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Behavior of Organic Matter in Liquid Phase during Hydrothermal Treatment of Sewage Sludge○Apip AMRULLAH, Yukihiro MATSUMURA *
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ABSTRACT

Hydrothermal treatment (HT) is a promising option for pretreatment of organic waste, due to its low energy consumption and contribution to increasing fuel energy density. HT has been also adopted as an energy effective method for dewatering. In this study, sewage sludge was treated in tubular reactor under hydrothermal condition over temperature range of 130–250 °C under the fixed pressure of 5 MPa, and the final products which were liquid and solid were analyzed. The aim of this study was to investigate the behavior of organic matter in liquid phase during HT of sewage sludge by varying the temperature. The total organic carbon increased with temperature.

[1] Introduction

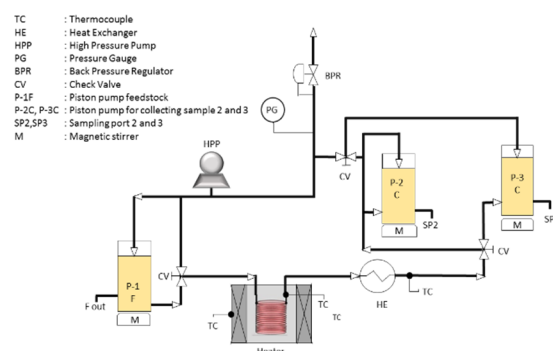
Sewage sludge is a waste product obtained from domestic and industrial wastewater treatment plant. Sewage sludge has drawn much attention due to the ecological problems associated as well as the health hazards to human resulting from their complex heterogeneous mixture of microorganism, undigested organics and heavy metals. With the increasing production of sewage sludge, the disposal methods is also gathering interest.

Various technologies have been employed to convert sewage sludge into beneficial energy sources via pyrolysis and combustion. However, the high drying cost for pyrolysis or combustion is a problem. The hydrothermal treatment (HT) employing high pressure (5 MPa) to convert waste into usable products is an applicable technology to sewage sludge. It has been applied to sewage sludge to improve their dewaterability¹. This fact was confirmed by Haug et al.². They reported biodegradability and dewaterability was increased when thermal treatment was applied. HT will rupture the cell wall and membranes of organic in sewage sludge, and will improve the dewaterability of the sludge at the same time. The solid phase is

always used as a kind of refuse derived fuel or reused for agricultural fertilization after anaerobic digestion. However, the liquid phase, which is rich in dissolved organic compounds has not been studied well. Thereby, the objective of research is to study the behavior of organic matter in liquid phase during HT of sewage sludge.

[2] Experimental

Fig. 1 shows the experimental apparatus employed in this study. The reactor was made of SS316 steel tubing. The length of the reactor was approximately 15.7 m, and the inner diameter was

**Fig. 1** Experimental apparatus

4.35 mm. To start up the experimental setup, the feedstock was placed in the piston pump, and high-pressure water was fed from the other side of the piston (5 MPa). The feedstock slurry in the pump was pushed out of the cylinder, and was delivered to the preheater, then to the reactor. The reaction temperature was controlled with the furnace in the range of 130–250 °C. The reactor effluent was then cooled down by a heat exchanger, and liquid phase was collected. Total organic carbon was analyzed by using a total organic carbon (TOC) analyzer to quantify the amounts of carbon in the liquid product (non-purgeable organic carbon or NPOC) and that in the dissolved gas product (inorganic carbon or IC). The details of experimental conditions are shown in **Table 1**.

Table 1. Experimental conditions

Feedstock	active sludge
Concentration of solid	0.2 wt %
Temperature	130–250 °C
Pressure	5 MPa
Residence time	10 min
Flow rate	20 mL/min

[3] Results and discussion

Fig. 2 shows the TOC change as a function of temperature. The TOC increased with temperature after HT of sewage sludge. The TOC increased dramatically at 180 °C. This result indicated that HT led to modification of sludge characteristic especially for the cell wall. Everett et al.³ determined the destruction of the cell wall during HT releases the content of the cell and insoluble protein are broken down into more

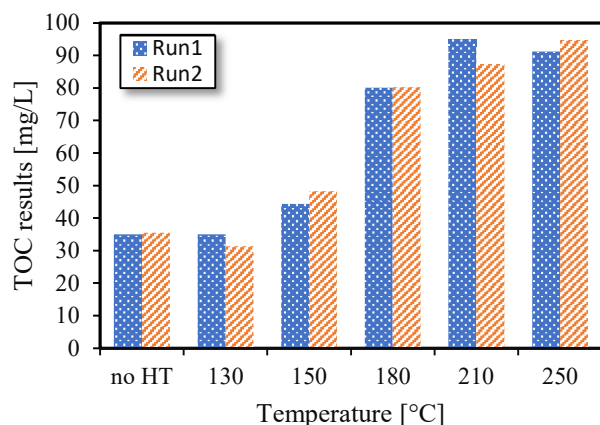


Fig. 2 TOC result for each temperature

soluble compounds (i.e. amino acids). This finding was in turn in agreement with previous work of Imbierowicz et al.,⁴ who reported that the process temperature had a crucial impact on the rate of TOC solid conversion into liquid phase. Around 50–55 % of the initial TOC solid was transferred into the liquid phase.

[4] Conclusions

The HT of sewage sludge in the temperature range of 130–250 °C has been investigated. It was obvious from the result that the organic matter in liquid phase increased with temperature. Temperature was effective in HT of sewage sludge. At 180 °C, the TOC in liquid phase was increased.

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