A study on effect of cavitation on biogas production

H. J. Son[1], B. C. Koo[2], H. S. Kim[1], S. Y. Na[1] and J. Y. Yoon[3*]

[1]Department of Mechanical Design Engineering, University of Hanyang, Seoul, Republic of Korea
[2]School of Mechanical Engineering, University of Hanyang, Seoul, Republic of Korea
[3]Department of Mechanical Engineering, University of Hanyang, Ansan, Republic of Korea

[*]Corresponding author: joyoon@hanyang.ac.kr

1. Abstract

The present work will deal with the effect of cavitation induced by hydrodynamic cavitation on the biogas production. In this study, all experiment will be performed with tap water containing waste activated sludge and cavitation will be generated by hydrodynamic cavitation reactor, which it is a stator and rotor assembly cavitation reactor. Firstly, cavitation intensity will be estimated by changing inlet pressure and rotation speed. After the estimation of cavitation intensity, waste activated sludge will be treated with hydrodynamic cavitation. Total pretreatment time will be 15 min and sample of each cases will be drawn after pretreatment. Energy efficiency and biogas production from sample will be estimated and the result will be presented. Also, effect of cavitation will be analyzed from the result.

2. Introduction

By industrial development since 18th century, energy consumption has increased, thereby, we will be faced with oil depletion in the future. Also, such as GHGs (Greenhouse Gases) emission or fine dust in South Korea and China, environmental problems have induced people`s health problems. Many researchers have been trying to solve the problem. one of them is the biomass like lingocellulosic biomass and sewage sludge. Biogas is an alternative and renewable fuel that can produce power that need to live or move the world and it can be produced by anaerobic digestion(AD). AD is not only a biological method which converts biomass into biogas under anaerobic condition by microorganisms but also an environment-friendly, such as reducing GHGs emission, and economic method to produce energy, but there is limit with process time due to the structural and chemical property of organic material [3-5]. During decades, many researchers have been studying methods to intensify the biogas production and it have been reported. Among the pretreatment methods, pretreatment method using cavitation may be referred to as a promising method to intensify the biogas production.

When the local pressure in flow systems is lower than vapor pressure, cavities or micro bubbles are generated and then they collapse violently in the liquid. This phenomenon is called cavitation. When the cavities collapse, it is known that large magnitude of energy is released and high oxidizing substance(-OH) is generated in the liquid. Because of physical and chemical advantages, cavitation is widely used in various industry fields, but it is not fully understood. Normally, Cavitation is divided into two sorts, acoustic cavitation induced by ultrasound wave through the liquid and hydrodynamic cavitation induced by changing flow system such as geometry change. In comparison with acoustic cavitation, it is known that Hydrodynamic cavitation has advantage about scale-up. Hence, hydrodynamic cavitation is widely used for full-scale plant. In this work, hydrodynamic cavitation will be dealt with for investigation.

Cavitation has a variety of advantage. Hence, many researchers have studied on cavitation to apply to industry field. T. Tuziuti et al. [1] estimated volume of cavity by laser-light scattering and showed that light scattering intensity is related to the size and number of micro bubbles. Pengfei Wu et al. [2] studied on the mechanism of cavitation by image analysis. They evaluated the cavitation state variable(CSV), it means the ratio of volume occupied by micro bubbles to control volume, using high speed camera and compared the result of image analysis with cavitation induced noise estimated by hydrophone. They showed that it can be used to describe the characteristics of cavitation.

There is a lot of research about cavitation but it is not fully understood. In this work, we will study on cavitation intensity to intensify the biogas production.

3. Experiment

A stator and rotor assembly cavitation reactor and experimental design is same with reference [7]. Fig.1 presents design of the cavitation reactor. there are equidistant 32 dimples, which is con-shaped dimple with diameter of 10mm and depth of 4.5mm, located 122mm from center of the rotor. When the fluid pass through the dimples rotating with rotor, pressure fluctuation is generated due to the high turbulence intensity, as a result, cavitation can be generated in the dimples.

Experiment will be done by open-loop Experimental set up and Fig.2 present the schematic of the experimental set up.

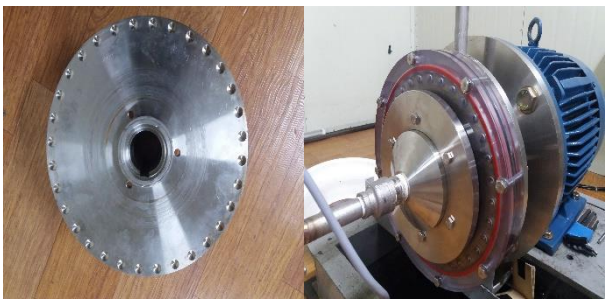
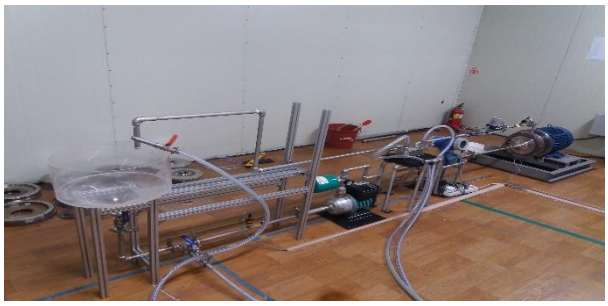


Fig. 1 Design of rotor and cavitation reactor.



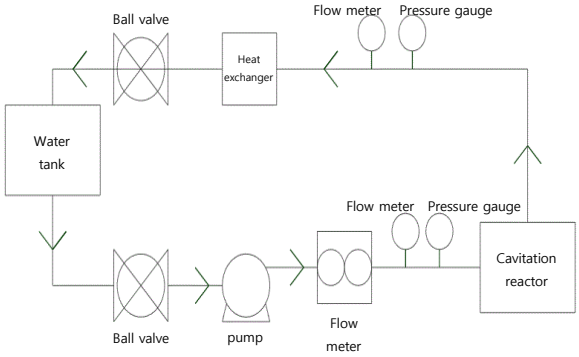


Fig. 2 Schematic diagram of the experimental set up

4. conclusion

Application of cavitation is useful, but cavitation is not fully understood, therefore, many studies on cavitation have been doing. In bioenergy field, limit with process time due to material property exists. To intensify the biogas production, waste activated sludge will be treated with stator and rotor assembly hydrodynamic cavitation reactor and we will present the effect of cavitation on biogas production.

Acknowledgment

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