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# Influences of volatile solid concentration, temperature and solid retention time for the hydrolysis of waste activated sludge to recover volatile fatty acids

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## HIGHLIGHTS

- ▶ Waste activated sludge was fermented at 50 °C, 23.78 gVSS/L and uncontrolled pH.
- ▶ When SRT of reactor was two days, VFA yield was 5699.43 mgCOD/L more than other ways.
- ▶ Iso-valeric acid, acetic acid and *n*-butyric acid were the dominant VFA produced.
- ▶ Long-chain fatty acids were beneficial for forming more PHV in mixed VFA.

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## ABSTRACT

The study evaluated influences of sludge concentration, temperature and solids retention time (SRT) for the hydrolysis of waste activated sludge (WAS) in anaerobic digesters. The results indicated that volatile fatty acids (VFA) production increased when the concentration of mixed liquor volatile suspended solids (MLVSS) was higher. When SRT was 48 h, VFA concentration increased 8.43 times from 4.57 to 23.78 gMLVSS/L. VFA generation was significantly affected with different temperature and SRT. When the temperature changed from 40 to 50 °C, it induced 1.65-fold increase in VFA yield. The optimal SRT was 48 h. As VFA concentration decreased only 1.31 times compared with maximum VFA production at SRT of 120 h. Iso-valeric acid, acetic acid and *n*-butyric acid were the dominant VFA produced and would improve ployhydroxyvalerate proportion in polymer. The feasibility of nitrogen and phosphorus recovery and the risk of metal ion released depended on the nature of WAS.



## 1. Introduction

Anaerobic digestion is employed worldwide as the most important process for sludge stabilization (Metcalf and Eddy Inc., 1991; Mata-Alvarez et al., 2000). The process of anaerobic digestion has four major steps. In the first hydrolysis step, both solubilisation of insoluble particulate matter and biological decomposition of organic polymers to monomers or dimmers take place. Acidogenesis and acetogenesis follow in the second and third step. While in the fourth and final step, methane is produced by methanogenic bacteria (Pavlostathis and Giraldo-Gómez, 1991). Methanogenesis is considered rate-limiting for fermentation of soluble substrates (Gavala et al., 2003), whereas hydrolysis is the first and usually the rate-limiting step in the digestion of solid substrates (Eliosov and Argaman, 1995; Zeeman and Sanders, 2001), since the products are rich in readily biodegradable substances, which are potentially renewable carbon sources, such as volatile fatty acids (VFA), and had been utilized to produce biogas (Guo et al., 2008), generate electricity (Jiang et al., 2009), synthesize polyhydroxyalkanoates (PHA) (Jiang et al., 2009) and been used as preferred external carbon source for nitrogen and phosphorus removal (Tong and Chen, 2009).

The specific operational conditions for acetogenic–methanogenic stages have been extensively studied, however relevant literature on the hydrolytic–acidogenic is still scarce. The factors that affect waste activated sludge (WAS) of hydrolytic–acidogenic stage include operational parameters such as solid content, temperature, solids retention time (SRT) etc. Few studies report that low mixed liquor suspended solids (MLSS) (5–10 g/L) and sometimes synthetic substrates are used for hydrolytic stage (Shana et al., 2002; Yu et al., 2008). There is a lack of knowledge about operation conditions of hydrolytic–acidogenic reactors fed with only WAS with high MLSS and high mixed liquor volatile suspended solids (MLVSS) concentrations.

Temperature is an important control parameter which can be manipulated causing considerable effects on the hydrolytic products. Several studies reported on the effect of temperature on

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