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# Enhancement of anaerobic sludge digestion by high-pressure homogenization

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## HIGHLIGHTS

- ▶ HPH pretreatment improved the organic matter biodegradation.
- ▶ HPH pretreatment promoted the biogas production.
- ▶ HPH pretreatment enhanced the sludge disintegration.
- ▶ Sludge disintegration degree was the key factor to improve anaerobic digestion.

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## ABSTRACT

To improve anaerobic sludge digestion efficiency, the effects of high-pressure homogenization (HPH) conditions on the anaerobic sludge digestion were investigated. The VS and TCOD were significantly removed with the anaerobic digestion, and the VS removal and TCOD removal increased with increasing the homogenization pressure and homogenization cycle number; correspondingly, the accumulative biogas production also increased with increasing the homogenization pressure and homogenization cycle number. The optimal homogenization pressure was 50 MPa for one homogenization cycle and 40 MPa for two homogenization cycles. The SCOD of the sludge supernatant significantly increased with increasing the homogenization pressure and homogenization cycle number due to the sludge disintegration. The relationship between the biogas production and the sludge disintegration showed that the accumulative biogas and methane production were mainly enhanced by the sludge disintegration, which accelerated the anaerobic digestion process and improved the methane content in the biogas.


## 1. Introduction

When the organic pollutants are degraded by microbes in activated sludge process, huge amounts of excess sludge were produced (Zhang et al., 2008). The total sludge amount in EU countries reached 10 million tons dry solids per year (Appels et al., 2008), and the total sludge amount in China was estimated to be about 11.2 million tons dry solids per year and would rapidly increase (Chu et al., 2009). In addition, both the investment and operation costs of the sewage sludge treatment are very high, accounting for 12–30% of the total investment and 20–60% of total operation costs in the WWTPs (Spingosa, 2007; Jin et al., 2009; Mahmood and Elliott, 2006). The sludge treatment has become one of the key problems for the WWTP development.

Different technologies have been developed for efficient sludge reduction and reuse. Anaerobic digestion is an effective technique for the sludge volume reduction, energy-rich biogas generation and pathogenic organisms destruction (Elliott and Mahmood, 2007). The biogas generated by the anaerobic sludge digestion consists of 50–70% methane, 30–40% carbon dioxide and other gases (Osorio and Torres, 2009). Nowadays, the anaerobic sludge digestion has been increasingly developed in the WWTPs, for example, 4 million tons sludge per year can be handled by the anaerobic digestion in more than 120 full-scale WWTPs in Europe (Baere, 2006). The anaerobic sludge digestion is a highly complicated biochemical process (Wang et al., 1990), which can be mainly divided into three stages: hydrolysis, acidogenesis, and methanogenesis (Bougrier et al., 2005). Generally, the hydrolysis is the rate-limiting step in the anaerobic sludge digestion, because the extracellular polymeric substances (EPS) and microbial cells are recalcitrant to the direct hydrolysis. Various pretreatment methods have been studied to improve the anaerobic degradability of the sewage

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