Advanced Science and Technology Letters
Vol.69 (Architecture and Civil Engineering 2014), pp.34-38
http://dx.doi.org/10.14257/astl.2014.69.09

Required Energy Reduction for Treatment of Excess Activated Sludge using Ultrasonic Vibration

Jun Soo Ha[1] , Jun Ho Moon[2], Zhenhua Xin[2], Kyo Young Koo[2], Young Uk Kim[2]

[1]Greentech Environmental Consulting Co, Anyang, Korea
[2]Department of Civil and Environmental Engineering, Myongji University, Yongin, Korea
Jun Soo Ha, Jun Ho Moon, Zhenhua Xin, Kyo Young Koo, Young Uk Kim, yukim@mju.ac.kr

Abstract. The goal of this study is to enhance secession ability of adsorbed water in the fine particles of sludge from waste treatment plant using ultrasonic wave energy. Results of the treatment involving reduction in the final sludge cake affect the usage of energy required for sludge combustion. Excess activated sludge before dewatering process was sampled in the local area and the test conditions included application time and power of the ultrasonic energy and types of flocculants to investigate the dewatering behaviors. Capillary suction time(CST) and viscosity of the tested sample were the main indicator for the dewaterbility of the treated sludge. The results of the study show that the ultrasonic treatment decreases the dewaterbility of sludge sample significantly. The degree of the effectiveness, however, varies with the test conditions. Energy and cost reduction caused by the ultrasonic treatment are also discussed in detail.

Keywords: Activated sludge, Adsorbed water, Energy reduction, Flocculants, Secession ability, Ultrasound, Wave energy

1 Introduction

The exhaustion of the natural recourses including petroleum becomes serious and most of the countries use their vigorous efforts to secure available energy. Very lately, traditionally ignored resources such as shale gas and oil sand have gaining popularity as an alternative energy. In addition to developing a new source, intensive studies have been undertaken to focus on energy reduction by the system renovation. Among the various systems using excessive energy consumption, the wastewater treatment plants consume the huge transferring costs and fossil fuel to combust sludge. It is caused by the high water contents of the sludge even after the dewatering process. Therefore, a wide range of researches have been undertaken to reduce the amount of sludge and water content from the waste treatment plant. (Müler, 2001, ; Neyens and Baeyens, 2003) Within the various studies, application of wave treatment to increase secession ability of adsorbed water to the sludge has gain popularity for its eco-friendly physical method. Lyons(1951) showed the effectiveness of ultrasound on settling of activated sludge for the first time. Then various studies (Banks and Walker,

ISSN: 2287-1233 ASTL

1977; Bien et al. 1997; Wang et al. 2006) have performed to enhance the energy efficiency for sludge treatment. Some countries made the technique commercially available usage. However, in Korea there has been a series of various laboratory experiments and it still need a further study involving a field investigation. In this study, we did full scale experiments in a waste treatment plant using a huge ultrasound processor. The research examined the effect of ultrasonic wave energy on enhancing dewaterbility of activated surplus sludge produced in the waste treatment plants. After applying the technique, the energy for combustion and cost reduction were discussed in detail.

2 Full Scale Experimental Study

This study was undertaken to investigate the effect of ultrasound on dewaterbility of activated surplus sludge that is obtained from a waste treatment plant near Seoul area. The final goal of the study was the physical behaviors of the treated sludge. The physical properties of the sludge with the wave treatment were viscosity, characteristics of the dewaterbility, and flocculated particles. CST (capillary suction time) indicates the dewaterbility of sludge and the time required for water separated from sludge to travel a certain distance through a filter paper(Watman 17CHR). As the dewaterbility of sludge increases, CST decreases. Experiments were conducted with and without the application of ultrasonic energy. Bath type processors (7 liter and 7 ton) in conjunction with a 28 kHz frequency were used. Test programs for the study is summarized in Table 1.

Table 1. Test Program

Measuring Factors		Test Condition(Ultrasound) Application Time (min)	Output power (% of 680kW)	Treating bath Volume
Viscosity		10, 20, 30, 60, 90, 120	10, 20, 30, 50, 60, 90, 100	7L
CST	Without Flocculants			7L, 7ton
	With Flocculants			7L, 7ton

3 Results and Discussion

It should note that the results of these experiments are a function of not only the power of ultrasound, but also the irradiation times and the volume of the sample to be treated. Therefore, the applied ultrasonic energy level per volume of sludge sample could be expressed in terms of the specific supplied energy parameter. Fig.1 shows the viscosity changes with the specific supplied energy. As shown, ultrasound begins to affect the viscosity of the sample right after sonication. However, over 700, the

effect of ultrasonic energy on viscosity reduction seems to be insignificant. It might be used as a operational factor in the field application.

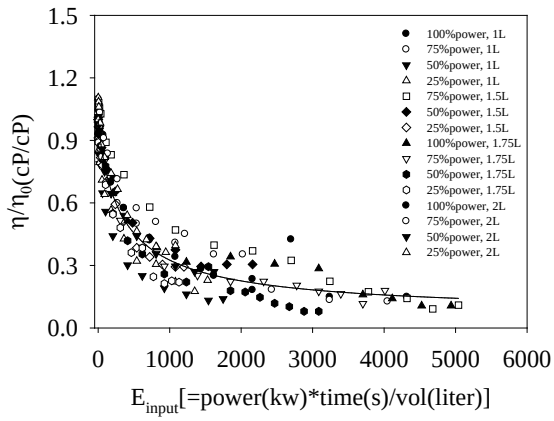

Fig. 1. Viscosity Reduction with Input Energy

Fig 2. illustrates the reduction of CST with various concentration of flocculants and time. It shows that the concentration of the flocculants influence the coagulation of fine particles significantly. It is observed that 0.1% of the flocculants concentration shows optimum coagulation.

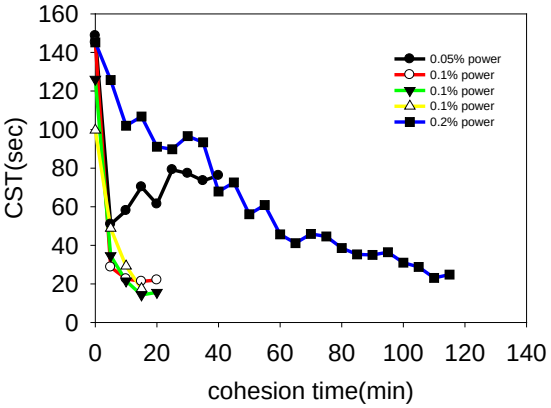

Fig. 2. Flocculating Time Variation with concentration

To draw the optimum treatment condition, various range of concentration of flocculants and time and power of the ultrasonic application were applied to the test program as shown in Table 1. The results of the experiments were presented in Fig. 3.

It shows a maximum reduction of CST around 60% of Ultrasonic power, 10 min. of application, and 0.15% of flocculent concentration. The original CST of the untreated sludge was about 30. From the results of the experiments, a reduction of the energy usage for dewatering sludge can be deducted.

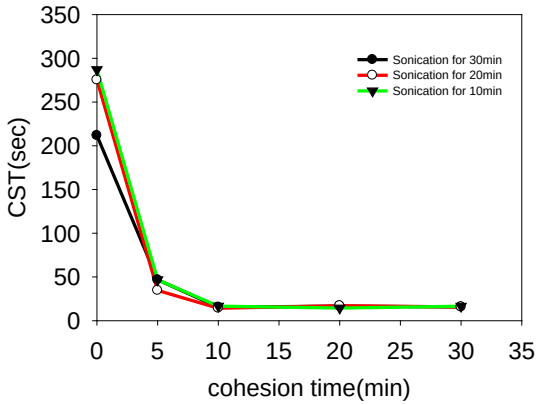

Fig. 3. CST with Ultrasonic Treatment

Based aforementioned results, operational costs reduction for the waste treatment plant can be calculated as the following. Operational cost for the control data was obtained the same plant from which the sludge sample collected.

Before:
▶ Dewatering sludge 50ton/day(Solid 1.5%), CST 20-40sec, Water contents 80%
▶ Sludge cake; 1,350 ton/year(113 ton/month) : 78mL/kg fuel for combustion

After:
▶ CST 30sec below, Goal water content 75%
▶ Sludge cake 1,080 ton/year(90 ton/month) : 20% reduction
▶ 48mL/kg fuel for combustion (38% cost reduction)

4 Conclusion

This study is undertaken to increase secession ability of adsorbed water in the fine particles of sludge from waste treatment plant using ultrasonic wave energy. The goal the pre-treatment includes a reduction in the final sludge cake and water content resulting in a decrease of energy required for sludge combustion. Excess sludge was obtained in the local area and the test conditions included application time and power of the ultrasonic energy and types of flocculants. Capillary suction time(CST) and viscosity of the treated sludge were measured. The results of the study show that the

ultrasonic treatment decreases the dewaterbility of sludge sample significantly. The degree of the effectiveness, however, varies with the test conditions. Based upon the results of the tests, operational cost reduction caused by the ultrasonic treatment was also discussed in detail. Further studies are warranted to reduce the use of fuel and develop an eco-friendly pre-treatment methodology.

Acknowledgments. This study was supported by the Next Generation Eco Innovation (research) enterprise fund from The Korea Environmental Industry & Technology Institute.

References

1. Banks, C. J. and Walker, I. (1977), Sonication of Activated Sludge Flocs and the Recovery of their Bacteria on Solid Media, Journal of General Microbiology, Vol.98, pp. 363-368.
2. Bien, J. B., Kempa, E. S. and Bien, J. D. (1997), Influence of ultrasonic field on structure and parameters of sewage sludge for dewatering process, Water Science and Technology, Vol. 36, No.4, pp. 287-291.
3. Lyons, W. A. (1951), The effect of ultrasonics on suspended matter in sewage, Sewage Industry Waste, Vol. 23, No.9, pp. 1084.
4. Müller, J. A. (2003), Prospects and problems of sludge pre-treatment processes, Water Science and Technology, Vol. 44, No. 10, pp. 51-67.
5. Neyens, E. and Baeyens, J. (2003), A review of thermal sludge pre-treatment processes to improve dewaterability, Journal of Hazardous Materials, Vol. 98, No. 1, pp.51-67.
6. Wang, F., Ji, M. and Lu, S. (2001), Influence of Ultrasonic Disintegration on the Dewaterability of Waste Activated Sludge Environmental Progress, American Institute of Chemical Engineers, Vol.25, No.3, pp. 257-260.

