Composting of urban solid wastes

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1. INTRODUCTION :

The paper reviews the present status of composting in various cities and towns of India and brings into focus some of the basic short comings in the technology that is holding up the progress of an otherwise sound programme. The authors suggest an appropriate technology with optimal degree of mechanisation suited to the refuse characteristics and techno-economic resources of the local government bodies in India, in the light of their experiences in the pilot compost plant in South suburban municipality, Calcutta.

2. COMPOSTING : BASIC PROCESS KINETICS :

In composting the aim is to provide Optimal areation, moisture, and temperature for the bacteria, moulds fungi and other form of life to flourish and perform their task in the stabilisation and decomposition of the wastes at rapid pace.

The organisms work on the surface of the organic wastes. Therefore, the speed, thoroughness, and uniformity of decomposition are improved if the material is first shredded in smaller pieces to increase the surface area exposed to biological activity. However grinding the particles to sizes less than 2" adversely affect aeration.

Mechanical compost plants for Municipal Solid Wastes consists of the following steps.

i. Reception
ii. Segregation and picking
iii. Compost preparation (shredding, pulverisation, magnetic removal of metals etc).
iv. Decomposition-In Windrows. -Aeration in enclosed cells.
v. Stabilisation in maturing yards.
vi. Post treatment (screening).
vii. Marketing.

These are the basic steps which are to be found in almost all process designs that are currently available in this country.

3. PRESENT STATUS OF COMPOSTING IN INDIA :

The physical and chemical characteristics of Indian city refuse, show that 40 to 60% of it is compostable and that it has adequate nutrients (NPK), optimal moisture content of 40 to 50%, and Carbon to Nitrogen ratio of 25 : 1 to 40 : 1. Hence, composting of city garbage can produce good quality organic manure and soil conditioner, at a cost which is much lower than that of artificial fertilisers. Considering the scope, need, value and importance of conversion of city refuse into organic manure, in the interest of both agriculture and sanitation, Indian Ministry of Agriculture, is subsidising city compost plants and assisting them in management and maintenance of plant as well as marketing their products. At the moment in India, two metnods of composting is practiced by different municipal organisations.

a) Pre-treatment or Post-treatment windrowing (Mechanical/semi-mechanical/mannual) : Larger City Corporation/municipalities.

b) Indore or Bangalore method of composting of refuse with night-soil in masonary pits or earth-trenches : Small and medium Municipalities.

Pre-treatment or Post-treatment Windrowing :

During the last decade, Mechanical compost plants of the above type, have been constructed in 25 cities which now treat 10 to 20% of Urban Solid wastes in most of the important cities in the country. A careful study of the Indian situation will reveal that.

i) Designs of various mechanical components of pre-treatment or post-treatment is yet to be standardised. In many of the existing plants inappropriate technology and unnecessary mechanisation has resulted in higher cost of production. Advantages of mechanisation should be made

TABLE : 1 - Relative Cost Effectiveness of Different Methods of Composting in INDIA

	Method of Composting	Capacity tonnes/day	Area required (M^2)	Production cost. Rs./ tonnes	Sale Price Rs/Tonnes	Remarks.
1.	Indore/Bangalore Method(Manual)	1 to 20		1 to 30	1 to 35	36% of the plants. are self paying.
2.	Windrow composting Post-treatment (Manual)	3 to 10 T	500 to 1000	30 to 50	30 to 50	Self paying
3.	- do -	10 to 20 T	1500 to 2000	20 to 40	30 to 50	Self paying
4.	-do-(Semi-mech)	50 T	4000	20 to 30	30 to 50	
5.	Post-treatment (semi-mechanical)	200 T	10,000 to 20,000	50 to 60	40 to 50	Could be self paying.
6.	Pre-treatment (Mechanical-Western type)	200 T	10,000 to 20,000	100	40 to 50	Losing

use of, but-turn-key projects of patented process developed for western conditions requiring high degree of skills for operations and maintenance, as have been done for many of the present plants in India, would be counter productive.

ii) Costly pre-treatment units like, hammer mills, magnetic seperator, mechanical aeration system etc. may not generally be required for Indian refuse, which comes mostly in sizes less than 2" and contains negligible amount of ferrous metals.

iii) Manually operated windrow plants would be cost effective upto 30 Tons/day capacity i.e. for a population of 60,000. At this level the transportation cost of refuse and compost would also be minimal. Hence, manual composting could be an ideal disposal method for small and medium suburban towns at close proximity of agricultural hinterland.

iv) For plants receiving 100 tons or more some mechanisation would be necessary for handling and turning of windrows and post-treatment.

v) One ton of finished compost produced from the Indian city refuse, would contain about 20 Kg. of Nutrient (NPK) value. At the current market conditions, it would be worth Rs.100/- (£ 1 = Rs.15/-, 1983). A semi-mechanical compost plant, with minimum mechanisation for handling and turning of windrows and post-treatment, would be able to produce it @ Rs. 50/- to Rs.60/- per ton. But the paradox of Indian situation is that unnecessary and avoid-able mechanisation, have pushed the production cost to Rs.100/- per ton and in absence of adequate sales-promotion efforts, most of the City Corporations are finding it difficult to sell their product at that price. Inadequate planning, inappropriate technology and poor management, is holding up the progress of a basically sound programme. However, one should not lose track of the fact, that even at the present level of production cost and market price, the net disposal cost of urban solid waste through composting, varies between Rs.15/- to Rs.20/- per ton, which is marginally higher than the cost of sanitary land filling as practised by the Delhi Municipal Corporation and almost comparable to the cost of crude dumping carried out by the Calcutta Corporation. Table-1 shows the relative cost effectiveness of different methods of composting. Table-2 shows the break up of capital O & M costs for manual, compost plant.

4. PILOT STUDIES ON MANUAL/SEMI-MECHANICAL COMPOSTING :

The pilot compost plant was developed to study the following aspects:

i) Considering the characteristics of Indian city refuse, effect of mechanical pre-treatment like shredding, grinding pulverisation etc. on the quality of finished compost.

2) Technical and economic feasibility of completely manually operated wind-row compost plants in respect of Land and labour requirement, production cost, quality of compost and its marketability and minimal and maximal plant capacity.

3) Optimal level of mechanisation needed for larger plants in respect of land requirement, production cost and capacities of municipalities to operate and maintain them.

A layout plan of the pilot compost plant is shown is fig. 1, and land requirement, labour, capital and O & M costs etc. are shown in Table-2.

TABLE : 2

Unit Cost of Manual Composting.

Capacity = 10 T refuse per day.

Required land area = 15000m^2 = 0.15 Ha.

A. Capital Costs	(In Rs.)
1. Land Cost @ Rs. 5,97,600/- per ha.	89,600/-
2. Screen	5,000/-
3. Fencing gate, flooring	50,000/-
B. Operating Costs (Annual average)	
1. Amortization @ 17%	9,350/-
2. Labour	33,600/-
3. Tools and Plants, etc.	3,000/-
	45,950/-
Add 12½% for establishment and contingencies etc.	5,743/-
	51,693/-

O & M Cost = Rs. 17.23 per ton.

Disposal Cost through manual composting = Rs.17.23 + Rs. 3.00 = Rs.20.23/Ton

Production Cost = Rs.40.46/Ton compost.

Anticipated Income = Rs. 40 per ton of compost i.e. Rs. 20 per ton of refuse.

5. SALIENT FINDINGS OF THE STUDY :

On the basis of the experiences gathered so far the following observations could be made.

(a) It could be seen from Table - 3 that manually operated windrow compost plants, without any mechanical pre-treatment like pulverisation, grinding, shredding etc. could produce compost manure of chemical quality comparable to those produced by mechanical compost plants.

(b) A period of windrow-aeration between 16 to 21 days, with 3 turning in between and a turning period of four weeks would be necessary for manually operated plants. The process becomes more efficient with minimal pre-treatment of chopping of larger organic metters, which could be done by simple manually operated machines.

(c) A higher windrow-aeration time and a higher maturing time would be necessary for plants without any pre or post treatment whatsoever.

(d) Optimum watering is a prerequisite for efficient composting. With a manually operated tube-well with a force-lift pump and a 25 mm polythene pipe, an worker can water effectively all the windrows of a plant of 10 T/day capacity.

(e) An efficient system of screening is an essential post-treatment, in absence of which the compost contains lot of fine grits, which are not liked by the farmers.

(f) For larger plants, scope of mechanisation is there for windrow turning and handling, watering, post screening and grinding. Mechanisation beyond this level would result in increasing the cost of production.

(g) A relative evaluation of production costs and returns from compost plants with varying levels of mechanisations are shown in Table - 1. It could be seen that small manually operated plants are more viable compared to highly mechanised plants. Semi-mechanical units would be appropriate for larger plants.

(h) Even though the actual production cost of compost manures, in the pilot plant was only about Rs. 40 per ton, the farmer had to pay about three times this amount, because of the high transportation charges, they had to pay to the private carriers. Unless the local government or the state government takes up the responsibility of marketing and distribution these plants would not be commercially viable. In order to minimise transportation cost of compost, they should be located close to the agricultural fields.

TABLE : 3 - Manually Operated Compost Plant Vs. Mechanically Operated One.

Type	Nutrient Content (% by weight)			Carbon Nitrogen	Production cost Rs./Ton of compost
	N.	P	K	Ratio	
1. Mech. Compost Plant, Calcutta	0.52	0.7	0.66	20	100
2. - Do - Delhi	0.66	0.51	0.87	17	100
3. Manually operated (Pilot project)	0.8	0.7	0.65	12 to 15	40

RLFERENCES :

1. Pilot Studies on Solid Waste Management in Municipal Towns.(Conducted by All India Institute of Hygiene & Public Health, supported by C.M.D.A./ World Bank). Report under submission.

2. 'Urban Solid Waste Management'- A report by Ministry of Works & Housing, Govt. of India.

3. FRANK FLINTOFF ' Management of Solid Waste in Developing Countries', WHO Publication.

FIGURE - 1. LAY-OUT PLAN FOR A MANNUALLY OPERATED WIND-ROW COMPOST PLANT.

CAPACITY=10 TONS REFUSE/DAY (POPULATION-20,000)
PRODUCTION = 5 TONS OF COMPOST MANURE/DAY.
AREA = 1500 M^2.