

Microbubble Generator (MBG) as Aeration System in *Techno Park* Retention Basin

Tri Yulianti^{1*}, Sri Puji Saraswati², Johan Syafri Mahathir Ahmad³

¹ Magister of Water and Wastewater Management, Department of Civil and Environmental Engineering, Engineering Faculty, Gadjah Mada University, Jalan Grafika No. 2 Yogyakarta

^{2,3} Department of Civil and Environmental Engineering, Engineering Faculty, Gadjah Mada University, Jalan Grafika No. 2 Yogyakarta, Indonesia

*Correspondent Email: triyulianti@mail.ugm.ac.id

Abstract

The *Techno Park* retention basin at the Faculty of Engineering Gadjah Mada University was built for the purposes of controlling the flooding into Code river and for improving the water quality. The water entering the basin, especially in the dry season, is characterized as greywater due to the dense settlements around the university. Dissolved Oxygen (DO) is one parameter determining how well aerobic bacteria to break down organic or nutrient loads in polluted water bodies. The purpose of this study was to determine the effectiveness of reaeration process using a Microbubble Generator (MBG) for increasing DO, with the final aim of an improved water quality. An MBG aerator, with submersible pumps and a horizontal MBG was installed at a depth of 40 cm from the water surface in the middle of the pond. The aerator was set permanently running. In situ monitoring of DO was carried out using a Seri Lutron WA-2017SD DO meter. DO measurement samples were taken radially around the aerator at every 60°, and at arange of distances of 0.5 m, 2 m, and 5 m from the aerator. Measurements were carried out for 6 consecutive days. The increasing DO correlated with the changes of the surrounding weather which had an effect on water and air temperature. At the time of DO data collection, the change in DO measured at the inlet and outlet of the reservoir was in the range 0.3 - 1.1 mg/L, with the DO directly surrounding the aerator reaching up to 2.4 mg/L from the basin inlet.

Keywords: Reaeration, Microbubble Generator (MBG), Domestic Wastewater, DO Concentration

1. Introduction

The *Techno Park* retention basin is located at Faculty of Engineering Gadjah Mada University situated adjacent to the Code river. It functions as a flood control when high rainfall run into the Code river, but also acts to improve water quality. In addition, during the dry season the basin also functions as a storage for grey water from domestic wastewater. The water flow through the drainage channel is low during the dry season. The drainage filled by domestic wastewater results from the dense settlement around the channel that flows into the basin (Figure 1a). The characteristics of domestic wastewater consist of; organic loads such as food waste from washing kitchen utensils, phosphate from the use of detergent or soap, and nitrogen from human or animal waste. These cause the water entering the reservoir to become turbid and foul smelling. Disposal of organic waste has a the detrimental effect of significantly decreasing dissolved oxygen (DO) levels. One of the causes of the decrease in DO concentration is the oxygen consumption by aerobic microorganisms when breaking down the organic load. DO in this case would drop sharply and, when there is no reaeration, can ultimately create anoxic to anaerobic conditions resulting in odor from methane or H₂S.

The main factor influencing the biological purification process of the water is the availability of oxygen transfer/aeration process which can take place through a variety of natural processes, such as flow patterns or wind gusts on the water so that it increases air contact with water, or through reaeration which break down organic loads and nutrients in water. In some conditions, with a serious pollution load, the process of decomposition of organic waste by aerobic bacteria

can decrease dramatically or even no longer work, and then time and a long flow is required to re-purify. The slow nature of this is the reason an additional external effort is required [1]. One way of doing this is to reaerate similar to natural processes, namely the reaeration process as a method to increase DO concentrations in water, thus allowing the biological oxidation process by microorganisms to run effectively. An aerator is used to carry out the reaeration process such as a Microbubble Generator (MBG) which is what was used in this research. MBG is type of air diffuser aerator which has advantages compared to other types. Microbubbles of oxygen or air remain longer in the water due to the small surface friction that pushes the bubble upward, so allowing more of the bubble to burst before reaching the water surface [3; 4]. The DO concentrations is an important

2. Research Method

The MBG installed in the basin was an orifice type (Figure 1c) which was developed by Deendarlianto, et al. (2015) [2]. The aerator contains 3 horizontal MBG's nozzle, has dispersers spaced 60° apart, and is placed at a depth of 40 cm from the surface of the water. The MBG is placed in the middle of the first floating box (Figure 1b) with coordinates 7°45 '59.56 "S 110°22 '28.13" E.

The DO data collection was carried out for 7 days divided into 2 periods. Period 1 was 3 consecutive days after the MBG had been operating for 24 hours. Then period 2 was begun after then MBG had been operating for 3 days and was a set of DO measurements taken on for 4 consecutive days. There

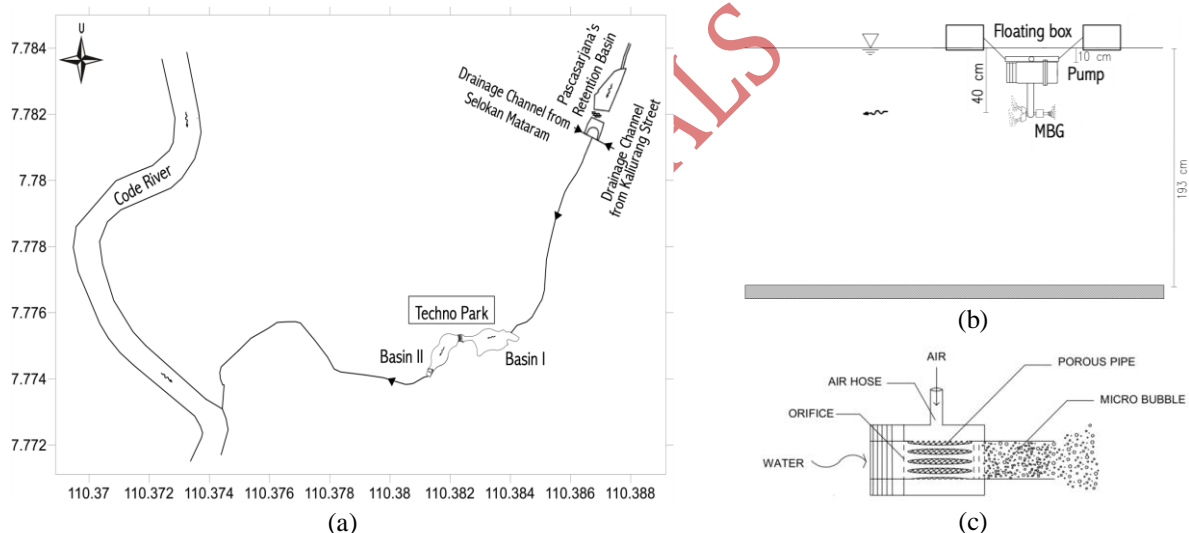
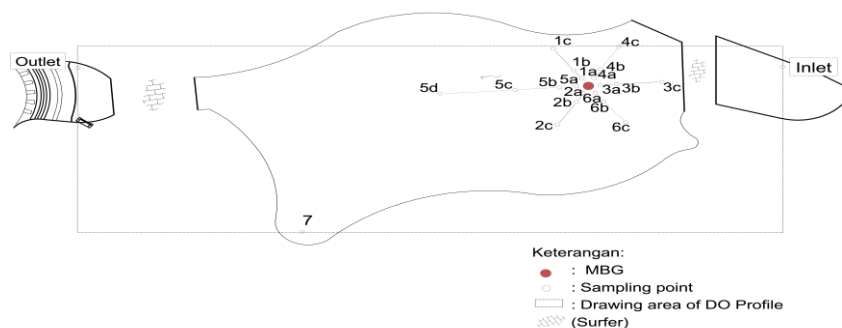


Figure 1. (a) In line water resources that enter the Techno Park retention basin and flow into the Code river; (b) MBG installation in the basin I; and (c) the form of the installed MBG



parameter in this study as the measurement determines the effectiveness of MBG in improving water quality for organic loads that enter the reservoir.

was an interval of 19 days between period I and period II due to technical problem in the field. DO measurements were taken once a day and at the same

time each day to attempt the effectiveness of the MBG aerator treatment, and to measure the rate at which water quality improved. Sampling points for DO measurements were at distances of 0.5 m; 2 m and 5 m from the nozzle location, at the inlet and outlet of the basin (figure 2).

Retrieval of DO data is done *in situ* using the DO meter series Lutron WA-2017SD. DO data is taken by

then analyzed using Surfer software to see the distribution of DO concentration in the water during the reaeration process.

3. Research Results and Discussion

3.1 DO Distribution in Period 1

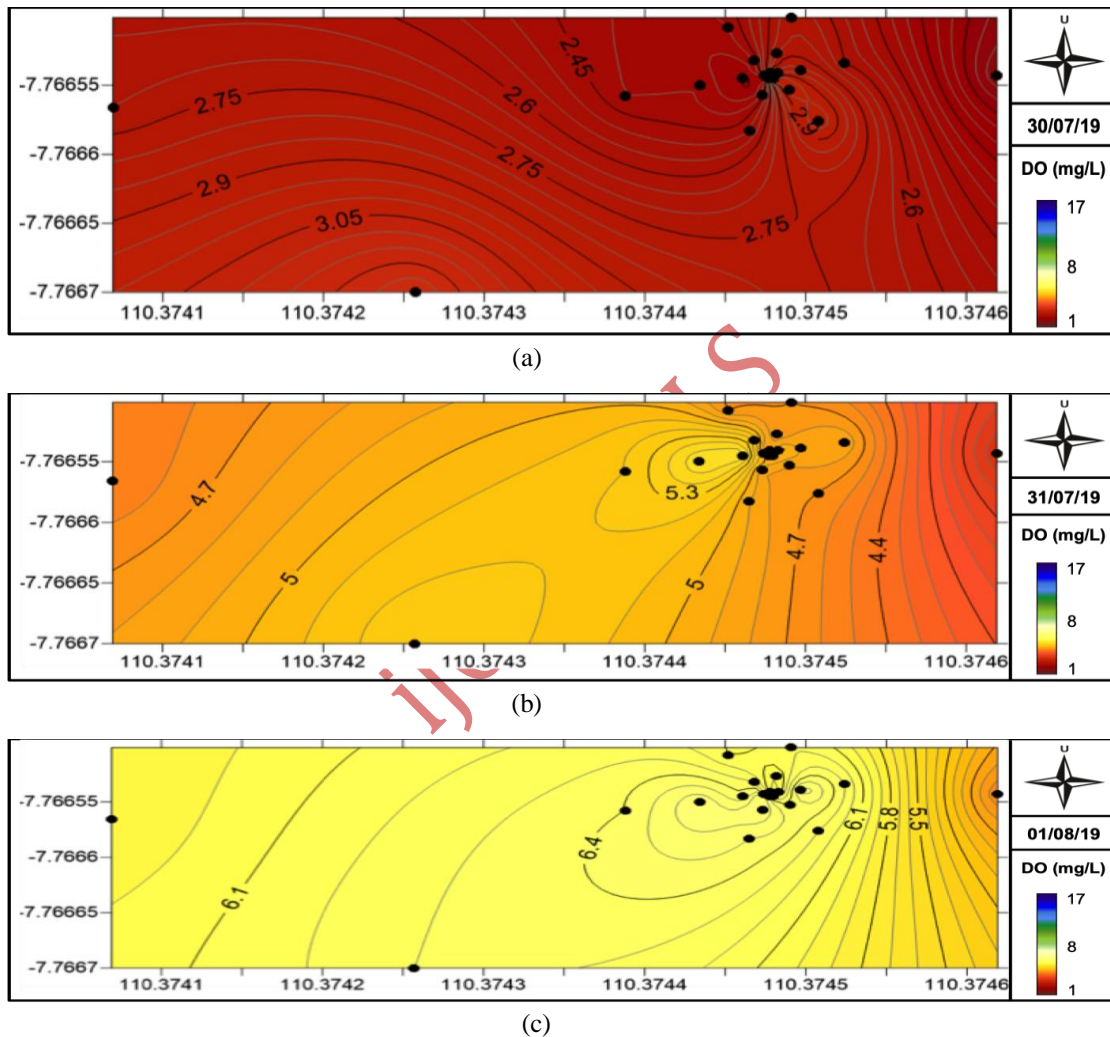


Figure 3. Distribution of DO during period 1 (a) first day; (b) second day; and (c) the third day

logger for 3 minutes at each sample point. DO data is

The MBG aerator was turned on the day after the basin has been drained and cleaned from sediment. DO measurements were first started after the aerator has been operating for 24 hours, And data retrieval is done within 24 hours. During the first 24 hours, the measured DO was between 2.3 - 3 mg/L in the range

which was 5.9 mg/L (Figure 3).

Vertical DO measurements in the water showed a decrease in the DO concentrations with increasing water depth. The depth of the reservoir in the center of basin was 1.93 m. As the DO on the water surface increased on the second day, at approximately 20 cm

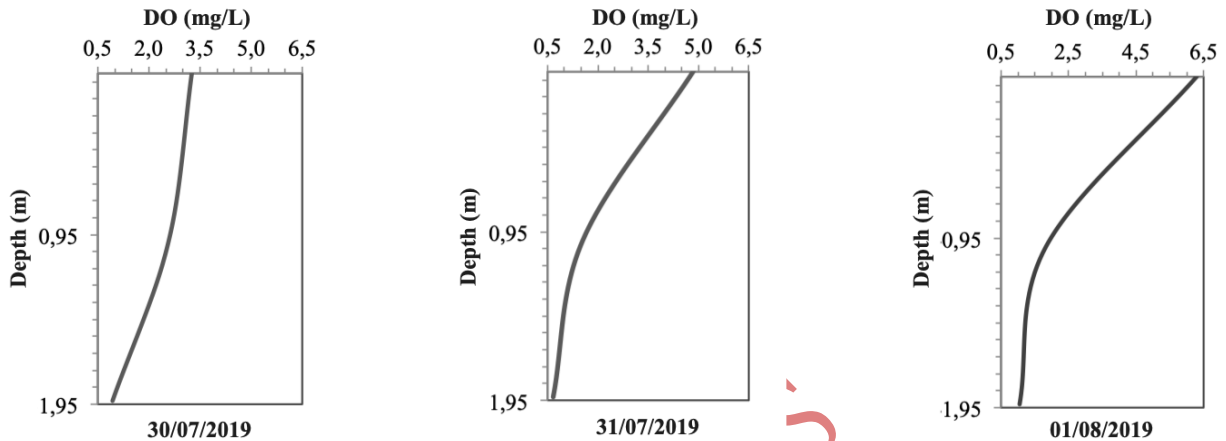
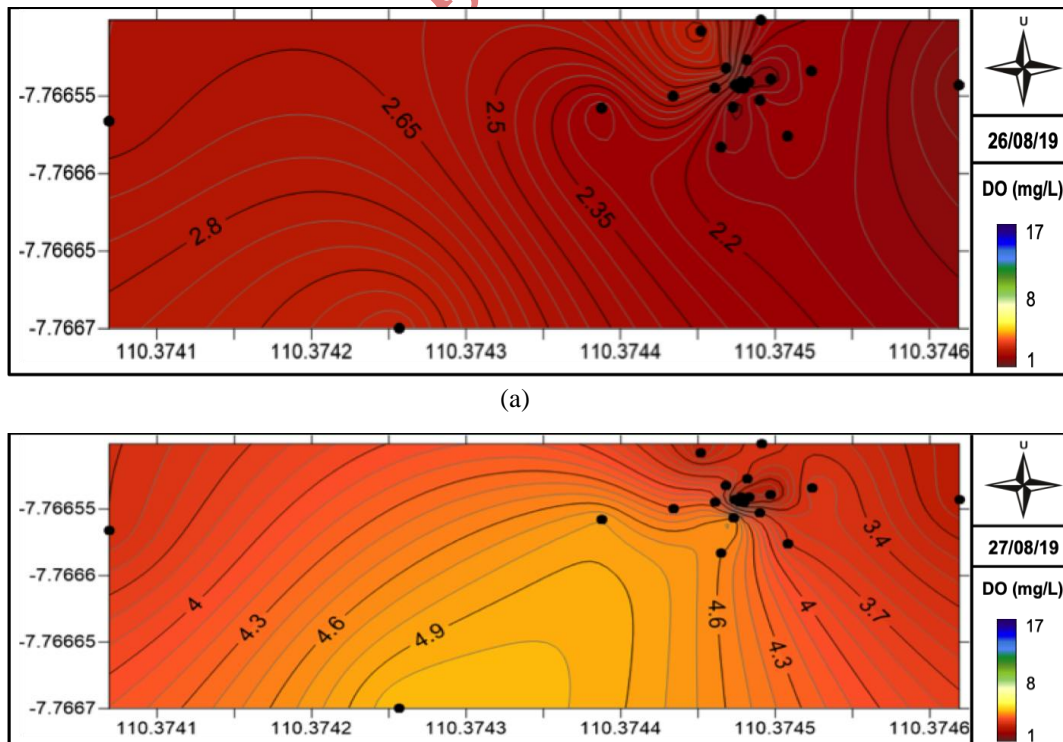


Figure 4 Stratification of the DO measured in the depth

of 5 m around the aerator. The increase in DO occurred for 3 consecutive days of measurement. On the second day, the DO concentration measured in the ranged of 4.5 - 5.6 mg/L, while on the third day the DO measurements were between 5.8 - 6.7 mg/L with DO at the inlet of the 4.6 mg/L. However, the increased DO was not only around the aerator but also at the outlet

below the nozzle (installed at a depth of 40 cm from the surface of water) a slight increase was still apparent. Down to a depth of about 60 cm from the surface of the water, the DO concentration were changing, but below that, from the depth of 60 cm to the bottom of the basin, they then remained approximately constant. It measured under conditions of



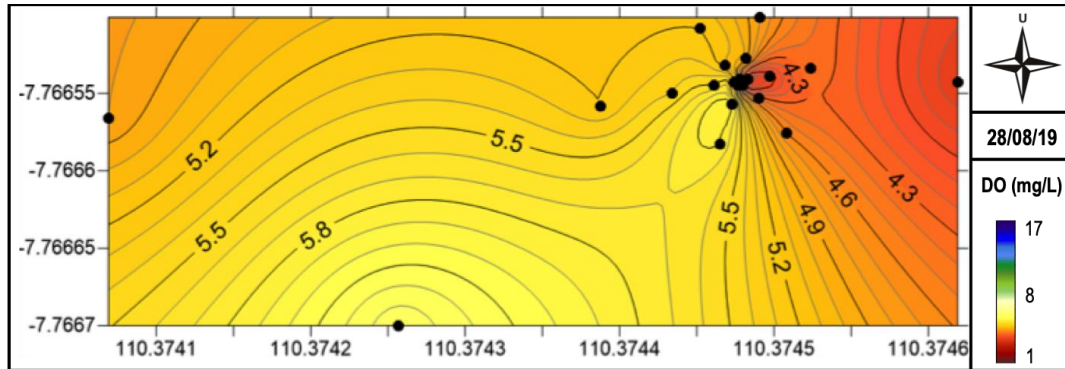
(a)

2 mg/L (Figure 4).

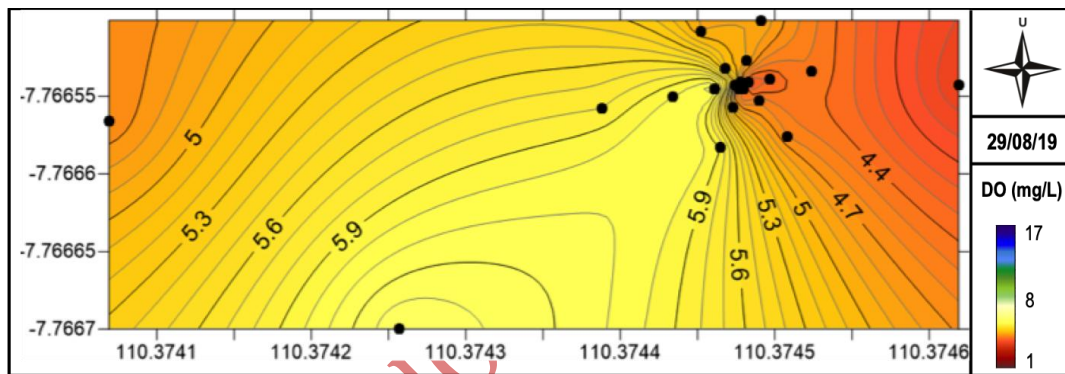
3.2 DO Distribution in Period 2

The measurement during the second period was carried

During the first 4 days, the measured DO concentration at a range of 5 m from the aerator was between 2 - 2.8 mg/L. DO measurements on the second day ranged from 2.6 to 4.8 mg/L, and on the third day DO



(c)



(d)

Figure 5. Measurements of DO during Period 2: (a) 4th day; (b) 5th day; (c) 6th day; and (d) 7th day

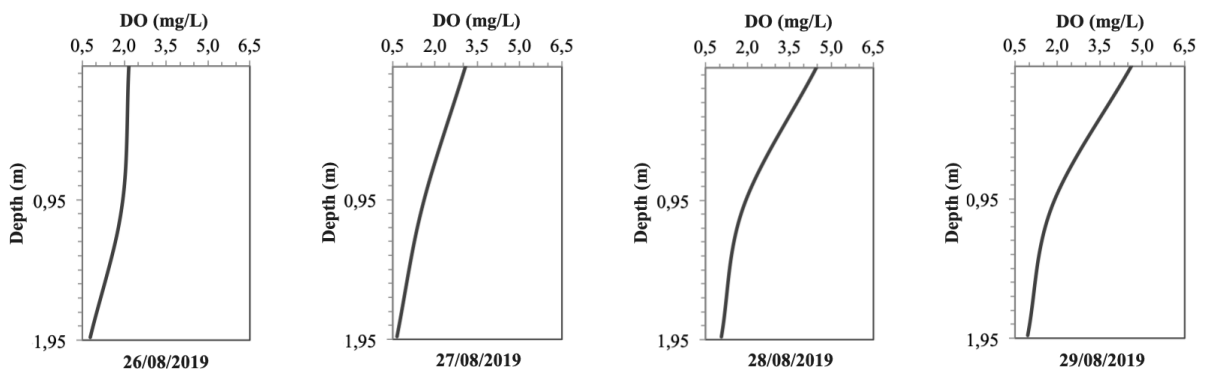


Figure 6 Stratified DO on the period 2

out at later date. There because of maintenance work being carried out on the basin and also a field survey by the government concerning change and repair of drainage channels flowing into the basin. To align with the measurements from Period 1, the Period 2 measurements started on the 4th day after the MBG's operation had been started (Figure 5).

measurements were between 4 - 5.9 mg/L. From these measurements, it can be concluded that the use of the MBG was able to gradually increase DO concentration.

3.3 DO Changes in the Inlet and Outlet of the Techno Park Basin

The results of DO measurements, when Periods 1 and 2 were combined to give a series over 7 days, showed an unexpected stepped structure (Figure 7). This was thought to be because the reservoir is in the open, and so the measurements were very dependent on variations of ambient weather.

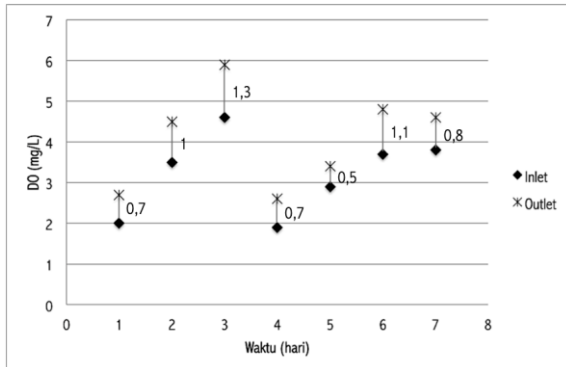


Figure 7. DO concentration

On the first day, the difference between the DO as measured at the inlet and outlets of the basin was $\Delta_{DO} = 0.7$ mg/L, whilst on the second and third days this difference increased to 1 mg/L and 1.3 mg/L. On the third day, there was still an increase of DO. While the DO concentration was reduced on the fourth day (period 2).

4. Conclusions

The use of Microbubble Generator (MBG) aerator as one of the efforts to improve water quality with aeration system showed an increase in the DO concentration of the Techno Park basin. The changes in the DO concentrations were greatly affected by the weather conditions in the field, especially air temperatures which were correlated to daily water temperatures. At the time of data collection, the change in the measured DO increased the inlet and outlet of the reservoir between 0.3 - 1.1 mg/L.

Acknowledgment

This research was supported by the Chemical Engineering Department of the Faculty of Engineering Gadjah Mada University in the procurement of MBG aerators and the licensing of the Faculty of Engineering in conducting research at the Techno Park basin.

References

- [1] Bhargava, D.S., *Simplified DO Sag Models for Rapid BOD Removal*, Environmentalist, 29, (2009) 87 - 100.
- [2] Deendarlianto, Budhijanto, W., Alva, E. T., Indarto, Anggita, G. W. I., *The Implementation of a Developed Microbubble Generator on The Aerobic Wastewater Treatment*, International Journal of Technology, 6, (2015) 924-930. DOI:10.14716/ijtech.v6i6.1696
- [3] Parmar, R. & Majumder, S. K. 2013. *Microbubble Generation and Microbubble-Aided Transport Process Intensification – a-State-of-the-Art-Report*. Chemical Engineering and Processing, 64:79-97.
- [4] Tamura, I., Uehara, I., & Adachi, K., *Developing a Micro-bubble Generator and Practical System for Purifying Contaminated Water*, Studies in Science and Technology, 3, 1, (2014) 87-90.