

Two-Phase Mesophilic Anaerobic Digestion of Waste Activated Sludge by Ultrasonic and Alkaline Pretreatment

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Abstract: Based on municipal waste activated sludge (WAS) obtained from Xijiao WWTP (A/O process) in Changchun, the effects of combined pretreatment of ultrasound together with CaO were investigated on subsequent two-phase mesophilic anaerobic digestion. The results indicate that the average volatile solids (VS) reduction is approximately 49.4%, and moisture content of effluent sludge decreases from 97.6% to 93.8% after anaerobic digestion. The sludge flocs are completely broken down in two phases by scanning electron microscopy (SEM) analysis. $\text{NH}_4\text{-N}$ concentrations in two phases are enhanced during anaerobic digestion. However, there exists no significant phosphorus release in two phases.

Key words: mesophilic anaerobic digestion; waste activated sludge (WAS); ultrasonic pretreatment; alkaline pretreatment; two-phase

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Anaerobic digestion is generally used for stabilization of sewage sludge in most wastewater treatment plants (WWTP)^[1]. As for degradation of waste activated sludge (WAS), the rate-limiting stage is the hydrolysis^[2]. Ultrasonic lysis is the most interesting process for improvement of methane generation; sludge degradation by ultrasound has been extensively investigated in the last decade in laboratory and pilot scale^[3]. The alkaline pretreatment can be used to hydrolyze and decompose lipids, hydrocarbon, and protein into soluble substances. It has been reported that disintegration of sludge was enhanced when NaOH together with ultrasound was used^[4]. The specific objective of this study was to investigate effect of combined pretreatment of CaO together with ultrasound on subsequent two-phase anaerobic digestion of WAS.

1 Experiments

The WAS used in test was obtained from Xijiao WWTP in Changchun. The pretreatment of CaO together with ultrasound was used considering probably phosphorus release during anaerobic digestion. The ultra-

sonic energy output was rated at 50W and its frequency was set at 40 kHz. The operation temperature of two-phase system was maintained in $35 \pm 0.5^\circ\text{C}$. The hydraulic retention times (HRTs) of the first and second phases were 4.5 d and 15.75 d respectively.

2 Results and discussion

2.1 VS Variation

Fig. 1 shows that average VS reduction is 16.6% in the acidogenic phase, and is 32.8% in methanogenic phase during anaerobic digestion. Tiehm et al. got the similar removal efficiency (VS reduction = 49.3%, HRT = 16 d) with only ultrasonic treatment. That suggests that the addition of CaO has no significant effect on the VS reduction.

2.2 $\text{NH}_4\text{-N}$ variation of supernatant

Fig. 2 shows that the feeding $\text{NH}_4\text{-N}$ concentration of pretreated WAS is within the range of 12 ~ 83 mg/L. The $\text{NH}_4\text{-N}$ concentration increased to about 170 mg/L in the acidogenic phase because of the pretreatment of CaO. The $\text{NH}_4\text{-N}$ concentration further increased to about 300 mg/L in the methanogenic phase.

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due to relatively high pH

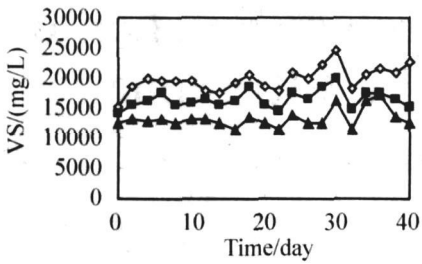


Fig 1 Anaerobic digestion performance of pretreated WAS in two Phases (◇ Feed ■ Acidogenic Phase effluent ▲ Methanogenic Phase effluent)

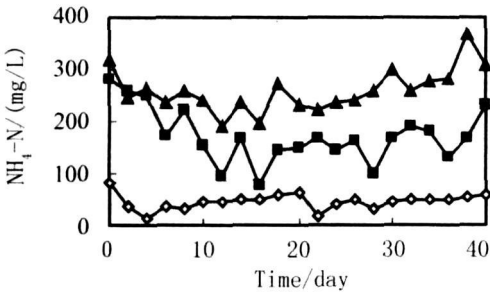


Fig 2 $\text{NH}_4\text{-N}$ variations of supernatant in two Phases (◇ Feed ■ Acidogenic Phase effluent ▲ Methanogenic Phase effluent)

2.3 Structural change during anaerobic digestion

Fig 3 shows that the structural integrity of flocs has almost completely broken down in both photographs. The sludge particles of methanogenic phase are looser than those of acidogenic phase because of the existence of more volatile fatty acids (VFAs).

3 Conclusions

(1) The similar VS reduction efficiency is obtained

as other pretreatment of ultrasound together with NaOH

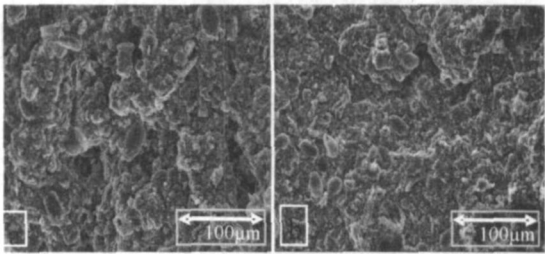


Fig 3 SEM Photographs of treated sludge from acidogenic Phase (a) and methanogenic Phase (b)

(2) The addition of CaO could decrease the phosphorus release to the supernatant mainly for chemical reaction and enhance the degradation of amino acid by ammonia release

(3) Moisture content and sludge flocs of pretreated sludge are also improved after anaerobic digestion

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超声与碱联合预处理剩余污泥中温两相厌氧消化

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摘 要: 以长春西郊污水处理厂 (A/O工艺) 剩余活性污泥为研究对象, 考察了超声与生石灰联合预处理对后续剩余污泥两相中温厌氧消化的影响。结果表明: 联合预处理的剩余污泥经过厌氧消化后, 平均 VS 去除率约为 49.4%, 污泥含水率从 97.6% 降低至 93.8%。SEM 分析表明两相反应器内污泥絮体被充分破坏。厌氧消化过程中在产酸相和产甲烷相内, $\text{NH}_4\text{-N}$ 浓度均有提高, 但是没有出现磷的显著释放。

关键词: 中温; 厌氧消化; 剩余活性污泥; 超声预处理; 碱预处理; 两相

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