EVALUATION OF EXISTING COMPOSTING PROCESS AT WASTE MANAGEMENT PLANT SITUATED IN KUET CAMPUS

M. K. Sutradhar*[1], M. R. Sarder[2] and M. Alamgir[3]

[1] *Undergraduate Student, Department of Civil Engineering, Khulna University of Engineering & Technology, Bangladesh, e-mail: sebokmishon@gmail.com*
[2] *M. Sc (Scholar), Department of Civil Engineering, Khulna University of Engineering & Technology, Bangladesh, e-mail: razibsarder08@gmail.com*
[3] *Professor, Department of Civil Engineering, Khulna University of Engineering & Technology, Bangladesh, e-mail: alamgir63dr@yahoo.com*

ABSTRACT

Due to rapid increasing of solid waste and scarcity of disposal site, solid waste management is a challenging issue for city authority in the developing countries like Bangladesh. Composting is one of the best options in solid waste management through which biodegradable waste is converted into compost by aerobic or anaerobic decomposition. Composting systems is helpful to create employment and produce soil conditioner which is useful for food production in developing countries and responsible for increasing the capacity of landfill. In support of the sustainable solid waste management at Khulna University of Engineering and Technology (KUET) campus, composting process has been conducting at solid waste management plant (SWMP) of KUET by passively aerated method. Solid waste collected from different zones of the campus are separated into compostable and non-compostable portions and hence transported to the SWMP. This paper presents the composting techniques and its evaluation based on some important properties such as moisture content, pH and C/N ratio. From the study it has been audited that the 65.09% waste are compostable and the total solid waste generation rate has been found as 0.0474 kg/capita/day and the average compost production has been observed as 48.57 kg/month. The quality of compost depends on moisture content, temperature, pH, C/N ratio. From the laboratory test the average value of moisture content, pH and C/N ratio of compost are found as 22.27%, 8.43 and 28.50:1, respectively.

Keywords: *Solid waste, composting, solid waste management plant*

1. INTRODUCTION

Most countries in the world experience challenges in managing waste. The challenges range from reducing generation of waste, separation, change of habits, collection, transport, treatment, reuse and disposal of the waste. Increasing environmental concerns and the emphasis on material and energy recovery are gradually changing the orientation of solid waste management and planning. The focus nowadays is to design sustainable and least cost solid waste management systems considering the variety of management processes (Gakungu et al., 2012). Due to increasing population, changing consumption patterns, economic development, changing income; urbanization and industrialization result in increased generation of waste (Ngoc & Schnitzer, 2009). Solid Waste contains recyclables (paper, plastic, glass, metals, etc.), toxic substances (paints, pesticides, used batteries, medicines), compostable organic matter (fruit and vegetable peels, food waste) and soiled waste (blood stained cotton, sanitary napkins, disposable syringes) (Jha et al., 2003 & Khan, 1994).

Solid Waste Management is associated with the control of waste generation, storage, collection, transfer and transport, processing and disposal in a manner that is in accordance with the environmental considerations. To reduce the load on disposal system, solid waste must be processed. Composting can be one such process. It is a process in which organic substances are reduced from larger volumes of rapidly decomposable material to small volumes of material which continue to decompose slowly. Compost is particularly useful as organic manure which contains plant nutrients (Nitrogen, Phosphorous and Potassium) as well as micro nutrients which can be utilized for the growth of plants. Composting can be carried out in two ways i.e., aerobically and anaerobically. During aerobic composting aerobic micro-organisms oxidise organic compounds to Carbon dioxide, Nitrite and Nitrate. Carbon from organic compounds is used as a source of energy while nitrogen is recycled (Sundberg et al., 2011). An anaerobic process is a reduction process and the final product is subjected to some minor oxidation when applied to land. Aerobic composting is a dynamic system wherein bacteria, actinomycetes, fungi and other biological forms are actively involved. Thermophilic bacteria are mainly responsible for the breakdown of proteins and other readily biodegradable organic matter (Wadkar et al., 2013).

Studies indicated that the maximum composting activity may be achieved in thermophilic conditions with the temperatures in the range of 50 to 60°C. On the contrary, (Rao et al., 1996) and (Vikman et al., 2002) reported that degradation of organic matter is faster in mesophilic temperatures. In their studies, higher rate of decomposition was observed at 35°C and increased rate of O_2 uptake was noted at a temperature of 43°C. Similarly, the rate of mineralization of carbon to CO_2 was also observed to be high in mesophilic temperature. These indicated that mesophilic composting at lower temperature ranges is more favorable for biowaste degradation, despite the fact higher temperature is effective for the elimination of pathogenic and weeds seed during composting (Anand et al., 2012)

The quality of compost depends on several important parameters such as: moisture content, carbon – nitrogen (C/N) ratio, oxygen requirement, temperature, and pH control. Moisture content should be within the limit of 50 to 60% during the process of composting, the initial ratio of C/N should be in the range of 30:1 to 35:1. The availability of air is an important factor for aerobic composting but it is difficult to calculate actual amount of oxygen requirements due to its dependence on several factors like temperature, moisture content and availability of nutrients. During composting pH varies with time and represents the extent of decomposition within the compost mass. The pH should not increase above 8.5 to minimize the loss of nitrogen in the form of ammonia gas (Ahmed & Rahman, 2007).

The objectives of this study are to find out the total amount of compostable waste, monthly compost generation, and performing some test to find out the quality of compost.

2. COMPOSTING AT BANGLADESH

Since its inception, Waste Concern addresses the twin problems of waste accretion and land infertility by reducing waste and converting it into usable compost as fertilizers for horticulture and agriculture. From 2001 to 2006, Waste Concern has been able to reduce 17,000 tons of Green House gas emissions, generate employment for 986 urban poor, and save a landfill area of 33.12 acres with a depth of 1 meter. During the same period, they processed 124,400 tons of organic waste and produced 31,100 tons of compost. Their composing activities benefited 60,000 people in Dhaka and an additional 434,290 people from its replication in other parts of the country (Austine, 2011).

Currently, Waste Concern produces 7,500 tons of compost in Dhaka and 8,087 tons in other parts of Bangladesh each year (Waste Concern, n.d.). Furthermore, the technology used for composting can treat 30,000 to 35,000 tons of waste per year and reduces carbon emission by 20,000 tons of CO_2 per year (Ventures, A. n.d.).

Amount of daily solid waste generated in Khulna City Corporation area is 520 tons and as the collection and disposal efficiency of KCC is 80%, amount of solid waste collected and disposed by KCC is 416 tons per day. About 70% of this waste (416 tons) is organic in nature which is 291 tons per day. Thus, total amount of organic waste, which can be used for composting, is 8730 tons per month. At present, RUSTIC is using only 46 tons (0.53%) of this organic waste and producing 30 tons of organic compost per month. So, the unused organic waste is 8684 tons (99.47%) per month. Some agroforestry nurseries and tea garden authorities are preparing compost for their own need (Roy et al., 2013).

Figure 1: Composting at RUSTIC at Rajbandh, Khulna (after Roy et al., 2013)

3. STUDY AREA

This study work was done at KUET campus, which is one of the leading public universities of Bangladesh giving special emphasis in the Engineering and Technological Education and research having around 3222 students, 16 Academic Department under 3 Faculty and having total number of population is around 4185 nos. including all stuff and stands at North-West corner of Khulna City Corporation, about 12km from the city center, situated over an area of 101 acres land.

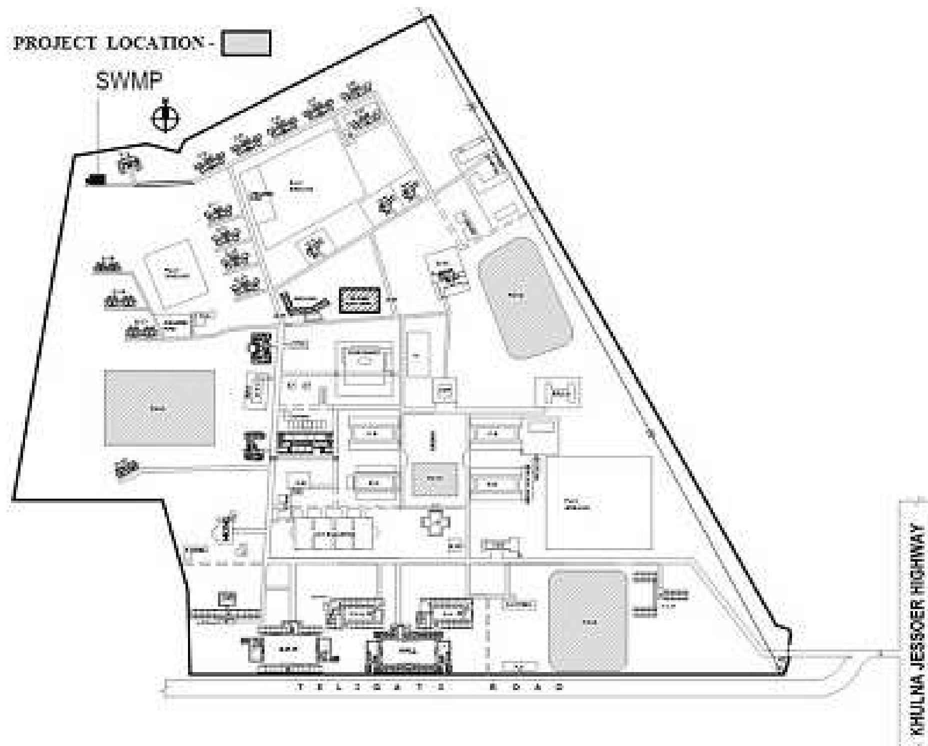

Figure 2: Layout plan of KUET campus including SWM plant.

4. MATERIALS AND METHODS

This study work has been done by direct investigation, data collection and analysis. For the purposes of this study following methodology has been followed.

The biodegradable and non-biodegradable waste has been collected separately from student halls and residential area. The waste come from academic premises and common places are mainly inorganic and have been collected from specified location. These waste have been transported to the SWMP for ultimate treatment. Data of compostable and non-compostable waste has been recorded. SWMP consists of composting plant, sorting unit, recycling unit and burning unit. In purpose of composting process there are 6 nos. of composting pile at SWMP which are made from bamboo and wood. Among them a pile is large and trapezoidal in shape (Figure 4) and others are small and triangular in shape (Figure 5). Piles are designed in such a way that the oxygen can enter freely into the waste through piles.

After sorting, only biodegradable waste containing 50 to 60% initial moisture has been imposed on trapezoidal pile. Temperature of waste has been measured. After 20 to 25 days the waste has been shifted to the triangular piles and temperature has been measured. It has been observed that the temperature has been rises at 60 to 65°C up to 45 to 50 days and then temperature began to decrease. After another 10 day temperature reaches at stable condition (about 30 to 35°C) and waste has been converted into finished compost having dark grey color. Two samples have been taken for measuring pH and moisture content. Another two samples has been taken for carbon and nitrogen measurement. Volatile solid was determined from ash content which is obtained from burning at 500°C through muffle furnace. The carbon content is obtained from the empirical equation as C (%) = % volatile solid/1.8. The Nitrogen content has been obtained from Kjeldahl method.

Figure 3: Solid waste management plant at KUET campus

Figure 4: Trapezoidal composting pile

Figure 5: Triangular composting pile

Figure 6: Finished compost

5. RESULTS AND DISCUSSION

Figure 7 shows the composition of solid waste at KUET campus where compostable part of waste have been found as compostable and the amount of compostable waste has been observed as 65.09% of total solid waste. Figure 8 describes the solid waste generation rate at different month and average solid waste generation rate has been found as 0.0474 kg/capita/day.

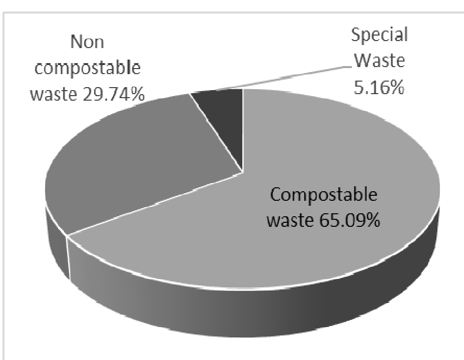

Figure 7: Composition of solid waste

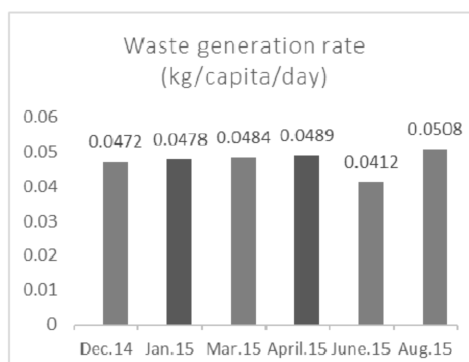

Figure 8: Solid waste generation rate

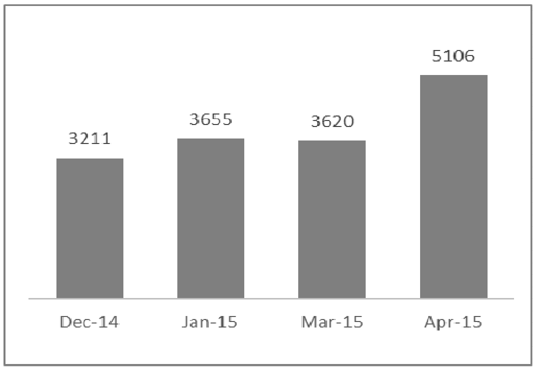

Figure 9: Monthly compostable waste generation (kg)

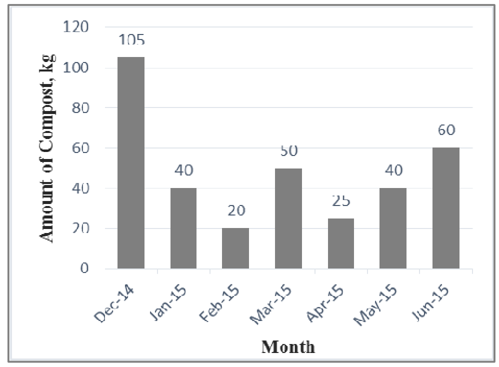

Figure 10: Monthly compost production

Figure 9 presents the amount of compostable waste at different months and average compostable waste has been found as 3898 kg/month. Figure 10 describes the generation of compost at different months and the average compost generation has been obtained as 48.57 kg/month.

Table 1 represents the moisture content (w%), pH and C/N ratio of the compost measured for two samples. The value of w, pH and C/N ratio are found as 22.6 and 21.94%, 8.32 and 8.54, and 29:1 and 28:1 for the samples 1 and 2, respectively. The pH value depends on types of feedstocks and composting operation techniques and value of pH has been found within standard limit. During composting process moisture content of waste in compost piles was measured in the range of 50 to 60%, which is needed to accelerate the composting process. The moisture content of compost is found to remain in the acceptable range (20 to 40%). However, the important controlling parameter of compost i.e. C/N ratio is found higher than the standrad limit (25:1).

Table 1: Moisture content, pH and C/N ratio of compost

Properties	**Sample-1**	**Sample-2**
Moisture content, w(%)	22.60	21.94
pH	8.32	8.54
C/N ratio	29:1	28:1

6. CONCLUSIONS

Composting process is an effective and important tier of solid waste management system by which a significant portion of generated municipal solid waste can be reduced and converted to a humus like material necessary i.e. compost which can increase soil nutrients. The compostable waste generated at KUET campus is found as 65.09% amounting 3898 kg/month and the averagage amount of compost production is found as 48.57 kg/month. The average moisture content, pH and C/N ratio of final compost are measured as 22.27%, 8.43 and 28.5:1, respectively. As the C/N ratio is measured as higher than the standard value, necessary steps should be taken to reduce the C/N ratio. The composting procees, passive aeration, practiced in the plant is found suitable. However the quality of the compost can be improved by ensuring proper segregation at the source, necessary shreeding of the waste, proper turning during the entire process and to maintain required moisture content as well as the level of temperature.

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