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REVIEW ON RAPID COMPOSTING TECHNIQUES FOR MUNICIPAL SOLID WASTE

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Abstract - *Rapid urbanization has led to tremendous increase in the quantity of waste produced. Significant rise has been observed in generation of municipal solid waste over the years. This has led to inefficient management of the waste and this waste is conventionally open dumped or landfilled which further leads to environmental degradation. The fraction of organic waste in MSW is high and hence method of composting can be utilized for management of this waste. Composting is the controlled conversion of degradable organic products and wastes into products with the aid of microorganisms. Composting, besides reducing the volume of waste generated and provides nutrients for plants. As conventional composting being time extensive process, this method is inefficient to manage the total municipal waste generated due to time and place constraint. Hence rapid composting techniques, which is time intensive process and takes up to 4 to 6 weeks can be utilized for the management of MSW. In this review paper we have summarized various rapid composting techniques which can be adopted for the efficient treatment of MSW.*

Key Words: **Rapid Composting, Municipal Solid Waste, Municipal Solid Waste Management, Aerobic Decomposition**

1.INTRODUCTION

This Municipal solid waste (MSW) which is generated via rapid population growth, improved technology, economic development and changing consumption habits has been increasing gradually. MSW includes both domestic and commercial waste account for a relatively small part of the total solid waste stream in developed countries [1]. The socioeconomic conditions, cultural habits, population, urban infrastructure are the factors that affect the quality and quantity of the MSW [2]. This MSW comprises of 68% organic waste [3] and with moisture content around 85 to 90% [4]. These organic matters include food, leaves and grass, branches and stumps, and manure [5]. The waste generated by India is itself around 100000 metric tons per day and the waste produced by the large metropolis cities such as Delhi and Mumbai are around 8300 and 9000 metric tons per day. Now the MSW generation is about 1.5 billion tons per annum, if the generation of MSW rate increases continuously then the rate of waste generation is projected to be 2.5 billion tons per year in the coming years [6]. This generated waste is often improperly managed using conventional methods like landfilling and open dumping [7]. Due to the higher percentage of organic fraction this waste can be treated with the process of composting. The normal time taken for composting in most methods is long, ranging from 100-180 days. These conventional methods are time consuming and inefficient in managing the quantity of waste produced. This inefficiency is caused due to the time and space constraints. Considerable research has therefore been done to accelerate the composting process. This is possible by the introduction of suitable microorganisms with demonstrate efficiency in the rate of organic matter decomposition or by variations in the physical processes [8].

2.Rapid Composting Techniques

2.1 Excel Technology [IISS Bhopal]

Excel technology based on the process of aerobic composting was developed by Excel Industries, Mumbai. This technology is largely used in large-scale mechanical composting plants. The methodology consists of the following steps and operations. Long windrows, about 5 m wide and 2-3 m high (deep) are erected and the municipal solid waste is then stacked in the windrows. A mixture of heterogenous materials is composted without segregation and the segregation is done at the finishing stage when the compost is ready. Bio conversion of wastes starts with the leveling of dump site, either cemented or paved with bricks on the bottom to prevent the escape of leachate and for easy movement of waste carrying vehicles. A 'slurry culture' containing active decomposer bacteria and enzymes is then added to the windrows to initiate rapid aerobic decomposition of the waste biomass. The culture is known as 'Celrich substrate' DF BC-01.

Table 1: Chemical composition Of Celrich Substrate

pH	7-8.2	Mg	0.7%
Total Organic Compounds	1.6%	S	0.5%
Nitrogen	1.5-2%	Fe	0.6%
P	1.25%	Zn	300-700 ppm
K	1.05-1.2%	Mn	250-740 ppm
Ca	1-2%	Cu	300-375 ppm

Ref: IISS Bhopal

About 1 kg of the slurry culture in colloidal emulsion form is mixed with 20 liters of water and used for spraying on about 3m of solid waste. The slurry is spread on the surface of garbage and inside the heaps in the windrows with help of probes, so that it penetrates every pocket of the heap. It is prepared after analyzing the composition of the waste and identifying the predominant materials such as celluloses, hemicelluloses, lignins, proteins, fats, etc. The microbes produce hydrolytic enzymes such as cellulase, lipase, amylase, protease, pectinase and phospholipase to breakdown the long chain compounds in the substrates. The heaps are turned once in 7-10 days for proper aeration and inoculant slurry is sprayed during each turning to enhance decomposition and to maintain the moisture level at 45-55%. The entire process of garbage decomposition is completed within 4-6 weeks and then the temperature comes down to normal. Segregation and sieving are done after the decomposition process is complete. The process recovers over 90% to the initial organic matter as compost [8].

2. 2 Microbially Enriched Compost for recycling of Municipal Solid Waste

Method of Preparation: This methodology was developed at Indian Institute of Soil Science. Compost was prepared by pit method. The pit should be concrete made so that the nutrients may not percolate in to the soil. About 2000 kg of wastes can be accommodated for decomposition in a pit (10 ft length x 5 ft width and 3 ft deep) method.

Ingredients Required: Waste materials (segregated material is preferable), fresh cow dung, urea, water, bioinoculum and polythene sheets**.**

200 kg of fresh waste is spread on the floor followed by 40 kg of fresh cow dung (on dry weight basis). 2.64 kg urea (0.5 % N basis) is dissolved in 20-liter water and is sprayed over the layer. Bioinoculum is added in the form of slurry on the layer (8 layers). These steps are repeated till the heap attains 3-4 feet high. Fungal culture is added at 500 g mycelial mat/tonne of material. Initially, at 1-5 days, bioinoculum such as *Aspergillus heteromorphus, Aspergillusterrus, Aspergillus flavus* and *Rhizomucorpusillus* is added and owing to a high initial temperature (55 to 70 C) at the thermophilic stage, the bioinoculum is again added after 30 days of decomposition. Finally, the upper side of the pit is covered with cow dung slurry. To avoid rain, wind and to maintain the moisture and temperature, one-polythene sheet must be used to cover the heap. After 3-4 weeks of decomposition, the first turning of heap must be done. Maintain the moisture content at 60-70% of materials on dry weight basis. Compost will be ready after 2.5 months. For 1000 kg microbial enriched compost production, the total quantity of fresh waste material, cow dung, urea required will be 1600, 320 and 21 kg respectively [8].

2.3 Berkley Rapid Composting Method

BRC advocates shredding and frequent turnings of composting material. This method suggests that any organic material can be composted best if it is between ½ to 1 ½ inches in size [9]. A size reduction of the particles and the resulting enlargement of the available specific surface can support the biological process. For the composting process to work most effectively, the material to be composted should have a C:N ratio of 30:1 [10]. Berkley method also uses mineral compounds like ammonium sulphate, chicken manure, urine [9]. Composting works best where the moisture content of materials in the pile is about 50 percent. Too much moisture creates a soggy mass, and decomposition will then be slow and the pile will smell. Where the organic material is too dry, decomposition is either very slow or does not occur at all. The compost pile needs to be turned to prevent it from overheating. If the temperature in the pile rises much above 71 °C, the micro-organisms will be killed, the pile will cool, and the whole process will have to start again from the beginning. Turning the pile prevents overheating and aerates the pile, both necessary conditions for keeping the most active decomposers functioning. The pile should be turned in a manner that the material is moved from the outside to the center. In this way, all the material reaches optimal temperatures at various times. After the compost has been turned, the plastic is placed directly on the top of the compost and is tucked in around the edges. If the material in the pile is turned every day, it will take two weeks or a little longer to compost. If turned every other day, it will take about three weeks. The longer the interval between turning, the longer it will take for the composting to finish. The rapid decomposition can be detected by a pleasant odor, by the heat produced (visible in the form of water vapor given off during the turning of the pile), by the growth of white fungi on the decomposing organic material, by a reduction of volume, and by the materials changing color to dark brown [10].

2.4 North Dakota State University Hot Composting

In this technique in order to keep the aerobic bacteria population high and active, 0.12 kg of actual nitrogenous fertilizer should be added per cubic foot of dry matter and holes punched (four to five) into the center of the pile [11]. Compost piles with a height of 1.8 m are raised. The maximum size of the organic matter pieces should be 15–23 cm long. The dimensions of the bin should be about 152 × 152 × 183 cm. This is best done in phases or stages as the compost pile is building up. In this high temperature, bacterially active system, it is best to turn the composting material every three or four days. Once activated, the temperature range should be 49–71 °C. The decomposition happens more rapidly in summer (as short as three to four weeks) and take more time in spring and autumn. Once the compost is no longer hot and is an odor-free, crumbling material, it is ready for use [12]**.**

2.5 Rapid composting of MSW by Chemical Addition

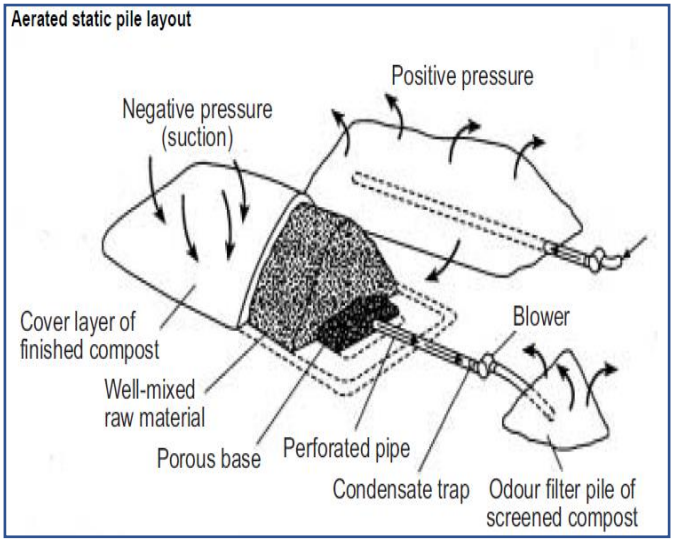
It has been reported that the addition of chemical agents such as phosphogypsum, bauxite residues etc. could enhance biodegradation of Municipal solid waste in the landfill [9]. Phosphogypsum and superphosphate had no negative effects on compost maturity, although superphosphate inhibited the temperature rise in the first few days [13]. Since phosphogypsum is enriched with sulfate, it is reasonable to assume that a sulfate using bacterial colony present in landfills will use phosphogypsum as an energy source after oxygen is depleted. The use of phosphogypsum as landfill cover can enhance biological decomposition of MSW [9]. Bauxite residue having good amount of trace elements can supply micronutrients to the growing microbes thereby increasing the rate of microbial activity. It is also found that bauxite addition increases pH, temperature and the rate of aeration of the composting mixture. It has been observed that the increases in water storage and retention and microbial activity induced by additions of the composts is likely to improve the properties of bauxite-processing residue sand as a growth medium but that allowing time for soluble salts, originating from the organic amendments, to leach out may be an important consideration before sowing seeds [14]. All these changes are expected to facilitate the rate of degradation of organic waste. Addition of glucose as instant carbon source into the composting mixture was also found to be useful in accelerating the rate of decomposition [9].

2.6 Rapid Composting by Forced Aeration Method

Gas exchange is crucial during compositing because oxygen based microbial metabolism is more efficient than fermentation. Lack of oxygen is a common reason for composting failures. Oxygen concentrations are determined by rates of diffusion and microbial uptake. Passive diffusion within the interstitial atmosphere is too slow to supply a large composting mass with sufficient oxygen; therefore, active ventilation is required.

Mechanical forced aeration, based methods like “Aerated static pile” reduce the composting time period further, allow for higher, broader piles and have lower land requirements as well [9].

The aerated static pile method takes the piped aeration system a step further, using a blower to supply air to the composting materials. The blower provides direct control of the process and allows larger piles. No turning or agitation of the materials occurs once the pile is formed. When the pile has been formed properly and where the air supply is sufficient and the distribution uniform, the active composting period is completed in about three to five weeks. It offers inherent advantages of odour control, accelerated decomposition as well as better control over the entire process.



Source: NRAES-114, 1999

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3. CONCLUSION

The extensive rise in the quantity of Municipal Solid Waste has created inefficiency in the management. Meanwhile the rejuvenation of degraded soils by protecting topsoil and sustainability of productive soils a major concern at the international level. Fraction of organic waste being high in MSW creates an opportunity composting. Compost, being good quality organic soil additive enhances the water holding capacity and nutrient supplying capacity of soil and also the development of resistance in plants to pests and diseases. Conventional composting methods being space and time extensive creates inefficiency which further leads to environmental degradation. Rapid composting being time and space intensive processes helps in efficient management of this valuable resource and solving the problems associated with landfills and incineration meanwhile providing good quality soil additive. Rapid composting thus is a waste management solution which can benefit municipalities, agriculture and environment at the same time [10].

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