RESEARCH PAPER:

Assessment of windrow composting plant's performance at Keru, Jodhpur, India

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SUMMARY

Open windrow composting methods are become increasingly popular in India for processing of municipal solid waste (MSW). Windrow composting plant at Keru, Jodhpur consists of 100 TPD capacity of MSW processing. The plant was monitored over a period of one year (March 2010 to February 2011) and physico-chemical analysis was carried out for the composting process of six weeks. The indicators for windrow composting process were developed. It has been observed that the windrow composting process was gradual throughout the composting period. The compost production efficiency was found to be 60 per cent. The concentrations of C, N, P, K, C/N and pH of the produced compost were 9.05 per cent, 0.68 per cent, 0.56 per cent, 0.65 per cent, 13.52 and 8.03, respectively. The quality of compost was compared with the quality control parameters prescribed by FCO and found lower compliance in terms of C, P and K. Hence, the segregation of MSW at source is recommended so that biodegradable and non-biodegradable fractions of MSW should be collected separately and only biodegradable fraction should be used for windrow composting. This will improve the efficiency as well as the quality of compost.

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Key Words :
Municipal solid waste, Biological processing, Windrow composting, Stabilization, Compost, Volume reduction

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Composting is the controlled decomposition of organic matter through biological process, resulting in nutrient-rich humus, called compost (Narayana, 2009). Composting has a long tradition in India. The compost made out of urban heterogeneous waste is found to be of higher nutrient value as compared to the compost made out of cow dung and agro-waste. Composting of MSW is, therefore, the most simple and cost effective technology for treating the organic fraction of MSW. Full-scale commercially viable composting technology is already demonstrated in India and is in use in several cities. Its application to farm land, tea gardens, fruit orchards or its use as soil conditioner in parks, gardens, agriculture lands etc., is, however limited on account of poor marketing (Asnani, 2006).

India generates about 50 million tones of MSW every year from cities. Generation of MSW has continuously been increasing due to rapid expansion of the cities / towns with massive migration of population towards urban centres (CPCB, 2000 ; Asnani, 2006). More than 90 per cent of these wastes are dumped on outskirts of town and cities, which have serious environmental implications in global warming by emission of green house gases (GHGs). Composting MSW is seen as a low cost method of diverting organic waste materials from landfills, while creating a product for agriculture purposes (Sharholy *et al.,* 2008).

A study was undertaken for performance assessment of MSW windrow composting plant at Keru, Jodhpur, Rajasthan, for the period of one year. The MSW samples from every stage of composting process were collected and analyzed for physico-chemical parameters. Further, the compost production efficiency of the plant was also studied for the period of one year. After interpreting the results obtained from the study, the suggestions and recommendations were posed for improving the efficiency of the plant as well as the quality of compost.

EXPERIMENTAL METHODOLOGY

Site specifications:

The windrow composting plant of 100

TPD capacities is located at Keru, 18 km away from the city on Jodhpur-Jaisalmer Road. It consists of windrow platforms, maturation yard (covered at top), screening facilities (16 mm and 35 mm tromels), curing shed, and compost separator with packing facility. Fig. A shows the schematic diagram for windrow composting at Keru.

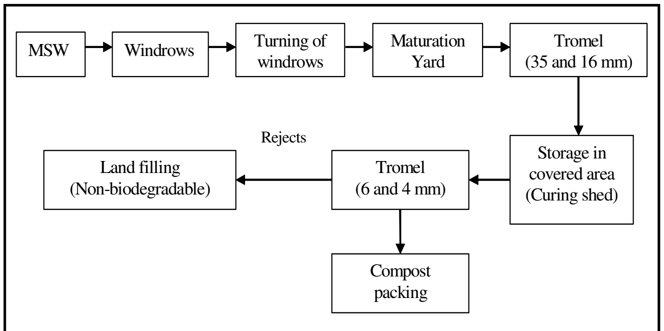

Fig. A: Schematic diagram of windrow composting process

Climate :

Jodhpur, popularly known as 'Sun City' has a tropical climate. The climate of Jodhpur district as a whole is characterized by extremes of temperatures, fitful and uncertain rainfall and dryness. The winter season starts in November and lasts up to February, followed by summer last up to June. The monsoon is between July and mid-September. The district has a considerable variation in maximum 47^0C and minimum temperature 3^0C in any typical year. The average normal annual rainfall is 318.70 mm, generally scanty and erratic (NBCCL, 2004). The average rainfall in the year 2010-11 was around 547 mm.

Sampling :

MSW grab samples were collected from windrows, maturation yard, curing shed and finished compost at the interval of seven days. The collected samples were segregated physically into various compounds like paper, glass, wood, plastic, leather, biodegradables etc. The remaining material was a uniform mixture of organic material along with soil, mud, sand and other inert materials that were not manually separable, and is termed mixed residue. About one kg of this mix from each sample was collected and brought to the Environmental Engineering Laboratory of Civil Engineering Department, M.B.M. Engineering College, J.N.V. University, Jodhpur, oven dried, grinded and fixed for physico-chemical analysis. The samples were collected and analyzed for six cycles throughout the year.

Analyzed parameters :

The temperatures were recorded at the plant itself on daily basis. Moisture content, pH, V.S., C, N, P, K, C/N ratio and bulk density were analyzed in the Environmental Engineering Laboratory of the department for the entire composting process. Analytical approaches were based on the standard methods prescribed in IS: 9235-1979 and IS: 10158- 1982 as well as APHA, AWWA, WEF, 1992.

Experimental Findings and Discussion

The results obtained for each stage and for the total composting process are presented in Fig. 1 to 8. The average quantity of raw MSW entering the composting system was 100 TPD, which was equivalent to the expected design. The observed averages of temperature, moisture, pH, V.S., C, N, P, K, C/N and bulk density were 34.66 per cent, 24.79 per cent, 7.13, 24.01 per cent, 14.07 per cent, 0.64 per cent, 0.65 per cent, 0.73 per cent, 22.27 and 540 kg/m^3, respectively. Thus, the raw MSW at Keru could be classified as high inert content with less biodegradable matter due to mixed waste and the C/N ratio was just at the ideal range (Tchobanoglous *et al.,* 1993).

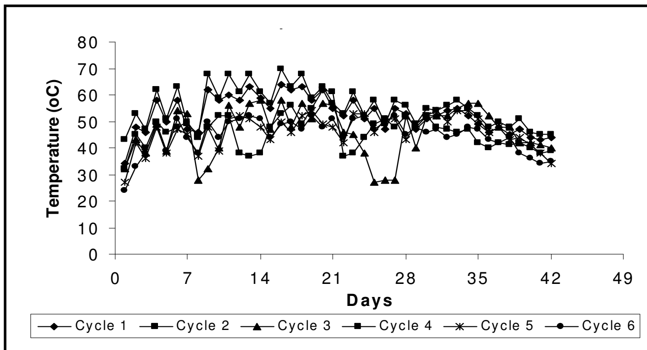

Fig. 1: Temperature variation during composting process

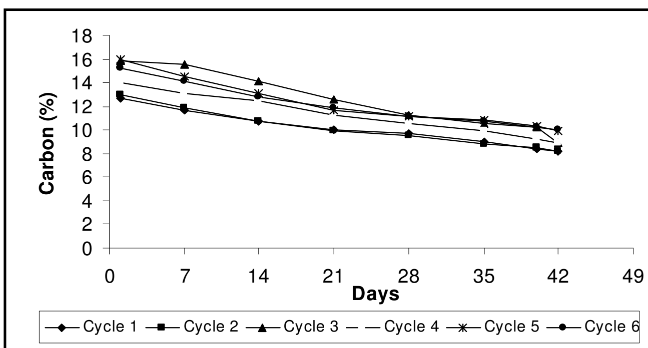

Fig. 2: Carbon variation during composting process

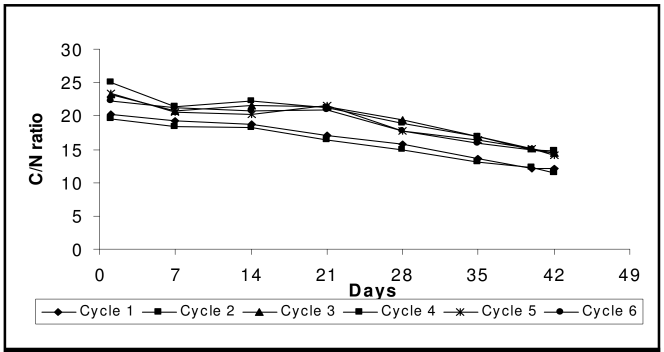

Fig. 3: C/N ratio variation during composting process

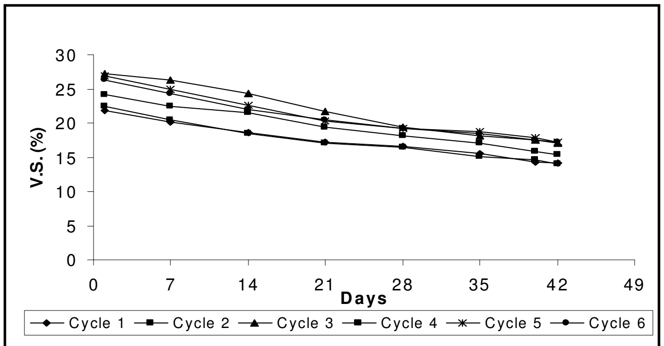

Fig. 4: V.S. variation during composting process

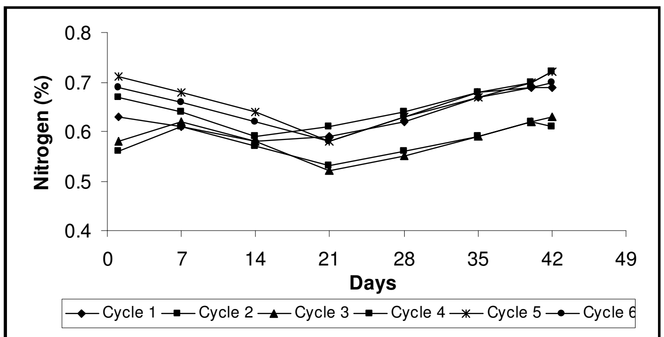

Fig. 5: Nitrogen variation during composting process

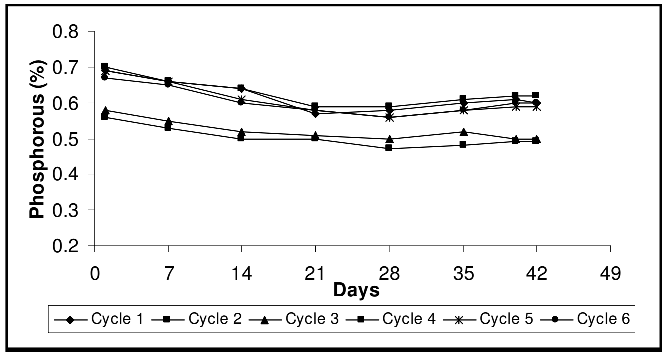

Fig. 6: Phosphorus variation during composting process

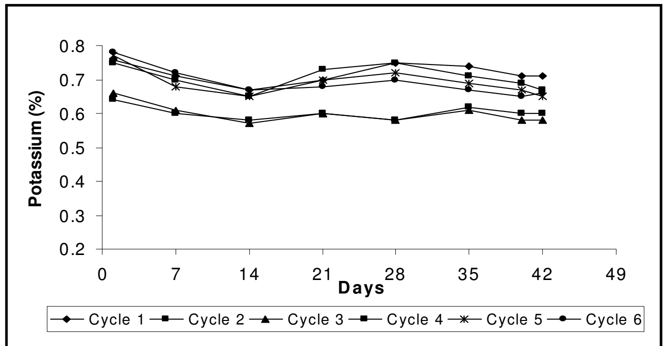

Fig. 7: Potassium variation during composting process

Analysis of process indicators:

Fig. 2, 4 and 5 show the indicators of the windrow composting process, which indicated that the process was gradual throughout the composting process of six weeks. The Final C, N, P, K and C/N ratio were 8.72 per cent, 0.67 per cent, 0.57 per cent, 0.65 per cent, and 13.51, respectively (Table 1). Further, the production of compost in cycle 1 and 2, cycle 3 and 4 and cycle 4 and 6 were 12 t/d, 8 t/d and 10 t/d, respectively, which indicated 50-60 per cent production efficiency.

Table 1: Performance of windrow composting process

Cycle		*V.S (%)*	*C (%)*	*N (%)*	*P (%)*	*K (%)*	*C/N*	*Compost production*
1.	Initial	21.85	12.66	0.63	0.69	0.76	20.23	12 t
	Final	14.16	8.22	0.69	0.60	0.71	12.03	
2.	Initial	22.47	13.03	0.67	0.70	0.75	19.61	12 t
	Final	14.05	8.15	0.72	0.62	0.67	11.41	
3.	Initial	23.30	13.51	0.58	0.58	0.66	23.22	8 t
	Final	15.71	9.11	0.63	0.50	0.58	14.48	
4.	Initial	24.21	14.04	0.56	0.56	0.64	25.00	8 t
	Final	15.33	8.89	0.61	0.49	0.60	14.75	
5.	Initial	26.94	15.91	0.71	0.69	0.77	23.40	10 t
	Final	17.18	9.97	0.72	0.59	0.65	14.06	
6.	Initial	26.31	15.26	0.69	0.67	0.78	22.16	10 t
	Final	17.27	10.01	0.70	0.60	0.66	14.43	

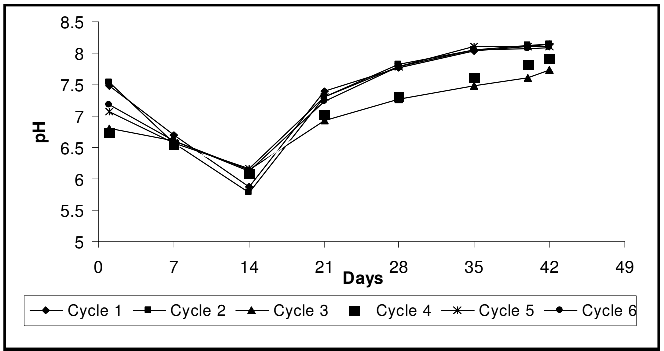

Fig. 8: pH variation during composting process

The temperature of the windrow was recorded every day using a compost thermometer at different points in the windrows (at extreme right and left edges and middle of the windrow to a depth of 15 to 20 cm). The temperature profile (Fig. 2) showed that the average temperature of the composting material changed according to typical temperature profile. The temperature remained above 60 °C for three weeks in cycle 1 and 2, which had experienced sufficiently high thermophilic temperatures and will result in almost complete destruction of pathogens. During composting period, the moisture content was monitored and maintained between 40 to 60 per cent. The volatile solids were gradually decreased throughout the composting period (Fig. 5). The final C/N ratios of the MSW composting process ranged between 11.41 to 14.75. The final carbon contents were observed in the range of 8.15 to 10.01 per cent. The nitrogen content of the final compost was more than 0.50 per cent in all cycles, phosphorus content was less than 0.50 per cent in cycle 3 and 4, whereas, the potassium content was less than 0.80 per cent in all cycles. This indicated that the quality of compost produced in Keru windrow composting plant was lower compliance in respect of C, P and K as per the prescribed limits given by fertilizer control order (FCO), 1985 (Saha *et al.,* 2010).

The production of compost in first two cycles was more as compared to other cycle, this is mainly due to acceleration of microbial activities as temperature was high than other cycles. The production of compost was reduced in cycle 3 and 4 because of the possibility of anaerobic conditions due to rains. The production was less in cycle 5 and 6 mainly due to slow composting process. Thus, the windrow composting plants operational efficiency was found to be about 60 per cent. Non-segregation of biodegradable wastes before composting can be ascribed as one of the major reasons for such lower compliance in respect of above important fertility parameters. Therefore, the segregation of MSW is urgently recommended for Keru MSW treatment plant prior to composting so that the quality of the compost as well as the operational efficiency of the plant might be significantly improved.

Conclusion:

The windrow composting process in Keru MSW treatment plant was found to be gradual throughout the composting process. The compost production efficiency was about 60 per cent. The quality of compost produced in Keru MSW treatment plant did not satisfy the quality control standards in respect of C, P and K. Hence, it is concluded that the quality of compost can be improved by using only biodegradable fraction of MSW as feed stock for composting process, further it will improve the operational efficiency of the plant also. The non-biodegradable fraction of waste can be directly landfilled, which reduces the emission of GHGs and safeguard the environmental pollution and health hazards. Extensive odor can be minimized by regular turning of windrows. The composting of MSW is a simple process, which reduces the volume of MSW, reduction in LFG production and leachate concentrations, reduce after care process as well as reduces the quantity of waste landfilled, thus, increasing the life of landfill area.

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