

Short Communication

WASTEWATER TREATMENT OPTIONS FOR PAPER MILLS USING WASTE PAPER/IMPORTED PULPS AS RAW MATERIALS: BANGLADESH PERSPECTIVE

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Received 20 February 2010; received in revised form 6 June 2010

Abstract: Paper sector in Bangladesh is currently expanding day-by-day to meet the increasing demand of industrial, writing/printing and specialty papers. Paper mills have adverse effects on the environment by producing huge quantity of wastewater. Yearly, approximately 14 million m³ wastewater is being discharged to the surface water bodies and irrigated lands without no/limited treatment. Water pollution from pulp and paper mills can be minimized through proper effluent characterization and design of appropriate treatment facilities. In this article different techniques of wastewater treatment for paper mills are discussed. Case study based on treatability analysis and jar test for a paper mill producing 200 m³/h of effluent is provided. On the basis of the case study a simplified treatment process is proposed. Proper treatment of such mills would not only save our environment but can also be beneficial for the industries by water usage minimization.

Keywords: *Pulp and paper mills, recycled paper, imported pulp, environmental impact, wastewater characterization, wastewater treatment*

DOI: [10.3329/cerb.v14i1.5236](https://doi.org/10.3329/cerb.v14i1.5236)

1. Introduction

The paper industry in Bangladesh went into operation in 1953 when Daud Group had established the Karnaphuli Paper Mill (KPM) at Chandragona in Chittagong using local bamboo and hard-wood as raw material [1]. Later, three more mills were setup under government initiative to use indigenous raw materials for paper production: Khulna Newsprint Mill (KNM) at Khulna to produce newsprint from Gewa; North Bengal Paper Mill (NBPM) at Pakshi to produce writing and printing paper from Bagasse and Sylhet Pulp and Paper Mill (SPPM) at Sylhet to produce pulp from muli bamboo and reed. Among them only KPM is operational and currently producing approximately 30,000 tonnes of paper per annum [2].

Bangladesh's private sector paper mills started with the setting up of Khan Md Iqbal Board Mill in early 1980s at Narayanganj [3]. However, private paper mills took a hike in the mid 90s when the state owned mills showed decline in production due to raw-material constraint and other operational problems. Currently, there are 55 paper and board mills in the country producing approximately 550,000 tonnes of paper and board per annum [3]. Products of these mills include writing, printing, bond, newsprint, tissue, carbon-less, cigarette and industrial papers, and different grades of paper boards [4]. Due to lack of raw materials all these mills are depending on the waste papers and imported pulps. Table 1 shows current varieties of raw material usage in Bangladeshi paper mills.

Table 1: Raw materials used in Bangladeshi paper mills [3]

Type of raw materials	Source	Share
Waste paper	Local	45%
Waste paper	Foreign	25%
Pulp	Local (only in KPM) and Imported	30%

Production of paper requires huge amount of water and chemicals other than the raw materials. As a result, such production facilities produce substantial amount of liquid effluent. Undesirable features of pulp and paper liquid effluents are high BOD load, color, higher suspended solids and presence of chemicals such as fillers, acids, bases etc. [5]. Highly toxic compounds such as dioxins and furans may form if chlorine based chemicals are used to bleach pulp [6].

Based on their environmental impact, Bangladesh Government has included pulp and paper mills in the "red category" [7]. The effluent from pulp and paper mills must meet the standards (Table 2) given in the Environmental Conservation Rule (ECR)-1997 before discharging into surface water bodies or irrigated lands.

Most of the current paper production in Bangladesh is

Table 2: Effluent standards for pulp and paper mills as per ECR 1997 [8]

Parameter	Large plants	Small plant s
Production capacity	> 50 tonnes/day	< 50 tonnes/day
pH	6-9	6-9
Suspended Solids (mg/L)	100	100
BOD ₅ at 20°C (mg/L)	30	50
COD (mg/L)	300	400
Wastewater flow	200	200 (from agricultural raw materials)
m ³ /tonne paper		75 (from wastepaper)

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Table 3: Typical wastewater characteristics from a mill using imported pulp/wastepaper as raw material

Parameter	Unit	Wastewater characteristics
pH	-	6.9-8.7
Suspended Solids	mg/L	412-1181
Dissolved Solids	mg/L	106-715
BOD ₅ at 20°	mg/L	90-150
COD	mg/L	320-810

made by the recycled paper and imported pulp. Such processes have advantages from environmental point of view since they require 40-50% less amount of water than the chemical pulping process [5]. However, paper production from repulping of waste paper and imported pulp would still require 20-35 m³/tonne of paper production [4]. Based on this value current wastewater production from pulp and paper sector is approximately 13,750,000 m³/year. The produced wastewater is currently finding its route into the waterways, since most of the paper mills are concentrated on the bank of river Meghna in Munshiganj, Shitalakhya in Narayanganj and Karnaphuli in Chittagong.

This article deals with the environmental issues associated with the paper production and mainly focuses on the handling of liquid effluent produced in the paper mills from Bangladesh perspective. Different treatment options for the wastewater from paper mills are discussed and a technically and commercially suitable pathway is provided.

2. Wastewater Characteristics

Wastewater from paper mills can vary in a great deal depending on the raw material and chemicals used, pulping process applied and management practices [9]. Several authors have reported wastewater characteristics for different pulping and papermaking processes [9-14]. However, all these published data are for integrated paper mills and therefore irrelevant in context of Bangladesh since all mills are using imported pulp and/or recycled paper as raw materials. Typical range for wastewater characteristics from paper mills using imported pulp/waste paper given in Table 3, are based on laboratory test results performed at Chemical Engineering Department of Bangladesh University of Engineering and Technology over a time span of three years.

3. Treatment Options

Pulp and paper mill effluents can be treated either by physicochemical, biological method or their combination. Biological treatment can further be classified as anaerobic and aerobic. Fungal treatment of colored effluent from pulp and paper mills has also shown satisfactory results [15]. Even significant decrease in pollution load and wastewater volume have been reported because of changes in mills' internal process and managerial measures [16, 17].

Physicochemical treatment processes remove suspended solids, colors and even BOD and COD by screening, coagulation, flocculation, sedimentation, flotation, adsorption etc. Chemical precipitation can be used for removal of heavy metals and dissolved solids.

Table 4: Influent and effluent characteristics for a local paper mill producing tissue, printing, offset, cigarette paper etc

Parameter	Influent(untreated)	Effluent (treated)
Average flow rate	200 m ³ /hr	
pH	7.37	7.15
TDS	450 mg/L	415 mg/L
TSS	470 mg/L	41 mg/L
BOD ₅	110 mg/L	12 mg/L
COD	225 mg/L	35 mg/L
Color	turbid/white	Colorless

In biological treatment, metabolic function of microorganisms are used to remove BOD, COD and capture suspended and nonsettleable colloidal solids either in presence (aerobic) or absence (anaerobic) of oxygen.

Combination of the above two processes are often employed. In most pulp and paper mills, biological treatment is followed by physicochemical process. More advanced tertiary treatment methods are also often employed. Detailed description of various treatment methods can be found in literature [9, 18, 19].

However, selection of appropriate method for effluent treatment is very important since the initial and operating costs vary a great deal among the various treatment processes. Moreover, wastewater characteristics from one mill to the other can vary to a great extent as indicated in Table 3, and depends on raw material specification and operating conditions of the particular mill. Therefore, treatability analysis is must for choosing appropriate treatment method. Treatability of a particular wastewater depends on the various parametric values such as BOD, ratio of suspended-colloidal concentration to soluble organic concentration, BOD to COD ratio, etc [20].

4. Case Study, Bangladesh Perspective

Treatability analysis was performed on influent of a leading paper industry in Bangladesh producing tissue, printing, offset, cigarette paper etc. Influent characteristics are shown in Table 4.

Influent characteristics show that the BOD load is comparatively low and can be treated either by physicochemical or biological process. Since, BOD load is very low and the BOD/COD ratio is less than 0.5 physicochemical treatment was selected for the study [19].

Figure 1 shows process flow diagram (PFD) of the proposed effluent treatment plant (ETP). Influent from the mill is passed through a coarse screen to remove large and suspended debris, if any. It is then sent to equalization tank. Aeration is provided in the equalization tank to make sure that the influent does not become septic. Coagulant is added in the flash mixing tank with agitation and followed by the addition of flocculant. It is then sent to the clarifier for settling flocs. Settled sludge is collected in the wet sludge tank and then dewatered through a belt press.

Supernatant clear water from clarifier is then passed to the H₂O₂ dosing tank. H₂O₂ is used for decolorization only if the influent is colored. Then it is passed through a granular filter bed consisting of anthracite, sand and gravel layer. The effluent (treated water) from the filter bed is collected in the

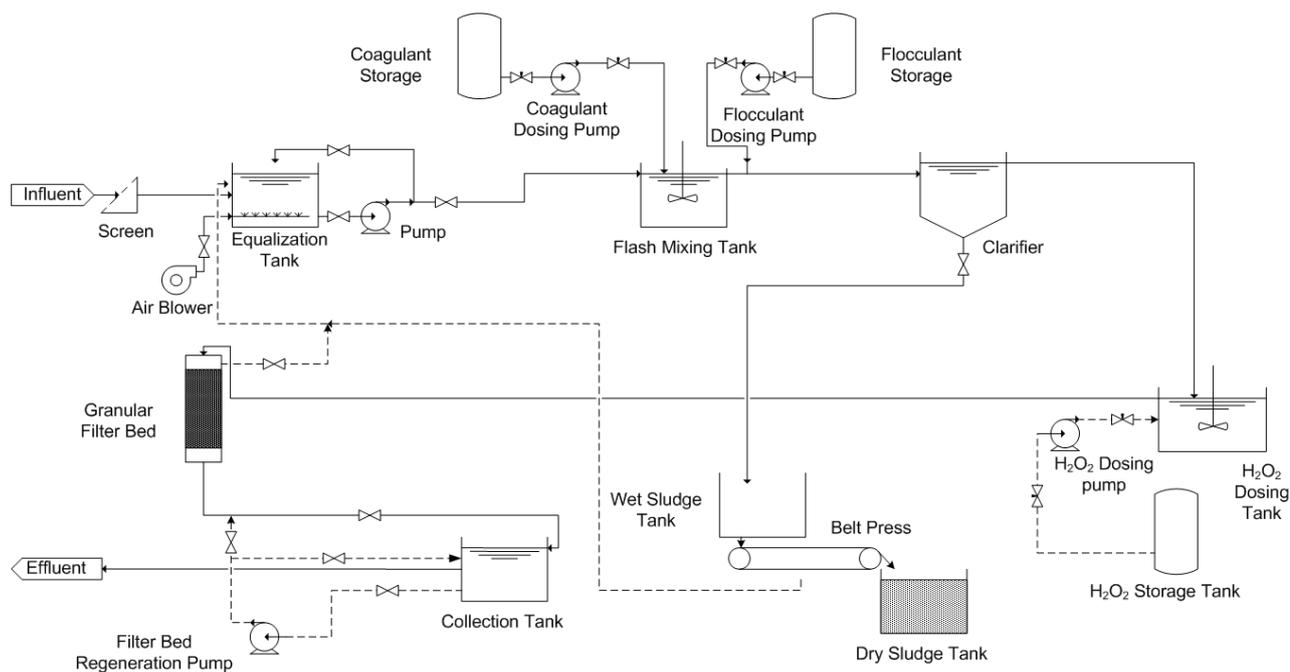


Figure 1: PFD of physico-chemical treatment of paper mill effluent (raw material: imported pulp/recycled paper)

collection tank. Treated water characteristics are shown in Table 4. Treated effluent from this plant can be used in the process through minimal treatment, as for example ion exchange. Treatment cost for this plant is approximately BDT $10/\text{m}^3$ influent.

Solid sludge produced from the treatment plant has high organic content (mostly cellulose) and hence can be converted to fertilizer and soil modifier either by composting or anaerobic digestion. This solid sludge after drying is also expected to be a good alternative of biomass fuel.

5. Conclusion

Paper sector in Bangladesh is growing very fast. Most of the mills are based on imported pulp and waste paper as raw materials. Very few of them have effluent treatment plants. Every year this sector produce several million tons of effluent that contaminates receiving water body. If this effluent is discharged directly, it will disrupt the ecological system. All the rivers surrounding Dhaka city are meanwhile biologically dead due to severe water pollution. Health cost of the city dwellers has increased to many folds due to impure drinking water supply as these polluted rivers are the sources of drinking water to the city people. Therefore, it is very high time to revive these rivers and re-establish the ecological system through setting up of properly designed and functional ETP at each and every effluent producing industry.

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