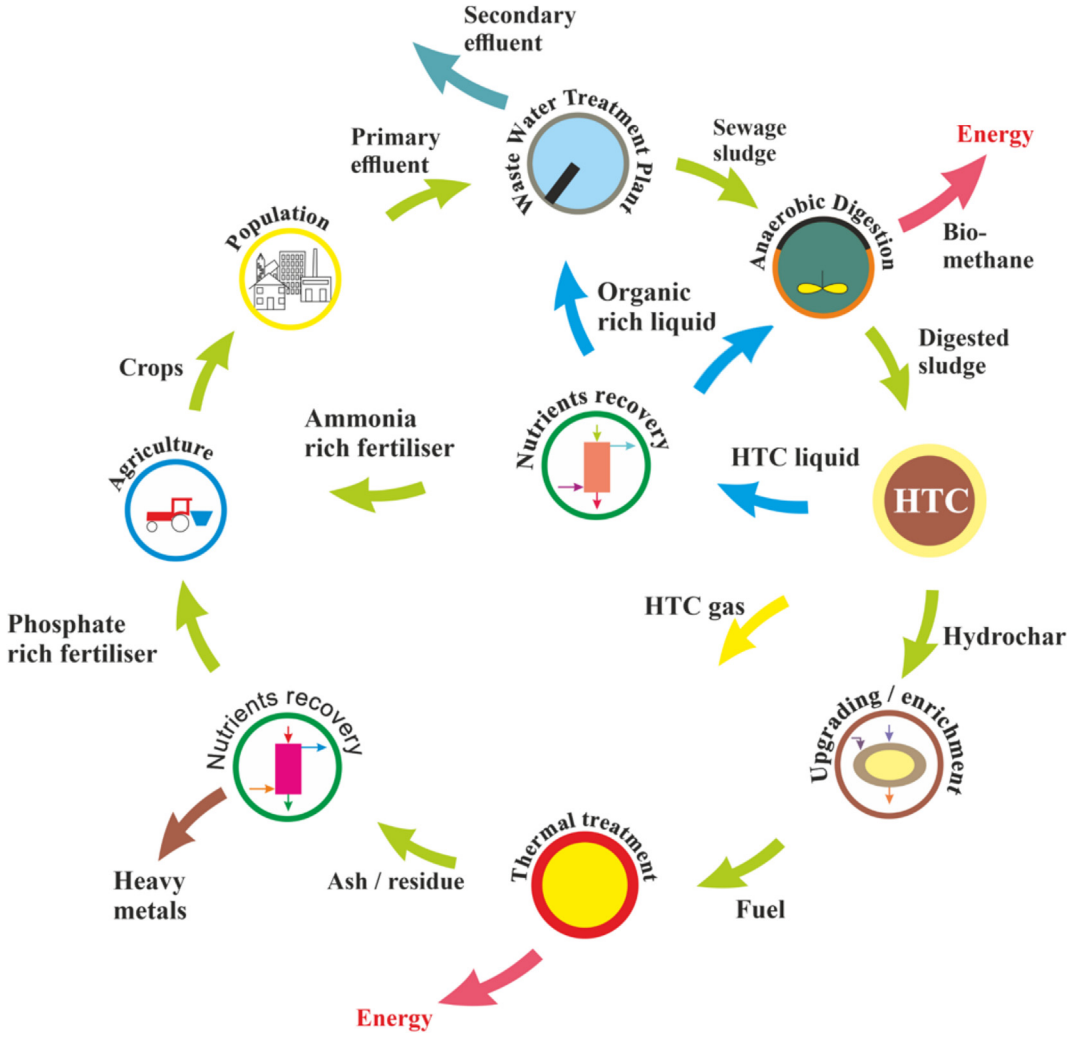

Fig. 7. Scenario 2: Circular economy with HTC process integrated with thermal methods for residue use in agriculture.

CRediT authorship contribution statement

Nina Kossińska: Writing – review & editing, Writing – original draft, Visualization, Validation, Formal analysis, Data curation, Conceptualization. **Renata Krzyżyńska:** Writing – review & editing. **Heba Ghazal:** Writing – review & editing. **Hussam Jouhara:** Writing – review & editing. **Marzena Kwapińska:** Writing – review & editing. **Witold Kwapiński:** Writing – review & editing, Visualization, Validation, Supervision, Conceptualization.

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Declaration of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

No data was used for the research described in the article.

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Further reading

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