# Status of Solid Waste Pollution From Indian Paper Industry and Future Prospects of its Management

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*ABSTRACT:-- All too often we tried to concentrate on some narrow aspect of Industrial activity, perhaps forgetting or ignoring some of the broader issues, such as how industry fits into the overall order of nature. Ideally industry should be as non-intrusive as possible, seeking wherever possible means of minimizing its impact on nature. A clean and healthy environment is vital for survival and welfare of human beings.*

*In this article, the authors have tried to analyze the solid waste pollution aspects in the Indian Paper Industry, particularly from small paper mills using non-woody raw material and suggest an integrated approach to tackle the problem and highlight the efforts which have been made in identification, quantification and reduction and utilization of solid wastes.*

## INTRODUCTION

Paper Industry generates large amount of solid waste which can be classified as organic and inorganic waste. At present, most of the waste is being landfilled. This waste creates nuisance and hazardous problems. In the future, solid waste disposal will become more problematic since environmental regulations for land fill will become more stringent, the sites available for the same will reduce, disposal costs will increase and socially the people will become more conscious about environment.

So, measures have to be taken to tackle the problem of solid waste disposal for cleaner environment.

The main effort should be towards minimization of waste at source but still if waste is there then it must be converted into some value added product because by definition 'a waste is deemed to have been one that is useless or of no use in a given context only'. This automatically implies that all wastes are useful and can be used or converted into products of greater utility in another situation or set up by due modification of waste or the situation. It to be noted that there is gross difference in wealth, use of resources, and quality of life between developing and developed countries. The wholesale imposition of Western technology will not solve the problem. The solution provided should take into account the following key issues.

1. Protection of health and environment at a level of cost that can be sustained locally (by mill).
2. Development of system based on local climate, physical, economic and social factors.
3. Production of efficient indigenous tools and equipment.
4. The achievement of high productivity from labour, equipment and motor transport.
5. Vocational and professional training of middle and top management.

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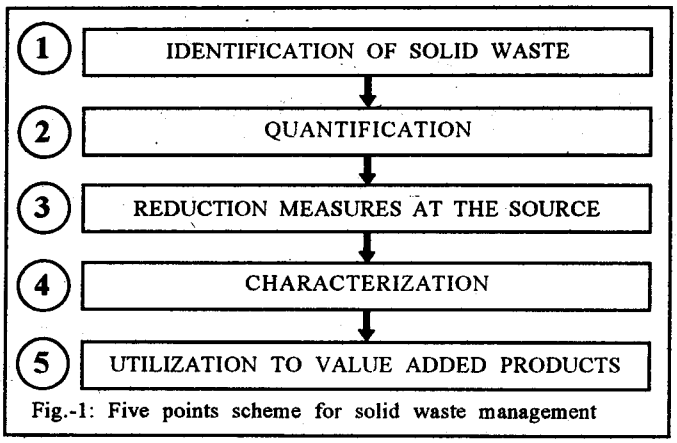

Fig.-1: Five points scheme for solid waste management

A five point scheme which is shown in figure-1, was planned by CPPRI scientists for solid waste management and these points are being discussed below step by step.

## IDENTIFICATION

The first point is to know about the source of solid waste generation and its nature. For identification of sources of solid waste generation, questionnaires were prepared and were sent to various Indian paper mills, mainly small paper mills using non-woody raw materials to collect the required data/information and also scientists from CPPRI visited various mills to collect on the spot information. The detail is as follows

| | Total | S.P.M.* | L.P.M.* |
|---|---|---|---|
| Questionnaires sent | 100 | 75 | 25 |
| Answers received | 21 | 10 | 11 |
| Mills visited | 13 | 10 | 3 |
| Mills included in survey | | 13 | 8 |

(Two small paper mills using non-woody raw materials were selected to gather extensive data)

* S.P.M.: Small Paper Mills, L.P.M.: Large Paper Mills

Based on the questionnaires response and study conducted by scientist in 1990-91, the main sources of solid waste have been indentified and listed in Table-1 and have been classified as organic/combustible and inorganic/incombustible solid waste.

## QUANTIFICATION

The amount of solid wastes generated has been estimated by the data based on the study conducted by CPPRI scientists and on questionnaires response received from the mills using non-woody raw material is shown in Table-2. The bar diagrams and pie diagrams regarding solid waste have also been

**Table-1**

**Points of solid waste generation from Indian Pulp and Paper Mill**

| Small Paper Mill | Big Paper Mill |
|---|---|
| 1. Organic Solid waste. | |
| (a) Storage | (a) Raw material preparation (Wood/Bamboo dust) |
| (b) Raw material preparation (Straw dust, Pith) | (b) Screening and cleaning rejects from pulp mill. |
| (c) Screening and cleaning rejects from pulp mill. | (c) Screen and cleaning rejects from paper mill. |
| (d) Screen and cleaning rejects from paper mill. | (d) ETP sludge. |
| (e) ETP sludge. | |
| 2. Inorganic Solid Waste. | |
| (a) Ash from boilers. (Only power boilers). | (a) Ash from boilers. (Recovery and Power boilers) |
| (b) Lime sludge grits from bleach liquor preparation. | (b) Lime sludge and grits from bleach liquor preparation and Recovery process. |

**Table-2**

**Total solid waste summary**

(Average of data collected from 13 small paper mills using agro waste as raw material)

The raw material base was:

| | Av.T/day | % | Moisture(%) | Yield(%) |
|---|---|---|---|---|
| Straw (rice and wheat) | 49 | 42 | 15 | 40 |
| Bagasse | 31 | 27 | 50 | 40 |
| Sarkanda grass | 16 | 14 | 15 | 35 |
| Cotton linter | 3 | 3 | 10 | 70 |
| Gunny bag, Hessian | 5 | 4 | 10 | 70 |
| Waste paper | 9 | 8 | | |
| Purchased Pulp | 3 | 2 | | |
| Total Raw material | 117 | | | |
| Tons Produced | 44 | | | |
| Tons RM/T Paper | 2.67 | | | |

The solid waste were categorized as follow

| | Kg/T Paper | Percentage Group | Percentage Total |
|---|---|---|---|
| Organic Solid waste | | | |
| Raw material handling | 397 | 59 | 34 |
| Storage | 217 | | |
| Preparation | 180 | | |
| Rejects | 96 | 14 | 08 |
| Pulp mill | 86 | | |
| Paper mill | 10 | | |
| ETP sludge | 180 | 27 | 15 |
| Total | 673 | 100 | |
| Inorganic waste | | | |
| Combustion ashes | 430 | 86 | 37 |
| Lime sludge from bleach preparation | 70 | 14 | 06 |
| Total | 500 | 100 | |
| Grand Total | 1173 | | 100 |

This leads to the following balance:

| | T/T |
|---|---|
| Raw materials | 2.67 |
| Estimated yield losses (raw material adjusted for yield abd moisture | 1.03 |
| Waste | 0.67 |
| Paper produced | 1.00 |
| Balance | 0.01 |

The balance error of 0.01 is small which means all assemptions made in this study are reasonable.

presented in Figures 2b, 2c, 2d and 2e. Figure 2a shows the raw material pattern being used based on the average data of the same. Table-3 shows the comparison of average data of solid waste being generated by the large mills.

It is clear that the major percentage of organic solid wastes in case of non-woody paper mills is from raw material storage and followed by the sludge from ETP (Effluent Treatment Plant). In most of the mills centricleaning rejects are going to effluent

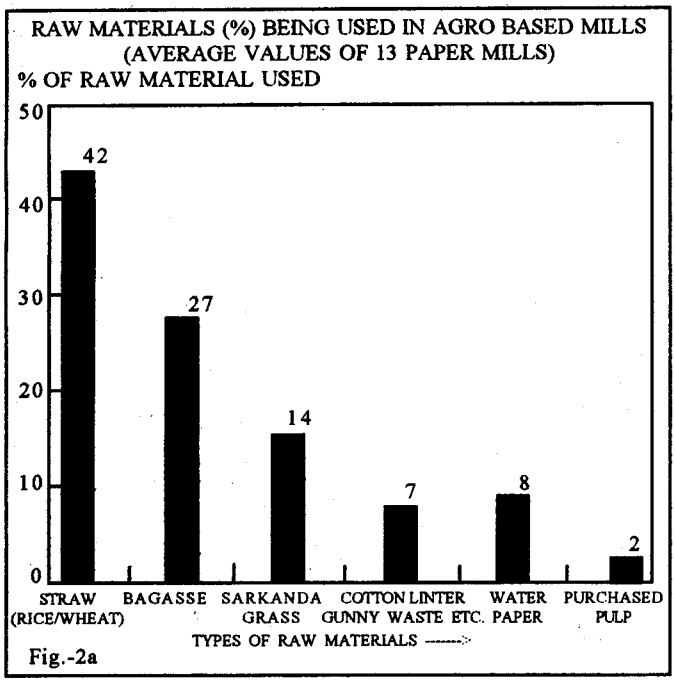

Fig.-2a

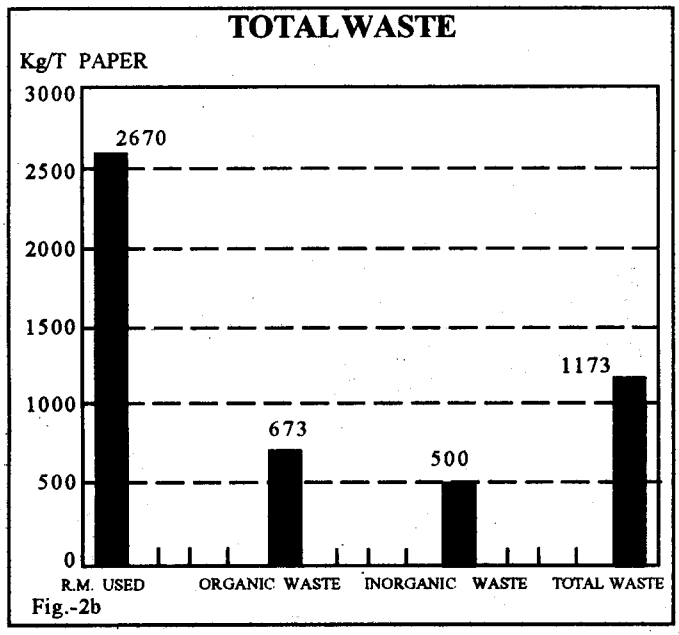

Fig.-2b

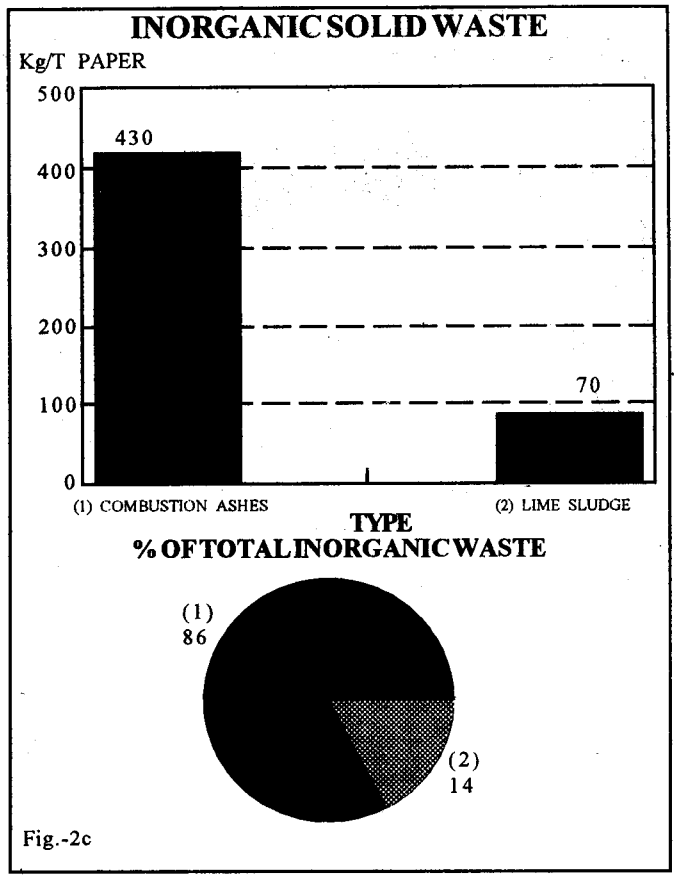

Fig.-2c

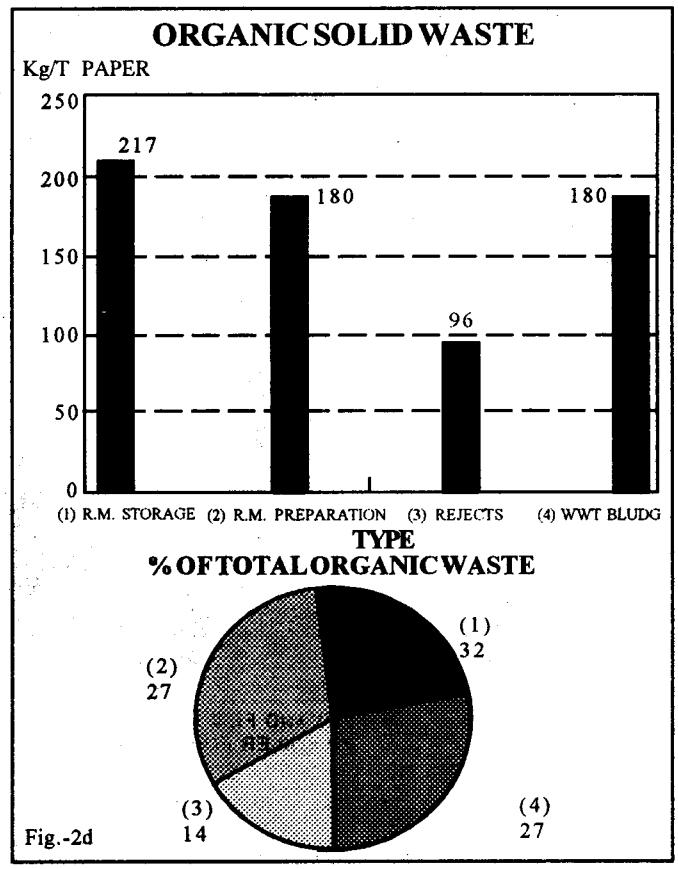

Fig.-2d

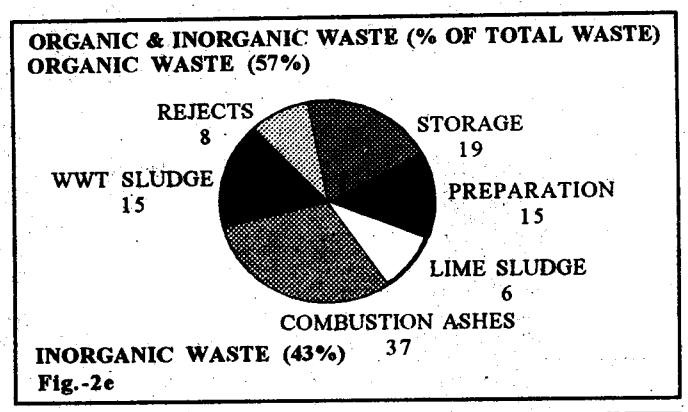

Fig.-2e

## Table-3

### Solid waste from big paper mills

(AVG DATA BASED ON DATA COLLECTED FROM 8 PAPER MILLS)

| | | | |
|---|---|---|---|
| Organic Waste : (T/T of Paper) | | | |
| 1. | Raw Material Preparation (Wood bamboo dust) | : | 0.1 |
| 2. | Pulp mill rejects | : | 0.01 |
| 3. | Paper machine cleaner rejects | : | 0.1 |
| 4. | ETP Sludge | : | 0.2 |
| | Sub-Total | : | 0.41 |
| Inorganic Waste: (T/T of Paper) | | | |
| 1. | Ash (Cinder+Fly ash) from boilers | : | 0.80 |
| 2. | Lime sludge and grits (Recovery+Bleach liquor preparation) | : | 0.70 |
| | Sub-Total | : | 1.50 |
| | Total | : | 1.91 |

stream. Similarly, white water and save all drain in all the mills is going to effluent stream. So there waste have been considered in ETP sludge.

The major percentage of inorganic waste from small paper mill is ash from steam boilers and a very low quantity is contributed by lime sludge and grit from bleach liquor preparation. However, in case of large paper mills sizable quantity of lime sludge is generated from recovery section.

The present way of handling of different type of organic solid waste in case of agro-based small paper mills has been also presented in figure-3. It is evident that most of the organic waste is being landfilled. Similarly, entire quantity of inorganic waste, ash and lime sludge is also landfilled.

## REDUCTION OF SOLID WASTE

After knowing the sources of solid waste and their quantity, the first objective is to reduce them to maximum possible extent at source of generation before thinking of utilization. However, the chances of reduction are little and even nil in some cases. Like in case of pith, Industry is interested to remove it as much as possible, thus resulting in its ever increasing quantity. The various

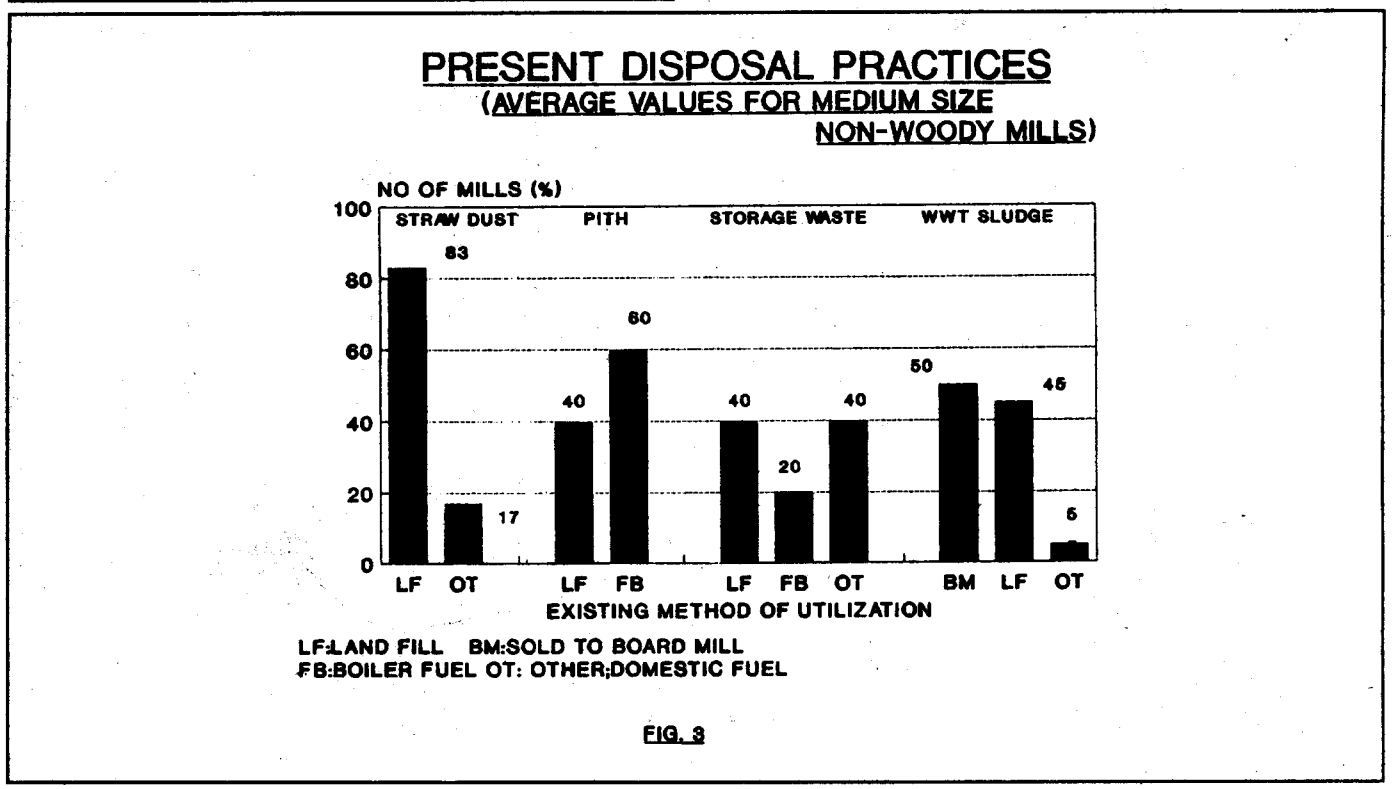


FIG. 3

possible measures, which can be adopted for reduction are listed below.

- By good management of storage facilities such as: Wet storage of bagasse, storing straw in bale form and protection of material during rainy season and general good house keeping etc.
- Dust and fines can be reduced by proper selection of equipments (Chippers, Chopper etc.), proper maintenance and change over of knives as dull knives give more dust. Optimization of other variables such as Speed, Dryness etc. is also important.
- Maximum recycling of streams-such as closing of Screening, Washing and White Water systems to an extent that it should not affect the efficiency of system and quality of product.
- Use of efficient saveall for maximum fiber recovery.
- By adopting retention aids fiber retention can be increased (Economic feasibility to be considered).
- By proper combustion of fuels in boilers.

## CHARACTERISATION

As it is not practical to reduce all the solid waste, so it is necessary to think of utilisation of the same as a value added product to reduce impact on environment and also from economic reasons. Before considering utilisation, it is necessary to characterise these wastes. Inorganic waste coming from the mill is mostly boiler ash and lime sludge and work on utilisation of these is already being done or has been done in other institutions like CBRI, NTPC etc. So only utilization of organic waste is being considered here.

The various organic wastes have been characterized for ash, silica, calorific value, C,H,N value, micro and macro elements and other heavy metals. Some of the parameters are given in Table 4a, 4b and 4c. These analysis help in proposing ultimate utilisation of solid waste.

## UTILISATIONS

### A) Organic Waste:

After looking into the characterization data, the following possible utilisations of organic wastes can be considered. However, a mill can adopt any one of them suggested after considering all factors like location, process, economic conditions. land availability, disposal suitability and other possible modes like those needed for agricultural use etc., rather than following a particular way of utilisation.

1. As a source of fuel.
2. As soil conditioner or fertilizer for land application.
3. Other utilization.

Conversion to : Fodder
: Board
: Conversion to Bio-gas
: Protein rich product, Alcohol and industrial importance chemicals by biotechnology application.

### 1. As a source of fuel:

The organic solid wastes generated, generally, have good calorific value and can be used as a co-fuel to substitute conventional fuel. There are three alternatives of utilising solid waste as a source of fuel viz.

1. Incineration 2. Pyrolysis 3. Wet Oxidation

Though pyrolysis and wet oxidation have certain advantages over incineration but these process are very sophisticated and have not been commercialised as yet and may not be suitable for paper mills in India in present conditions. Thus, solid wastes must be incinerated to obtain energy either in loose form or by making solid fuel by way of briquetting. However, incineration of pith, straw dust and sludge in loose form has number of associated problems and it is better to make briquettes from these wastes before incinerating them in the existing coal fired boilers.

It has been observed after various experimental run at CPPRI that it is feasible and also economical to make briquettes from wastes like pith, ETP sludge, straw dust and straw without adding any binder (Bindeless briquettes) because sludge serves as the binder and as a lubricant also when mixed with other wastes (1).

### 2. As a soil conditioner or fertilizer for land application:

The effluent sludge from paper industry can be

used for land application either directly in slurry form or after composting to improve its fertility. However, the direct application of sludge in slurry form has various drawbacks so it is better to make compost.

In the CPPRI, composting of ETP sludge at pilot plant has been done successfully by aerobic methods and plants have been grown and the results have been encouraging. The yield of sugar cane has been observed double in case of sludge compost compared to market manure of sheep dung. Heavy metal contents in sludge compost has been found within limit and macro and micro nutrients contents comparable to market manure (2).

**3. Other utilisation:**

***Fodder production--***

Sludge, pith and straw dust can sometimes be used as a food source for cattle because they contain protein particularly straw dust and pith contains reasonable high concentrations of protein. Techniques have been developed for producing animal feed from sludge (3). Sulfur dioxide is used to solubilize sludge, and the filtrate is evaporated to produce a molasses like material containing high concentration of protein. However, the other constituents like silica, mineral content and particularly black liquor content in sludge may have to be considered before utilizing it as a fodder.

***Fiber board production--***

Primary sludge can be used in fibre board production. Already many of the paper mills in India are selling their sludge and screening/cleaning waste to board mills. However, in some cases the fine contents in sludge are so high and overall fibre value is low enough to render the material unsuitable for board manufacture. This is the case particularly for mills using straw as raw material.

***Bio-gas production--***

Primary and secondary (biological) sludges generated in pulp and paper industry can be digested anaerobically to produce bio-gas.

Benefits of anaerobic digestion are:

- Production of Bio-gas which can be utilized as a fuel.
- Reduction of organic solids (and stabilization)
- Sludge can be used as a soil conditioner or fertilizer.
- Sludge can be treated without pre-dewatering.

Typical values of bio-gas production and organic solid waste reduction using anaerobic digestion of pulp and paper mill sludges are:-

Reduction of organic solids: 45-75%
Bio-gas produced : 0.5-0.7 $m^3$/Kg organic solids

However, we have to see the viability in Indian situation that how much portion is biodegradable and what yield of methane is expected. In CPPRI, lab scale trials are being planned using both primary and secondary sludges.

***Conversion to protein rich food, alcohol or to industrial importance chemicals by application of biotechnology--***

Pulp and paper mills organic wastes, mainly sludge, are in general largely cellulosic and are therefore amenable to conversion to glucose. If glucose can be produced cheaply from a low cost raw material such as paper mill sludge, many interesting avenues of producing commercially useful products will open up. With the application of biotechnology, it will be possible to convert cellulose to glucose and thus a range of products viz. protein rich food, chemicals and fuel in form of ethanol can be made from the lignocellulosic waste of pulp and paper industry.

**B) Inorganic Waste:**

As it has been already mentioned that on inorganic waste boiler ash and lime sludge (from bleach liquor preparation and recovery plant), the work is already being done in other institution like CBRI, NTPC etc. So in CPPRI, main stress has been given on organic wastes. However, the outlines of utilization of inorganic waste is being presented here. Most of this information has been collected from CBRI, Roorkee (4).

***Boiler ash--***

Coarse cinder from boiler house is widely used as fuel for burning bricks and lime stone (Kankar) in clamps is rural and under developed regions of the country. Fine cinder (passing 2mm screen) is often used as an admixture with brick making plastic clays to reduce losses in bricks during drying process.

While reclamation of low-lying land and refuse dumps and building of roads and embankments has been the major areas for fly ash utilization, extensive R & D work has been carried out in India and abroad on the utilization of fly ash in the production of different building materials, which can be produced from Indian fly ashes.

Rice husk ash being siliceous material with reactive surface characteristics, has been investigated world over for the production of building materials and components such as bricks, tiles, cementitious binders, activated lime pozzolana mixtures, masonry cements etc. CBRI has done a great deal of work to utilize this material in a variety of building products. Rice husk ash is utilized as an additive with highly plastic soils.

Utilization of ash as a by-product agricultural lime substitute has also been reported (5, 6). Ash has been viewed as a valuable soil amendment and contain additional soil nutrients.

***Lime sludge--***

As lime sludge contain high silica content, so its burning is not considered economical. However, the following approach can be considered.

(a) Burning to get low grade lime.

(b) In the cement industry for partial substitution of lime stones.

(c) As a conditioner for soil especially acidic one.

(d) Burning after desilication

## CONCLUSION

The large amount of solid waste generated from pulp and paper industry should not be considered as a waste only for dumping. There is tremendous scope for its utilization as value added products. The main thing is the efforts needed from all sides, for research in R & D institutions, from equipments manufacturers and also from paper mill itself. However, maximum efforts should be to minimize the waste at the source but still if it occurs, it must be utilized for making value added products. CPPRI with its manpower will continue to take a leading role in this task for realizing the cherished goal of channeling the utilization of solid waste through an effective planned and phased program.

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