Composting : A Solution to Disposal and Management of Organic Solid Waste

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ABSTRACT

Present days, due to the increased environmental awareness around the world, disposal and management of organic solid waste generated from pulp and paper industry is a serious problem, especially the waste activated sludge from the activated sludge effluent treatment process. Due to the slimy nature, dewatering and disposal of waste activated sludge is becoming highly expensive and a difficult task. At the same time, disposal of bagasse pith generated from the bagasse based pulp and paper mill is also becoming a serious problem, due to its huge volume. Microbial composting is found to be an ideal solution for this unique problem. Mixture of these two waste i.e. Waste activated sludge and bagasse pith at proper ratio can be converted to useful organic manure by microbial composting.

INTRODUCTION

Paper Mills around the world produce various types of solid waste materials during various stages of paper manufacturing process. They are mainly primary and secondary sludge from the waste water treatment systems, lime and hypo sludge from the chemical recovery plant, fly ash and unburned rejects from boilers, bark and wood from wood based industry and bagasse pith from the bagasse based industries. Among these sludges secondary sludge i.e. waste activated sludge from the activated sludge process is found to be very difficult to dispose, because it contains mainly microbial biomass and partly decomposed organic residue which is slimy in nature. Due to its slimy nature, dewatering is found to be very difficult and expensive (1).

At present, in TNPL we are having activated sludge process to treat our waste water and it produces about 4 to 5 tons (OD basis) of sludge every day which needs to be separated and disposed off. Currently it is mixed with primary sludge and disposed off as landfill. After the expansion, we are producing around 100 tons (OD basis) of bagasse pith every day of which pith from depither with 50% moisture is used in the power boiler as fuel, pith from the new Chemical bagasse pulp mill pith press with 70% moisture is used in the power boiler after solar drying, pith from the old Chemical bagasse pulp mill pith press with 80% moisture is disposed off as land fill, finally sludge from the bagasse clarifier, containing mainly bagasse pith and some waste bagasse is mixed with secondary sludge (waste activated sludge) and disposed off as land fill. To reduce the pressure on the land

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filling of organic waste, various alternate systems were explored and also to convert the organic waste to useful product, one among them is microbial composting.

COMPOSTING

Composting is a microbiological process where all the organic residues of plant and animal origin is converted into humus rich organic manure using micro-organisms such as bacteria, fungi and actinomycetes. This is done by providing optimum conditions for bio-degradation of organic residues by micro-organisms. Composting is an age old practice. However, tremendous efforts has been put recently to improve this technique and it is applied even for the trouble-some waste such as municipal sewage sludge. Also, composting of lignocellulose substrate is an important process in modern mushroom cultivation where lignocellulose substrate is converted to humus rich compost and then used for mushroom cultivation. Basically, there are two processes i.e. anaerobic composting and aerobic composting mostly aerobic composting is employed because this process is fast and easy (2, 3).

ENVIRONMENTAL AND BIOCHEMICAL PARAMETERS CONTROLLING THE COMPOSTING PROCESS

Compost heap is a microecosystem where interaction between biotic and abiotic factors control the composting process. The main factors that control the composting process is: 1. Nature of raw materials (waste), 2. Carbon: Nitrogen ratio, 3. Moisture, 4. Aeration, 5. Temperature.

RAW MATERIALS

All the organic waste generated from our process is mostly plant origin i.e. bagasse pith, fibre and various type of pulps except Waste Activated Sludge (MLSS) from activated sludge process. These waste materials contains mostly cellulose, hemicellulose, lignin and protein. Except lignin, all others are highly susceptible to microbial degradation, on the other hand, lignin which contains aromatic polyphenols and phenylpropanoid polymers are resistant to microbial degradation.

CARBON (C): NTROGEN (N) RATIO

C:N ratio plays a very important role in the microbial food supply. C:N ratio between 30 to 50 is ideal for composting. Higher C:N ratio will increase composting time, on the other hand low C:N ratio i.e. high nitrogen will lead to loss of valuable nitrogen as ammonia, which may reduce the final quality of the compost.

MOISTURE

Water is essential for the microbial metabolism. Moisture any where between 60% to 70% is ideal for composting. Low moisture may reduce the microbial activity and at the same time high moisture may reduce the availability of air which in turn create anaerobic condition and lead to decreased activity.

AERATION

Good aeration may result in effective degradation and this can be achieved by turning the compost heap frequently.

TEMPERATURE

With the availability of air and water, micro-organism utilise the organic mater as food. The rapid utilisation of organic mater by micro organisms with increased metabolic activity rises the temperature of the compost heap to 50 to 60°C some times it even goes up to 80°C. This high temperature induces growth of thermophlilic micro-organisms and destroy the native pathogenic micro-organisms and worms present in the waste materials.

Waste activated sludge from the activated sludge process has relatively high nitrogen content of about 3.5 to 4.5% (4) when compared to other organic waste such as bagasse pith which has nitrogen content of about 0.4 to 0.6% (5). The mixture of these to wastes in proper ratio froms a ideal raw material for the composting. Therefore, studies were carried out at our mill site to work out the feasibility of microbial composting for organic solid waste disposal and management. The results are discussed in this paper.

EXPERIMENTAL

The experiments was divided into two phases, first phase is small scale study and second phase is large scale study. In the small scale study for the pile no. 1:bagasse pith (283 kg OD), waste activated sludge (201kg OD), bagasse clarifier underflow sludge (470 kg OD) and for pile no 2:mixture of primary clarifier sludge and bagasse clarifier underflow sludge (1096 kg OD), activated sludge (274 kg OD) were used as raw materials. Composting piles were formed

Table 1 (Pile No. 1)

(Small scale study)

Properties of organic waste generated from TNPL before and after composting.

S. No.	Parameter	Before Composting	After Composting
1.	Carbon %	47.0	28.8
2.	Nitrogen %	0.88	1.78
3.	C/N ratio	53.5	16.1
4.	Ash %	19.2	33.0
Raw materials used (OD basis)			
1.	Pith from pulp mill pith press	283 kg	
2.	Waste activated sludge (MLSS)	201 kg	
3.	Bagasse clarifier under flow sludge	470 kg	
	Total	954 kg	

manually by mixing all the raw materials thoroughly. For aeration, piles were manually turned upside down every week and moisture content was maintained around 60 to 65% by spraying water. Carbon and nitrogen contents were analysed using standard methods (6). For the large scale study, the sludge from the vacuum filter containing approximately 30% Waste activated sludge and 70% bagasse clarifier under flow sludge (mostly bagasse pith) was used as raw material to avoid manual mixing. Total weight of the raw material was around 110 tons with 79.1% moisture (20.8 tons OD). The length, breadth and height of the pile was around 80 X 3 X 0.75 meters respectively. Mixing and turning was done using the Dozer every week for aeration. Biochemical analysis were carried out similar to the small scale study.

RESULT AND DISCUSSION

The composting study was carried out for about four months. During that period micro-organisms started utilising the organic matter for its growth and metabolic activity. This is evident by the decrease in carbon content due to the microbial oxidation of organic matter (Tables 1 & 2). At the same time

Table 2 (Pile No. 2)

(Small scale study)

Properties of organic waste generated from TNPL before and after composting.

S. No.	Parameter	Before Composting	After Composting
1.	Carbon %	42.1	28.2
2.	Nitrogen %	0.86	1.65
3.	C/N ratio	48.9	17.1
4.	Ash %	20.0	35.8
Raw materials used (OD basis)			
1.	Waste activated sludge (MLSS)	274 kg	
3.	Bagasse clarifier under flow sludge & Primary clarifier under flow sludge	1096 kg	
	Total	1370 kg	

Table 3
(Large scale study)
Carbon and Nitrogen content during composting

Date	Carbon	Nitrogen	C/N
16.04.97	35.7	0.83	43.1
04.05.97	34.2	0.87	39.4
23.05.97	33.8	0.92	36.7
06.06.97	32.3	1.02	31.6
27.06.97	32.0	1.42	22.5
16.07.97	30.9	1.64	18.8
23.07.97	31.6	1.76	17.9
02.08.97	30.3	1.85	16.4

microbial growth and metabolism increased the microbial biomass which resulted in the decrease in C/N ratio and increase in nitrogen content (Table 1 & 2). Finally, after the composting, the C/N ratio had come down from 53.5 to 16.1 for pile 1 and from 48.9 to 17.1 for pile 2.

In the second phase, further studies on large scale using 110 tons of raw materials was carried out. To eliminate initial manual mixing, it was decided to use materials which comes out directly from the vacuum filter. Accordingly the filter was operated at 30:70 ratio (30 : Waste activated sludge, 70: bagasse clarifier underflow sludge which contains mostly bagasse pith) and out coming materials were used directly for composting. The values of carbon, nitrogen and C/N ratio during the composting is given in the table 3. The results are almost similar to the small scale study for example C/N ratio which had come down from 43.1 to 16.4. Overall, after the composting nearly 45% of materials was oxidised by micro-organisms results in 45% reduction in the total weight of the materials needs to be disposed off.

Raw sludge from waste water treatment system, both primary and secondary used for soil amendments elsewhere (4). These sludge contain mostly cellulosic materials and organic matter which can improve soil

Table 4
(Small scale study)
Properties of organic waste generated from TNPL before and after composting.

S. No.	Parameter	Before Composting	After Composting
1.	Carbon %	35.7	30.3
2.	Nitrogen %	0.85	1.85
3.	C/N ratio	43.1	16.4
4.	Ash %	25.0	31.5
5.	Weight (OD)	20.8	11.7

Raw materials used

1.	Waste activated sludge and Bagasse clarifier under flow sludge (30 : 70)	110 Tons
2.	Moisture	79.1%

Table 5

(Large scale study)

Compression of TNPL compost with others

S. No.	Parameter	TNPL Compost	CPPRI Compost* Compost	Cowdung* Manure
1.	Carbon %	30.3	35.1	29.35
2.	Nitrogen %	1.85	2.06	1.64
3.	C/N ratio	16.4	17.09	17.9
4.	Ash	31.5	36.5	47.0

*Dhingra et. al (1993)

moisture, nutrition retention and cationic exchange capacity. However relatively high carbon and low nitrogen i.e. high C/N ratio in the raw sludge cause competition for nitrogen between micro-organisms and plants which leads to the non availability of nitrogen to plants. During the composting process where microbial utilisation of carbon and conversion of nitrogen into microbial nitrogen in sludge results in low C/N ratio and high humus rich compost and also most of the microbial activity ceases in the compost yard itself. This reduces the microbial competition for the nitrogen in the soil and improves the availability of nitrogen to the plants.

CONCLUSION

Use of waste activated sludge and bagasse clarifier sludge for composting gives dual benefit. In the waste water treatment plant the disposal and removal of waste activated sludge is a serious problem today due to its resistance to dewatering which can be solved permanently by removing waste activated sludge and bagasse clarifier sludge in 30:70 ratio using vacuum filter. The removed filter cake can be converted into humus rich compost. This will reduce the load on the organic solid waste generation because nearly 45% of the raw materials is oxidised into CO_2 and water and the remaining in to product, i.e. compost which can be sold as organic manure.

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