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Physiochemical Analysis and Economic Potential of MSW from Nagpur City: Opportunities under Swachh Bharat Abhiyan

Environmental Science

KEYWORDS: Ultimate analysis, proximate analysis, MSW, Swachh Bharat Abhiyan, Nagpur

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ABSTRACT

Human existence has never been as prone to self-destruction as in these times. Rapid development and urbanisation has led to waste disposal problems beyond natural sustenance. India, in recent times, has witnessed a lot of scientific investments in waste management including launch of Swachh Bharat Abhiyan in October 2014. But the proportion of land and technology required is not sufficient to handle the current and projected waste generation. In this background current paper proposes to offer solutions for solid waste management of a city in India (Nagpur) which can be modelled for other cities as well. This study recommends the suitable waste disposal technique for the Nagpur city on the basis of Ultimate and Proximate analysis. The analysis shows that the solid waste of the city has high moisture content, organic content and high C/N ratio, making composting a best suitable technique for disposal. Revenue and employment can be generated by proper disposal of MSW in Nagpur city and hence help in financing the resources for the propagation of Swachh Bharat Abhiyan.

INTRODUCTION

Rapid industrialization and population explosion in India has not only led to the precipitous growth of cities but also the migration of people from villages to cities, which in turn generates thousands of tons of MSW daily. The MSW amount is projected to increase appreciably in the future [Sharma and Shah, 2005, CPCB, 2000 and Shekdar et al., 1992]. Flaws in collection, segregation, transportation, appropriate choice of technology for disposal etc., contribute to not only the accumulation of MSW even at public places. The management of MSW suffered till now due to the unavailability of suitable facilities to treat and dispose of the larger amount of MSW generated daily in metropolitan cities. Unscientific disposal causes an adverse impact on all components of the environment and human health [Rathi, 2006, Sharholy et al., 2005, Ray et al., 2005, Nema, 2004, Jha et al., 2003,Kansal, 2002, Kansal et al., 1998, Singh and Singh, 1998 and Gupta et al., 1998].

The general practice is to dispose off MSW in low-lying areas, open plots, any free land without taking any precautions or operational controls. Therefore, Municipal Solid Waste Management (MSWM) is one of the major environmental problems of Indian cities. It involves generation, storage, collection, transfer and transport, processing and disposal of solid wastes. MSWM requires proper infrastructure, maintenance and scientific upgrade for all activities by incorporation of latest technologies. This makes this process all the more expensive and complex due to the continuous and unplanned growth.

The difficulties in providing the desired level of public service in the urban centers are often attributed to the poor financial status of the managing municipal corporations [Ramachandran et al., 2007, Mor et al., 2006, Siddiqui et al., 2006, Raje et al., 2001, Ahsan, 1999]. A lot of innovative and emerging techniques including use of information technology, data mining, web image mining and their applications [Bhateja et al., 2013] could be utilized for better MSWM.

CURRENT MSWM AT NAGPUR CITY

Nagpur city is the largest city in the central India with the population of 24,05,421 as per the 2011 census of India [Chandramouli and General, 2011]. Rapid Economic growth, increasing population and change in the living standards of city are the factors responsible for high generation rate of the Municipal Solid Waste (MSW) in the city. At present, Nagpur Municipal Corporation (NMC) is facing problems related to MSW collection, waste management, waste disposal and the lack of financial support from State or Central Government. The total solid waste generated in the Nagpur city is 504 tons/day out of which the waste collected by municipality is 300 tons/day while almost 204 tons/day of the waste remains uncollected [Modak et al., 2011]. This shows that the waste collection efficiency is about 60% which shows that the waste management techniques in the city are not efficient. The solid waste generated in city contains paper, textile, leather, plastic, metals, glass, ash with fine earth, and compostable matter with relative percentage composition of 4.5, 7, 1.9, 1.23, 0.35, 1.2, 53.4 and 30.40 respectively as shown in Fig. 1 [Sharholy et al., 2008]. There should be focus on designing intelligent machines for segregation and disposal of wastes in line with intelligent vending machines [Dua et al., 2014]. The waste collected from the city is taken to the dumping site at Bhandewadi dump yard. The waste is dumped there without any provision for collection and treatment of leachate. Also the processing of waste is done on a very small scale and a vermin-composting plant has also been setup at the dumping site.

ECONOMIC POTENTIAL OF MSW FROM NAGPUR CITY

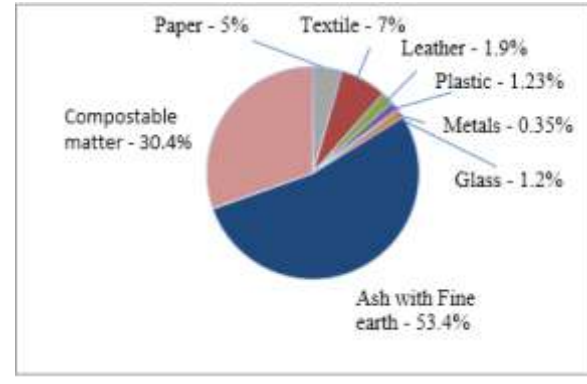

Figure 1: Percentage physical composition of Waste

One of the prime hindrances in waste management is the revenue needed for different aspects the process. By producing composts, recovering metals and recyclables etc. and selling them, a lot of money can be generated as well as saved by avoiding the future remediation burden that will be caused by indiscriminate disposal of waste into the environment. Revenue and employment can be generated by proper disposal of MSW in Nagpur city and hence help in financing the resources for the propagation of Swachh Bharat Abhiyan.

METHODOLOGY

For the Ultimate and Proximate analysis of the waste the values of percentage carbon, hydrogen, oxygen, nitrogen, sulphur and ash present in different components of the waste were taken from the literatures. The moisture content and higher heat values were also taken from the literatures for different types of waste components [Parikh et al., 2005]. The heat values and moisture content values taken from the literature show the range of values, the average value (middle value of the range) was taken for the calculation as shown in the table 1 [Parikh et al., 2005]

In proximate analysis the volatile part includes the carbon, hydrogen, oxygen, nitrogen and sulphur present in the components of waste whereas the inerts include the dust, fine earth and the ash component of waste. The ultimate analysis was done on the dry basis hence the dry weight of the waste is taken for the ultimate analysis of waste.

Total 6 chemical components of waste were considered including carbon, hydrogen, oxygen, nitrogen, sulphur and ash with fine earth. Based on the quantity of different components the chemical formula was estimated to represent this MSW of Nagpur city. The higher heat content of the waste was estimated by using the heat values of different components of the waste and the carbon to nitrogen ratio was also estimated by ultimate analysis. Based on these results the best suitable technique for the disposal of waste was suggested.

RESULTS AND DISCUSSION

Table 2 shows the chemical composition of dry waste in terms of C, H, O, N, S and ash contents. Collected MSW of the city contains huge quantity of ash and fine earth as high as 125.387 t out of total 222.4 t of dry waste and comprises of 56.38% of total dry waste. The waste collected in the city has the moisture content of about 77.6 t with 222.4 t of dry waste. The proximate analysis shows that the inerts content of the raw waste was 41.78% with the moisture and volatiles content of 25.87% and 32.35% respectively as shown in Fig. 2. The ultimate analysis of the dry waste shows the weight of C, H, O, N, S and ash in the waste was 64.519, 7.868, 22.003, 2.130, 0.465 and 125.387 tonnes respectively with percentage composition of 29.011, 3.538, 9.894, 0.958, 0.209 and 56.379 % respectively as shown in fig. 3. To represent this MSW the chemical formula was estimated to be $C_{358.4}H_{524.5}O_{91.7}N_{10.1}S$.

TABLE – 1
AVERAGE VALUES OF MOISTURE CONTENT AND HEAT VALUES TAKEN FOR CALCULATION

Components	Moisture content (% by weight)	Middle value of moisture content (% by weight)	Heat content (BTU/lb)	Middle value of Heat content (BTU/lb)
Paper	4 - 10	7	5000 - 8000	6500
Textile	6 - 15	10.5	6500 - 8000	7250
Leather	8 - 12	10	6500 - 8500	7500
Glass	1 - 4	2.5	50 - 100	75
Plastics	1 - 4	2.5	12000 - 16000	14000
Metals	2 - 6	4	100 - 500	300
Compostable	50 - 80	65	1500 - 3000	2250
Ash and fine earth	6 - 12	9	1000 - 5000	3000

Table -2
REPRESENTATION OF DRY WASTE IN TERMS OF C, H, O, N, S AND ASH CONTENT.

Components	Weight (tonnes)	C	H	O	N	S	Ash
Paper	12.6	5.481	0.756	5.544	0.038	0.025	0.756
Textile	18.8	0.094	0.019	0.075	0.019	0.000	18.593
Leather	5.1	3.060	0.408	0.592	0.510	0.020	0.510
Glass	3.5	0.018	0.004	0.014	0.004	0.000	3.434
Plastics	3.6	2.160	0.259	0.821	0.000	0.000	0.360
Metals	1.1	0.050	0.007	0.047	0.001	0.000	0.996
Compostable	31.9	15.312	2.042	11.994	0.829	0.128	1.595
Ash and fine earth	145.8	38.345	4.374	2.916	0.729	0.292	99.144
Total	222.4	64.519	7.868	22.003	2.130	0.465	125.387

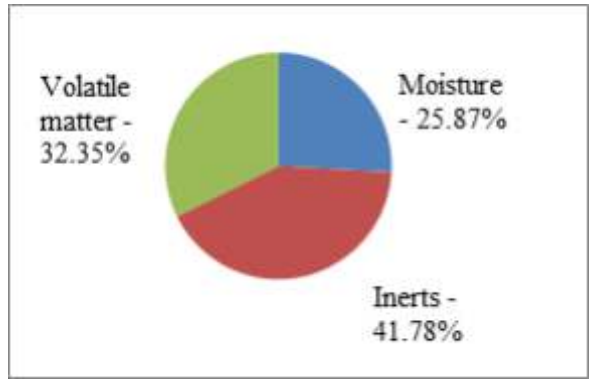

Figure 2: Percentage composition of solid waste

The Higher Heat content of the raw MSW and dry waste was estimated to be 7913.11 Kg/KJ of raw MSW and 10674.161 Kg/KJ of dry MSW. The result shows that the waste generated in the Nagpur city is suitable for the thermal technique of disposal by using incineration. Also the Carbon to Nitrogen (C/N) ratio of the waste was estimated to be 30.29 hence making the waste suitable for composting. The analysis shows the solid waste of the city has high moisture content, organic content and high C/N ratio, making composting a best suitable technique for disposal.

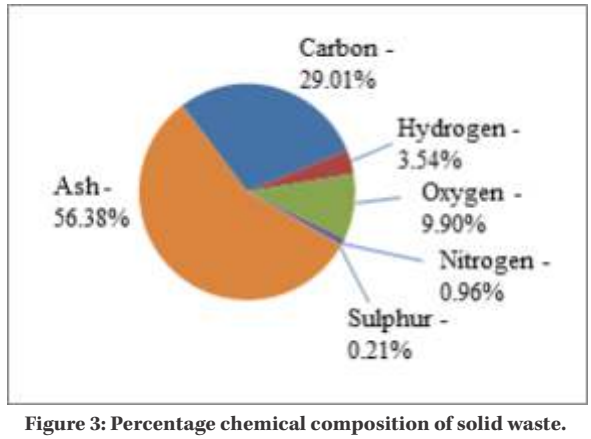

Figure 3: Percentage chemical composition of solid waste.

CONCLUSIONS

The existing waste management system of the Nagpur city is not efficient in terms of collection and disposal. Since the population of the city is increasing rapidly so there is the need of improvement in exist-

ing waste management system of the city. The waste has high moisture content of about 25.87% which shows the incineration is not suitable for disposal of waste. MSW of the city has high value of C/N ratio, high moisture content and high organic content hence making composting and sanitary landfilling after recovery of metals and recyclables the best disposal techniques. These will also give employment and revenue generation opportunities in the long run for self-sustenance of the waste management facilities.

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