Effect of EM Ball on DO, BOD and COD of Wastewater Treatment Plant in Bangkokthonburi University, Thailand

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***Abstract*—** The main objective of this work was to treat wastewater by EM ball from wastewater treatment plant of Bangkokthonburi University. The water samples were collected with the composite sampling type. The experiments were divided into three sets: Set A was the experiments with adding aeration, but do not adding EM ball. Set B was the addition of EM ball from our laboratory, but do not adding aeration. And set C was the addition of commercial EM ball, but do not adding aeration. Water samples from each treatment both before and after treatment for 4 weeks were analyzed. The physical properties and water quality parameters were measured in Do, BOD, and COD. The results showed that all treatments were affected in the treatment of wastewater from wastewater plant. When compared with before treatment found that DO was increased for 16.44% of treatments A, and reduced for 48.82% and 51.75% in the experimental set B and C, respectively. The effective on BOD was reduced for 60.19%, 61.89% and 52.08% in the experimental set A, B and C, respectively. And the effective on the COD was decreased for 97.35%, 74.02% and 61.18% in the experimental set A, B and C, respectively. All conditions were compared with measuring value before treatment. Therefore, EM ball had efficient on treatment wastewater from wastewater plant of Bangkokthonburi University. The wastewater was treated with set A had parameter value better than set B and C for all parameters, except the BOD parameter. The BOD of set B had the value better than set A and C. However, the results show that EM ball from our laboratory had value better than commercial EM balls in all parameters.

***Keywords*—**EM ball, Biological process wastewater treatment DO, BOD, COD

I. Introduction

Natural resources are important for human life and all living things, because it is habitat and food sources. Water is one of main natural resources for human life such as

used for drinking and consuming, the transporting, agricultural, and industrial. Moreover, the water used as the place for supporting many waste from human activities. These are causes of destroying water quality and wastewater problem occurred. It is a source of disease and bacteria that are harmful to humans. It can be seen that the water that is essential and very important. If not make it a priority to take care and maintain the natural water resources are in good condition as it can cause problems and human impact environment and difficult to resolve. Therefore it should be maintained of wastewater before releasing into the natural rivers or public rivers.

Wastewater treatment currently exists a wide variety of ways such as chemical process [1], biological process [2], physical process [3]-[4] bio-chemical process [5], bio-physical process [6]-[8] physico-chemical process [9]-[11] and combined process [12] depending on whether it is appropriate to choose any method of wastewater treatment. Considering the nature of the waste water can be considered from the condition of the area, as well as performance and the budget must be worthwhile and the most economical. Water containing organic material should be used for the treatment of biological waste water containing organic biological decomposition. Wastewater treatment by EM ball is a method of biological wastewater treatment. The EM ball is the effectiveness microorganisms are capable of degrading organic matter. This is effective in the treatment of waste water from the building community and general establishment. If the microorganism in EM ball can treat wastewater to water better quality, so it is the way to decrease cause of water pollution.

Effective Microorganisms (EM) is a microorganism that effective to destroy organic compound [13]. These microorganisms derived from natural microbes cultured and expanded using natural bait such as molasses, rice bran protein and other compounds that do not harm the creatures. There are applied to many aspects of the problems, which are based on biodegradable waste, sewage, dirt in the bathroom, septic and sewer smell. EM is easily purchased in the general market for affordable. A water resource in Bangkokthonburi University is the place for support the wastewater from many building of University. Water released into this water resource are the water from washing equipment, bathroom activities that make water smell and caused by organic substances in wastewater. These characteristics cause problems for environment of this area.

Therefore, in this work, the microorganism in EM ball was used as the way to treat wastewater in wastewater plant of Bangkokthonburi University to help reduce the problem of water pollution before releasing into Klong Taweewattana.

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II. Procedure and Method

A. Surveying the Wastewater Plant

The general physical environment of the surrounding water sources in Bangkokthonburi University was surveyed. It was found that waste water resulting from activities in the building, such as the activities of the food center, a wash various kitchen utensils, cleaning materials, activity of study buildings, and the use of toilets, etc. The wastewater from these activities will flow down the drain and flow together into this waste water treatment plant. This is the only one place for support the used water. Now are in a somewhat degraded. Therefore to determine this water quality, this wastewater plant was considered for sampling point.

B. Collection and preparation of waste water

Water samples used in these experiments was collected from the waste water treatment plant that was released together from the activities of Bangkokthonburi University. The water samples were collected in plastic and pour into a large plastic bucket. The collected waste water was collected in volume of 120 liters with the repository using composite sampling type from 9:00 am to 11:00 am.

C. Preparation of EM and EM ball

Preparation of EM and EM ball in this experiment, EM was extended to enhance effective before molding into the ball by mixing EM, molasses and water in the ratio. EM: Molasses: water = 1:1:20 into plastic bottles. Close to protect the vacuum and incubated for a period of seven day. Then, the expanding EM was molded into EM ball by mixing as bran, rice bran and sand in a ratio of 1:1:1 and fill the expanding EM. The moisture was content of 60% and forms a ball sphere as shown in Fig.1. After that, EM ball were incubated at room temperature for seven days before using. The EM ball was used as the treatment of 108 grams per 120 liters of waste water sample.

Fig. 1 EM ball preparation

D. Experimental section

In wastewater treatment, the experiment was divided into three set, each set of the third repeat. Set A, sample was not EM ball but only added the air using pump air flow. Set B, sample was added only EM ball from our laboratory room. Set C, sample was added only commercial EM ball. The process of implementation can be divided into two parts. The first one, waste water sample was separated two parts. The first part was determined the characteristics and properties of the water before the experiment. The second part was tested with EM ball. The last one, wastewater after treatment was collected to measure water quality analysis every seven days for four weeks after the addition of EM ball. Analysis of water samples before and after treatment with the parameters in TABLE I.

TABLE I
PARAMETER AND METHOD OF INTERESTED

Parameter	Method
Dissolved Oxygen (DO)	Azide Modification of Iodometric Method
Biological Oxygen Demand (BOD)	Dilution Method
Chemical Oxygen Demand (COD)	Spectrophotometric Method

E. Determination method

Dissolve Oxygen (DO) was determined with Azide modification of Iodometric method using a BOD bottles and Manganese Sulfate and Alkali-iodide-azide [14]. Biological Oxygen Demand (BOD) was determined by Dilution method. [15]. Chemical Oxygen Demand (COD) was determined by spectrophotometric method [16]

III. Analysis

A. One-way ANOVAs (Analysis of Variance)

The results of all parameter from three set (A, B and C) were analyzed by statistically method with One-Way ANOVA followed with Duncan's multiple comparison tests. ANOVA is a technique used to compare means of three sample set of waste water treatment. The ANOVA tests the null hypothesis that samples in three groups are strained from samples with the same mean values. P values less than 0.05 were considered statistically significant.

B. Arithmetic Mean Average ($\bar{X}$)

Arithmetic mean average is the sum of a collection of sample quality values divided by the number of numbers in the collection.

C. Standard deviation (SD)

Standard deviation is a measure that is used to quantify the amount of variation or dispersion of a set of data values.

D. Efficiency of treatment (SD)

The efficiency of treatment was calculated from the results in each parameter. The equation of efficiency is shown in equation 1.

$$E = \left(\frac{A_{in} - A_{out}}{A_{in}}\right) \times 100 \quad (1)$$

Where; E is efficiency of treatment in each parameter
A_{in} is Results before treatment
A_{out} is Results after treatment

IV. Results and Discussion

Investigation of EM ball efficiency for the treatment of wastewater from waste water plant in Bangkokthonburi University is divided into three experiments by a set of experiments, including Set A, is the sample was added only the air-flow, but do not add EM ball. Set B is the sample was added only EM ball from our laboratory, and set C is the sample was added only commercial EM ball. The water samples were analyzed for water quality over the past one week, for a total of four weeks following the addition of EM ball. The parameters for the determination of water quality including the dissolved oxygen (DO), Biological oxygen demand (BOD), and Chemical oxygen demand (COD). The results are shown in detailed below.

A. Properties of water samples before treatment

The results of the three set of experiments treatment found that the temperature of sample in set A of 28.55 ^{o}C, pH of 7.00, DO of 6.08 mg /L, conductivity of 647.00 µS /L, turbidity of 43.60 NTU, BOD of 11.38 mg /L, COD of 151.00 mg /L. In Set B, temperature of 28.55 ^{o}C, pH of 7.00, DO of 5.96 mg /L, conductivity of 633.00 µS/L, turbidity of 44.80 NTU, BOD of 12.15 mg /L, COD of 154.00 mg /L. For set C, temperature of 28.55 ^{o}C pH of 7.00, DO of 5.70 mg /L, conductivity of 638.00 µS /L, Turbidity of 48.10 , BOD of 12.00 mg /L, COD of 152.00 mg /L. These are indicated that that water sample from waste water plant of Bangkokthonburi University still standard properties of water. It is not wastewater. However, it is can be changed to waste water if it was not attended. The results of physical properties of water before treatment are shown in TABLE II.

TABLE II
PROPERTIES OF WATER SAMPLES BEFORE TREATMENT

Parameter	Sample A	Sample B	Sample C
Temperature (^{o}C)	28.55	28.55	28.55
pH	7.00	7.00	7.00
Conductivity (µs/L)	647.00	633.00	638.00
Turbidity (NTU)	43.60	44.80	48.10
DO (mg/L)	6.80	5.96	5.70
BOD (mg/L)	11.38	12.15	12.00
COD (mg/L)	151.00	154.00	152.00

B. DO of water samples after treatment

Study the effect of EM balls on properties of water sample after treatment of waste water treatment plant Bangkokthonburi University found that the dissolved oxygen before treatment of three sets of trials have very similar values are 6.08, 5.96 and 5.70 for set A, B and C, respectively. The dissolved oxygen after treatment with EM ball in the first week of treatment B and C series of experiments, down from the original and is equal to 0 mg/L. Because the water is dirty from addition EM ball that is organic bran and rice bran used in the process, it needs oxygen to decompose organic matter by bacteria. When the organic decomposition occurs during the first week, the dissolved oxygen was decreased. Fig. 2 show the DO of water sample after treatment of three sets in four weeks. The results shows that DO are not significantly changed in set A, while set B and C were increased continuously for four week. And found that the dissolved oxygen was increased from a 0 mg/L to 0.25, 0.13 in the set of experiments B and C, respectively after the addition of EM ball in two weeks. In third week and fourth week were increased rapidly to 1.20, 1.38 and 3.05, 2.75 mg/L of a set of experiments B and C, respectively. These results may caused the organic matter in the water sample was digested as low. Oxygen is used in the process of oxidizing the organic matter less. As a result, the diffusion of oxygen from the air in a water sample is dissolved in water to rise in test for the set A. It was found that the dissolved oxygen increased markedly during the first and second week of 7.85 and 8.00 mg/L and will reduce slightly over third to fourth weeks (7.80 to 7.88). It can be concluded that EM ball can enhance the DO of waste water after addition EM ball for two weeks up.

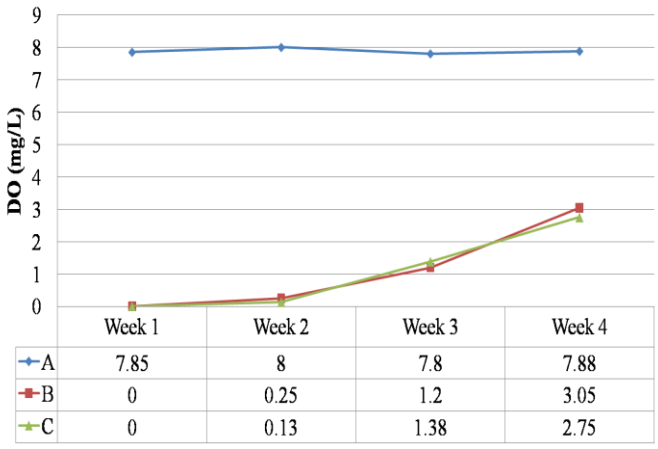
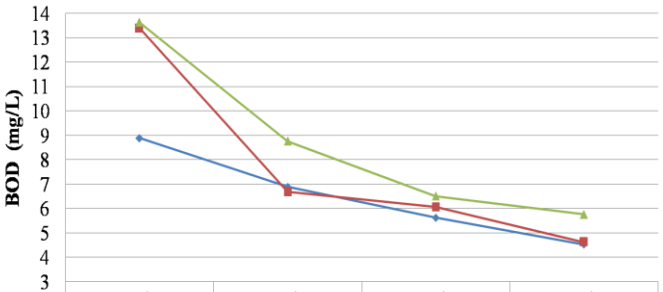


Fig. 2 Dissolved Oxygen (DO) of water sample after treatment

C. BOD of the water samples after treatment

The BOD of treatments in set A, B and C was analyzed at four weeks. In samples before treatment, the BOD had no significantly different is equal 11.38, 12.15 and 12.00 mg / L of treatments A, B and C, respectively. Fig. 3 show the BOD of water sample after treatment for one to four weeks. It is found that the BOD was increased in the first week when compared to before treatment. The sample of set B, the BOD started the trend has decreased in the second week from 13.38 to 6.67 mg/L. The sample of set C, the BOD started the trend has slightly decreased in the second week from 13.63 to 8.75 mg/L. These results indicated that the BOD is lower than before treatment. It may be caused by the aerobic species in the sample were decreased. Consequently, the EM ball can reduced the BOD in water sample after addition for the first week.

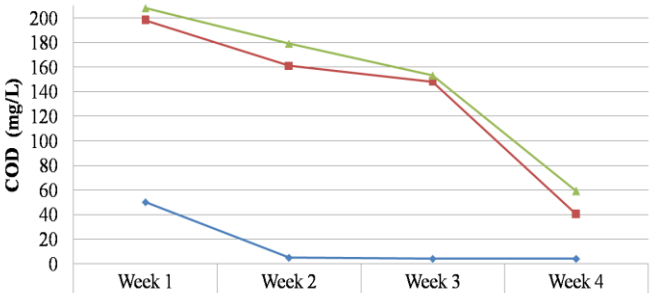


	Week 1	Week 2	Week 3	Week 4
A	8.88	6.88	5.62	4.52
B	13.38	6.67	6.05	4.62
C	13.63	8.75	6.5	5.75

Fig. 3 Biological Oxygen Demand (BOD) of water samples after treatment

D. *COD of water sample after treatment*

The COD of sample in study effect of EM balls on the treatment of wastewater from wastewater treatment tank of Bangkokthonburi University were analyzed by spectrophotometric method. It is found the three sets of experiment had very similar values are 151.00, 154.00 and 152.00 of set A, B and C, respectively for water samples before treatment. The COD of water samples after treatment were increased when compared to before treatment in set B and C. On the other hand, it was decreased rapidly in set A. Fig. 4 show the COD of all set was continuously decreased after treatment two weeks. It is found that the COD of set A had steadily decreased, because there is a constant at 4 weeks after aeration. From the first week to the fourth week, which is the amount of oxygen used to oxidize at 50.00, 4.80, 4.00 and 4.00 mg/L, respectively, because oxygen from filling air-flow in treatments A to digest organic matter. The increase in the first weeks after adding EM ball of set B and C is caused by the EM is organic substances and inorganic sand bran and rice bran makes up the COD in the first week with the COD increased to 198.00 and 208.00 from a series of experiments B and C, respectively. It decreased steadily after the addition of EM in week 2 to week 4, because microorganisms in EM ball to increase the oxygen in water samples and organic substances and inorganic water samples are digested. Therefore, the oxygen is used to oxidize as 161.00, 148.00 and 40.00 mg/L in week 2, 3 and 4, respectively for set B. And the COD was 179.00, 153.00 and 59.00 mg/L in week 2, 3 and 4, respectively for treatments C.



	Week 1	Week 2	Week 3	Week 4
A	50	4.8	4	4
B	198	161	148	40
C	208	179	153	59

Fig. 4 Chemical Oxygen Demand (COD) of water samples after treatment

E. *Statistical analysis*

The study effect of addition EM ball on the wastewater treatment can be divided into three treatments are set A, adding only the air-flow. Set B is the water sample was added only EM ball from our laboratory room for 108 g in water samples 120 liters. Set C is the water sample was added only commercial EM ball for 108 g in water samples 120 liters. The efficiency of all experiment were analyzed and compared. A relative comparison of efficiency of water treatment is used to indicate the relationship of the parameters analyzed using ANOVAs in DO BOD and COD. When analyzed using ANOVAs to compare the relative efficiency of water treatment with the three sets of DO, BOD and COD parameters. The results show statistically insignificant differences at 95% confident as shown in TABLE III.

TABLE III
TEST OF HOMOGENEITY OF VARIANCES

Parameter	Levene statistic	df1	df2	Sig.*
DO	2.257×10^{16}	14	15	.000
BOD	3.510×10^{15}	14	15	.000
COD	3.640×10^{15}	14	15	.000

* p <0.05 the experiment has shown that the difference was statistically significant.

TABLE IV is statistical data when compared to between group and within group. It can be seen that the between group shows statistically insignificant differences at 95% confident. On the other hand, within group, shows not significant.

TABLE IV
ONE-WAY ANOVAS

Source of Variation	Sum of Squares	df1	Mean Square	F	Sig.*
Between Group	298.625	14	21.330	18.343	.000
Within Group	17.443	15	1.163		
Total	316.068	29			

* p <0.05 the experiment has shown that the difference was statistically significant.

It can be concluded that all parameters show statistically significantly different at 95% confidence interval.

V. CONCLUSION

The effect of EM ball on wastewater treatment tank of Bangkokthonburi University was studied. Set A of experiment sample was added only air-flow, Set B experiment sample was added only EM ball from our laboratory room, and Set C experiment sample was added only commercial EM ball. The DO parameter of set A was increased for 16.44%, set B was decreased for 48.82%, and set C was decreased 51.75% when compared with the water sample before treatment. The BOD parameter of all sets was decreased for 60.19, 61.89 and 52.08% of set A, B and C, respectively. The COD parameter of all sets was decreased for 97.35, 74.02 and 61.18% of set A, B and C, respectively. The results of the efficiency of EM ball on wastewater treatment of wastewater treatment tank in Bangkokthonburi University show statistically significantly different for between groups. The water sample after treatment

with set A, only added air-flow is best treatment way when compared with water sample after treatment with set B and C in all parameter except BOD parameter that the water sample after treatment with set B had efficiency more than set A and C. Although the water sample after treatment with set B and C had trend to same direction, the water sample after treatment with set B had efficiency more than the water sample after treatment with set C in all parameters. Moreover, the odor, clarity and color were observed. It can be seen clearly after treatment in two weeks such as odor was disappeared, color starts to clear and more transparent through the second week of the trial.

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