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ASSESSMENT OF WASTE GENERATION AND WASTE TREATMENT IN PULP AND PAPER INDUSTRY- A CASE STUDY FROM RAJAMUNDRY, ANDHRA PRADESH, INDIA

KEYWORDS: Pulp and paper industry, Cleaner production, Primary and Secondary treatment

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ABSTRACT *The country like india is a vast country with an average of 700 pulp and paper mills. It is been one of the highest polluting industries in India and is highly water intensive. Relatively large wastewater discharges and accompanied release of high pollution load into the environment is the sequel of high water consumption and pollution generation in the process of pulp and paper manufacture. Steps are been taken to preserve the resources, especially water which is an integral part of the pulp and paper industrial functioning. The need of cleaner production programs has been felt in recent times by the paper industry by way of a resource and waste minimization concept. In India efforts have been going on for years to improve house keeping, optimize process parameters, increase recycles and adopt improved technology. This paper aims at highlighting the process used during manufacture, sources and types of waste generated and treatment options available for improving the quality of waste to be discharged.*

1. INTRODUCTION

Water is a precious commodity and nature's greatest gift to the living kingdom. Total utilizable water resources in India in 2005 have been estimated to be 1122 billion cubic meter per year, 38% of which is presently exploited for total national use [2,3]. Water consumption in agriculture, industrial sector and domestic purposes are 85.3, 8.0, and 6.6% respectively. Water use in industrial sector is 34 billion m^3 per year which is estimated to increase by four folds by 2050. With the continuously increasing demand and strong competition among industrial, agricultural and domestic sectors, water availability will be severely affected particularly to the large consuming industrial sectors like pulp and paper. Present national norm of water consumption per tonne of paper is 200 and 250 m3 in agro and large pulp and paper sectors whereas that set up World Bank is much lower (56 and 55 m3 per tonne of pulp and paper). By reducing the water consumption to 75m3 per tonne of pulp and paper the paper industry can produce double the amount of paper with the existing water allocation/draw. Pulp and paper industry is the third largest water consuming industrial sector in the country (www. water and agro industries. org/pulp paper.htm). Fresh water consumption in wood based, agro-based and waste paper based mills is 125-200, 125-225, 75-100 m3 per tonne of paper respectively [1]. With average water consumption was 151m3 per tonne of paper. With the moderate per capita paper consumption of 10kg, water demand in this sector might increase to more than 1.5 billion cubic meter with the current rate of water consumption[4,5].

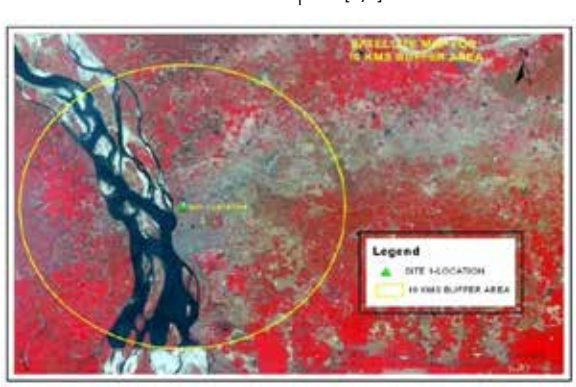

Figure 1: Showing the Satellite Date for 10kms Buffer area

2. MANUFACTURE OF PAPER

The basic steps in making paper include:

- Suspension of cellulosic fiber prepared by beating it in water so that the fibers are thoroughly sepa- rated and saturated in water.
- Paper stock filtered on a woollen screen to form matted sheets of fiber.
- The wet sheet pressed and compressed to squeeze out a large proportion of water.
- The remaining water removed by evaporation.
- Depending upon use requirement, the dry paper sheet is compressed, coated or impregnated.
- Hydropulping.

3. SOURCES OF WASTE GENERATION

In pulp and paper industry, considerable quantity of water is used in paper making processes. The quantity of water consumption varies according to the quality and kind of paper to be manufactured. In addition considerable amount of solid waste and gaseous emission occurs[6,7].

(i) Waste Water Generation

- Washing wooden chips in large-scale pulp and paper mills using wool as raw material.
- Washing of bagasse for separation of pith.
- Washing of rice/ wheat before pulping.

1. Pulping and bleaching

- Washing of chemically cooked pulp.
- Washing of pulp during bleaching.
- Pulp cleaning equipments.

2. Stock preparation and paper machine

- Cleaning of pulp in cleaning equipment
- Filtration for wire section of paper machine
- Paper machine presses

3. Chemical recovery

- Foul condensate from evaporator and steam surface condenser
- Boiler blow down.

Beside above major sources of wastewater generation there are frequent leakages of black liquor from pump

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glands and its improper handling, which contribute significant color and pollution to the stream

(ii) Solid Waste Generation
In pulp and paper industry solid wastes are generated from following operation.

- Raw material handling.
- Rejects from screening and centri-cleaners
- Primary and secondary sludges from wastewater treatment system.
- Coal or boiler ash from steam and power generation
- Lime sludges from causticizing section of chemical recovery plant.

(iii) Air Pollution
In pulp and paper industry air pollution is caused due to odour emitting reduced sulphur compounds such as hydrogen sulphide, methylmercaptan, dimethly sulphide, and particulate matter SO2 and NOx present in the gases emitted by different process units. Gaseous emission from pulp and paper mills can be broadly classified into the following categories:

- Gases from digesters
- Gases from multiple effect evaporators
- Gases from recovery

4. CHARACTERISTICS OF POLLUTANTS
Pulp and paper industry is intensive in terms of raw material consumption. Besides pollution load generation, the other consumption includes chemical, energy, water and capital requirements. About 41.8% of wood is recovered as bleached pulp. Of the remaining wood, roughly 4.2% ends up as solid waste, 5.25% goes into wastewaters as dissolved organic matter and 2.3% goes as suspended solids in wastewater (Nemade et al. 2003). The potential pollutants from pulp and paper mill fall into four principal categories as under.

(a) Water effluents
- Dissolved colloidal organics like hemicelluloses, sugars, lignin compounds, alcohols, turpentine, sizing agents, adhesives like starch and synthetics
- Color bodies, primarily lignin compounds and dyes
- Dissolved inorganics such as NaOH, Na_2SO_4 and bleach chemicals
- Thermal loads
- Microorganisms such as coliform group
- Toxic chemicals

(b) Gases
- Malodorous sulphur gases such as mercaptans and H_2S released from various stages in Kraft pulping and recovery process
- Oxide of sulphur from power plants, kraft recovery furnace and lime kiln
- Steam

(c) Particulates
- Fly ash from coal fired power boilers.
- Chemical particles primarily sodium and calcium based
- Char from bark burners

(d) Solid wastes
- Sludges from primary and secondary treatment and causticizing in kraft mill recovery section.
- Solids such as grit bark and other mill wastes.
- Ash from coal fired boilers.

5. WATER CONSERVATION MEASURES
- Raw material washing should be done with treated effluent.
- Washing efficiency of pulp washers should be improved
- Paper machine back water should be used in the pulp dilution in the unbleached tower
- Backwater should be used in centri cleaning of pulp and vacuum pump sealing
- Bleach plant filtration should be recycled in pulp dilution in tower and vat, and shower sprays in the preceding stage
- Membrane based process for water softening should be installing in place of conventional chemical process.

6. POLLUTIONAL EFFECTS
The main polluting constituents in pulp and paper mill wastewater are suspended solids, color, foam, inorganics such as sodium carbonate, bicarbonate, chlorides and sulphates, toxic chemicals such as mercaptans and inorganic sulphides.

The effluent has high BOD and COD and when discharged untreated will damage the receiving water courses due to the presence of high oxygen demanding organics and inorganic constituents. Further the effluents impart colour to the stream and it persists for a long distance since lignin and its derivatives present in the effluent are not readily biodegraded. The effluent may also impart odour to the stream.

7. CLEANER PRODUCTION
Cleaner production means continuous application of an integrated approach to improve mill operation through adoption of modern technologies, optimized process operation, resource recovery and maximum output per unit of the raw material inputs. The Indian paper industry still uses old pulping technologies and elemental chlorine bleaching resulting in high level of AOX generation. Cleaner technologies for pulping of raw materials are continuous pulping, RDH pulping, oxygen delignification and for pulp bleaching are elemental chlorine free bleaching (EFC), chlorine dioxide bleaching, oxygen /peroxide bleaching.

8. EFFLUENT TREATMENT PRACTICES IN PULP AND PAPER INDUSTRY
Several control and treatment technologies have been developed to reduce wastewater discharge from the pulp and paper industry. The two major technology approaches are

1. At source treatment controls measurements aimed at reducing wastewater volume and pollutant load discharged from the mill
2. Wastewater treatment technologies or end-ofpipe treatment system aimed at reducing discharge of pollutants in the wastewater

Various approaches for the management of effluent discharged include:

Segregation : Highly concentrated and offensive effluents are segregated from relatively voluminous effluents.

Chemical Recovery: Efficient recovery of chemicals from the spent liquor is an integral part of modern sulphate (kraft) and soda processes.

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Good Housing Keeping: Proper installation and operation of equipment, keeping them well cleaned before emptying into drain. Avoiding unnecessary biodegradable material to be dumped into waste stream, reuse of water when possible, reduces considerably the pollution load.

Reclamation and Recycling: About 80-90% reduction in pollution load and 70 % reduction in effluent volume in chipper house can be achieved through effluent reuse. Similarly recirculation in multi-stage bleaching operation reduces pollution loads by 30- 80%. Effective fiber recovery from paper machine can reduce the pollution load by 20-60% and volume by 60-80% (Birdie and Birdie, 2008.

Primary Treatment: It includes coagulation & flocculation, floatation and sedimentation. A well designed clarifier is considered most suitable and is expected to settle 90-95 % of the settleable solids and removes 25-30% of BOD. Clarifier should be designed for an overflow rate of 30 cubic meters per square meter per day and a detention time of three hours. Settled sludge is regularly pumped out at about 3% solid consistency. The sludge can be dewatered to spedable consistency by drying on usual drying beds, vacuum bed filters, and solid bowl centrifuges.

Biological Treatment : Depending upon the conditions at site and degree of treatment required for final disposal of effluents, biological treatment methods that can be adopted include; oxidation pond, aeration lagoon, trickling filter with secondary clarifier and activated sludge process.

- Energy- efficient pulping process should be used wherever feasible. Acceptability of less bright products (newsprint, thermo-mechanical processes) and recycled fiber should be promoted
- Minimize the generation of effluent through process modifications and recycle wastewater, aiming for total recycling
- Reduce effluent volume and treatment requirements by using dry debarking instead of wet one; recovering pulping chemicals by concentrating black liquor and burning the concentrate in a recovery furnace; recovering cooking chemicals by recausticizing the smelt from the recovery furnace; and using high efficiency washing and bleaching equipments
- Minimize unplanned or non routine discharges of wastewater and black liquor, caused by equipment failures, human errors and faulty maintenance procedures. This can be done by training operators, establishing good operating practices, providing sumps and other facilities to recover liquor losses from the process.
- Aim for zero discharge wherever feasible.
- Reduce bleaching requirements by process design and operation.
- Sulphur emissions to the atmosphere should be minimized by using a low odour design black liquor recovery furnace.
- Energy efficient processes must be practiced for black liquor chemical recovery, preferably aiming for a solid content of 70%.

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