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RECLAMATION OF THE OLD DUMP SITE THROUGH CONTROLLED BIO-MINING: A CASE STUDY OF OMAGULAM DUMPING AREA

T. POONKUNDRAN[1*]

[1]Asst. Professor, Dept. of Civil Engg., Faculty of Engg. & Tech., Annamalai University, Annamalai Nagar, Tamil Nadu- 608002

[*]**Corresponding Author Email: geepoo76@rediffmail.com**

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ABSTRACT

The solid waste (SW) generation pattern is growing exponentially worldwide. Contrarily, the cost of scientific processing and disposal is limited. Therefore, addressing this rampant mass with a confident budget is of a greater threat. Ultimately, the aforementioned causes open dumping and burning of the SW. But the urban local bodies (ULB) often forget the serious environmental intimidation attributed to it. Thus, the present study tried to explore the feasibility of bio-mining towards the reclamation of the old dump sites. The Omagulam dump site located at the outskirts of the Chidambaram town was utilized as the source of unsegregated solid waste. The collected waste segregated and composition analysis was carried out to understand the property of the waste. Majority of the waste ranging approx. 65-70% (i.e. based on the four trail samples procured) found to be organic in nature and remaining includes non-recyclable plastics, inert glass pieces, rubbers, wooden twigs etc. The composition was also influenced by the activities of the informal rack pickers and seasonal variances. Based on the characteristics of the SW it was concluded that bio-mining is an appropriate approach to address the present issue. A lab-scale study was conducted within Annamalai University premises by randomly sampling of the heterogeneous mass from the prior mentioned source. The biodegradable fraction was manually segregated and a hip was formed layer by layer of 1 m^3 volume. Effective microorganism (EM) culture was sprayed and the degradation rate was accelerated. Whereas, the recyclables were separated and sold to the authorized recyclers to generate revenue. The compost yield was recorded as 55.6% and

contributed a decent fraction towards the economic recovery. The non-process-able inert fraction is suggested to be disposed of using the scientific landfill. Ultimately the research work concludes that the bio-mining is utmost preferable to reclaim the old dump sites and preserve the environment.

Keywords: bio-mining, compost, inert, landfill, recovery

INTRODUCTION

Open dumping is a rampant practice, mostly in underdeveloped and developing countries. The major reason behind the same is the lack of investment, despite withholding an enormous potential. As per the presently available data approx. 50-60% of the entire solid waste management (SWM) cost is consumed only by the collection and transportation (C&T) (Annepu, 2012; Frank and Tchobanoglous, 2002). Therefore it's quite evident that performing a scientific treatment and pertinent disposal is a difficult affair (Agarwal at al., 2005). So, around 50% or more of the SW generated in 3rd world nations, simply goes unaddressed (Jampala et al., 2016; Gupta et al., 1998). The open dumping of the waste not only occupies the valuable land, but also creates a wide range of environmental pollutions such as soil and air pollution, groundwater contamination, odour and rodent nuisance etc. Prevention of such practice may ensure against the possibility of further contamination, but remediate the previously practiced illegal activities is another challenge (Ghose et al., 2006; Goel 2008). Hence the newly introduced concept of bio-mining is quite important from the context of reclamation of the obsolete brown fields. No wonder the process managed to get a significant popularity in a stipulated period due to its simple mode of operation and inexpensiveness. Rawlings and Johnson (2007) has explicitly mentioned in their study about the positive impacts of bio-mining and the microbial sciences behind it. Wolsink (2010) have also stated the scope of bio-mining in Asian continent and its importance towards cost-effective reclamation. Considering the aforementioned as benchmark, multiple reclamations have already been successfully executed in different parts of the nation, includes Mumbai, Kumbakonam etc. (Dumpsite rehabilitation manual 2010, Rehabilitation of Gorai Dumping Ground 2013, Landfill Biomining at Kumbakonam 2016). The idea of similar conversion and environmental detoxification provoked the present study.

The main objective of this research work was to successfully showcase the potential of bio-mining with the help of lab-scale demonstration and propose a handy solution to the local ULB to recover the

expensive piece of land located at the vicinity of the highway and ensure healthier environment.

MATERIALS AND METHOD

The study is a micro-scale adaptation of the on-site remediation, reclamation, rehabilitation of the Kumbakonam bio-mining project. The same tried to be replicated based on the similarity of the existing conditions. The entire practical and analytical studies for the present research work have been carried out within Annamalai University premises. Further details are depicted below.

Collection of the MSW

The heterogeneous solid waste sample of 3 tons was manually assorted and conveyed to the experiment site with the help of suitable vehicle, covered with tarpaulin sheets to avoid any sort of spillage. Four samples were collected over a period of one week and thoroughly mixed before the sampling for compositional analysis.

Segregation

The standard method of composition was used to acquire necessary quantity of solid mass to be considered for final evaluation. The entire waste was spread over an impervious concrete platform and divided into four parts diagonally. Two counter parts located opposite to each other were chosen and mixed thoroughly before the final compositional examination.

Composting

The biodegradable fraction, exclusively comprising vegetable market waste, waste with high fibre content, leafs etc. were opted for windrow composting. A heap of 1 m^3 capacity was formed in three layers and EM culture was manually sprayed on each layer maintaining a ratio of 1:100 with the waste mass. The rhomboidal heap was manually turned on regular basis to ensure optimal supply of oxygen. The same was maintained over a period of 27 days and certain parameters such as temperature, moisture etc. were monitored throughout the tenure.

Recovery

The remaining fractions with certain commercial value were considered as recyclables. It included different categories and grades of materials like glass bottles, plastics, ferrous and non-ferrous metals etc. Glass bottles were sent to recyclers; both high density and low density poly ethylene (HDPE & LDPE) were sent for the granule preparation; whereas, metals were sent to ore extraction and recovery facility for co-processing with the virgin materials. The entire process flow is elaborated in figure 1 with the help of a flow diagram.

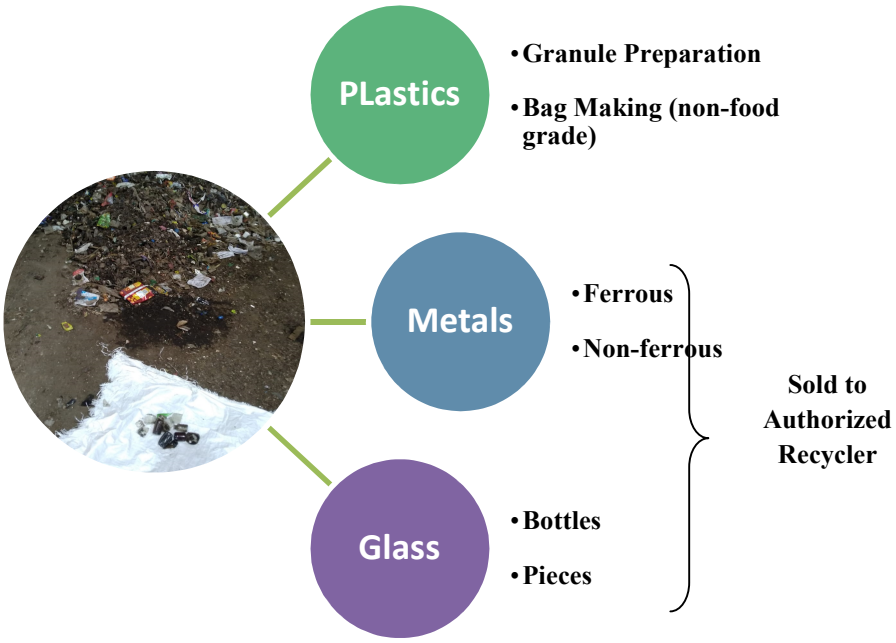

Figure 1: Recycling process flow

RESULTS AND DISCUSSION

The investigation revealed the utmost feasibility of bio-mining method towards the reclamation of the obsolete dump sites. The observed recovery was as high as 75% based on the mean of four trails conducted. The further details are furnished as follows.

Compositional Analysis

Despite the minute heterogeneity in composition (i.e. a variation of ± 5% among all categories), all four different batches almost registered similar characteristics. The biodegradable fraction contributed approx. 66% of the entire composition (Das, 1999; Sand, 1993). On the other hand, the quantity of recyclables was marginally low, possibly due to the activities of informal rack pickers. Figure 2 portrays the mean composition of the legacy dumping.

Figure 1 revealed that other major fractions in the dumped consortium were plastics and followed by stones. Majority of the plastics were of LDPE category with little to no recycling values. The entire plastic mass was further classified into two sub-categories namely, recyclable and non-recyclable, which were present in a ratio of 1:5. Brierley (2008) also mentioned similar level of recovery, based on the study carried out at China. The non-recyclable plastics alongside the inert stones and compost rejects are advised to be landfilled (i.e. approx. 25% of the entire mass). The value is almost on par with reported figures

by Thosar et al. (2014); Tiwari and Singh (2014).

Characteristics

The MSW was further analysed and parameters are depicted in Table 1. The pH found to be lying in alkaline range showcasing the impact anaerobic activities due to the time being. On the other hand, the value of C/N ratio portrays the non-stability of the waste mass.

Compost

The quality of the final compost was analysed in terms of C/N ratio, presence or absence of pathogens, quantity of essential elements such as phosphorus, potash, nitrogen etc. The analysis values are depicted in Table 2.

It can be clearly seen that the majority of the components are on par with the prescribed values as per FCO standard, except total phosphate and potash. The primitive nature of the feed stock is the probably the reason behind this deficiency (Ribeiro, 2000; Rosen et al., 1993; Manios, 2004). Therefore based on the above values it can be deficiently used as soil conditioner or enriching agent, before the application of actual fertilizer.

Recycled Materials

Due to the uncontrolled activities of c sectors in and around the dumping yard area majority of the high value materials were segregated and manually picked from site prior to the sample collection, affecting the cost recovery aspect. Approx. 5% weight of the total composition majorly plastics; metals such as aluminium cans, broken bolts & nuts etc.; glass bottles were recovered in the form of recyclables. Metals were segregated with the help of magnetic separator in ferrous and non-ferrous category and sold to the open market at a rate of Rs. 20/kg. Whereas, pre-sorted plastics were sent to Ramky Reclamation & Recycling Ltd., Hyderabad at a price of Rs. 18/kg. There it has undergone a set of operation includes washing, drying, agglomeration, extrusion etc. Glass was further sub divided into two categories namely, glass bottles and glass pieces and sold at a rate of Rs. 15/kg and 10/kg respectively.

A minute fraction was recovered with higher calorific value ranging approx. 3500 cal/ gm (Kothari and Thorat, 2014). The materials include non-recyclable polyethylene, dry cloth pieces, dry coconut coir, jute bags etc. The same was analysed for understanding its feasibility as Refuse derived fuel (RDF) and the results were satisfactory (Table 3). Though, the same couldn't be sold due to get limited quantity.

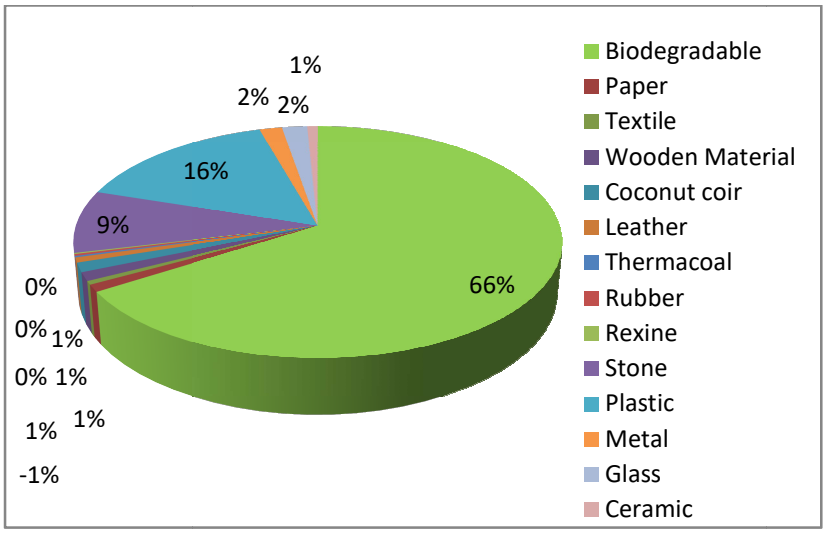

Figure 2: Composition of the legacy dumping

Table 1: Analysis of Solid Waste

Sl. No.	Parameters	Value*
1	Moisture Content	41.1%
2	C/N ratio	26.70
3	Organic content	66%
4	Organic Carbon	38.44%
5	pH	8.77
*values are location specific		

Table 2: Windrow Compost Analysis Report

Sl. No.	Parameters	Units	Compost Test Values	FCO* standard
1	Particle size	%	92.23	Minimum 90% material should pass through 4.00mm sieve
2	C:N Ratio	-	14.81	20.0 Max
3	Bulk Density	gm/cm^3	0.78	<1.0
4	Moisture	%	21.19	15.0-25.0
5	Total Organic Carbon	%	13.53	12.0 min
6	Total Nitrogen as N	%	0.98	0.8 min
7	Total Phosphate as P_2O_5	%	0.37	0.4 min
8	Total Potash as K_2O	%	0.37	0.4 min
9	Pathogen	-	Not detected	Absent
*Fertilizer Control Order				

Table 3: Analysis of RDF

Sl. No.	Parameters	Unit	Value*
1	Moisture Content	%	15.2
2	Calorific Value	Cal/gm	3482
3	Chloride Content	%	1.60
4	Sulphur Content	%	1.94
*values are location specific			

CONCLUSION

The study successfully showcased the potential lies within the obsolete dumping and the pertinent method to retrieve it. The thorough investigation of the waste has been carried out and suitable method of recovery was finalized based on it. Major fractions were separated manually and individual recovery was facilitated. The compost yield from organic fraction was recorded as 55.6% and the same contributed a decent fraction towards the economic recovery. Additional recovery was carried out by selling recyclables. As the study was a micro-scale adaptation of the real bio-mining method it's hard to calculate the cost-benefit analysis. But, still, it's needless to say that the overall revenue generated was considerably good and ranged approx. Rs. 120 for 2 tons of waste processed. Ultimately the research work concludes that the bio-mining is utmost preferable to reclaim the old dump sites and preserve the environment.

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