Performance of Selected Paper and Pulp Industrial Effluent Treatment Plant (ETP) of Narayanganj Area

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A thesis submitted to the Department of Civil Engineering in partial fulfillment for the degree of Bachelor of Science in Civil Engineering

Department of Civil Engineering

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147/I, Green Road, Dhaka-1215, Bangladesh

Section: 15C

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BOARD OF EXAMINERS

The thesis titled "PERFORMANCE OF SELECTED PAPER AND PULP INDUSTRIAL EFFLUENT TREATMENT PLANT (ETP) OF NARAYANGANJ AREA" submitted by Md Erfan Chowdhury, BCE 1803015049; Riday Chandra Shutra Dhar, BCE 1803015115; Md Rehan-Ul-Islam, BCE 1803015005; Muslima Yasmin Bithi', BCE 1803015091; Fatema Akter, BCE 180301518, has been accepted as satisfactory in partial fulfillment of the requirement for the degree of Bachelor of Science in Civil Engineering on 10-09-22.

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DECLARATION

It is hereby declared that this thesis/project or any part of it has not been submitted elsewhere for the award of any degree or diploma.

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Dedicated

to

"Father of The Nation Bangabandhu Sheikh Mujibur Rahman and Our Freedom Fighters"

ABBREVIATIONS

ETP = Effluent Treatment Plant

EIA = Environmental Impact Assessment

BOD = Biochemical Oxygen Demand

DO = Dissolved Oxygen

TDS = Total dissolved Solid

TSS = total suspended solids

pH = Potential of Hydrogen

COD = Chemical Oxygen Demand

P&P= Pulp and Paper Industry

NEP = National Environment Policy

ECA = Environment Conservation Act

ECR = Environment Conservation Rules

ADB = Asian Development Bank

NCTB = National Curriculum and Textbook Board

DOE = Department of Environment

GOB = Government of Bangladesh

CASE= Clean Air and Sustainable Environment

BPMA = Bangladesh Paper Mills Association

KPM = Karnaphuli Paper Mills

SPPM = Sylhet Pulp & Paper Mills

NBPM = North Bengal Paper Mills

KNM = Khulna Newspaper mills

ACKNOWLEDGEMENTS

All the praises are for the almighty Allah, who bestowed us with the ability and potential to complete this thesis. Our first and biggest appreciation goes to our supervisor, ***Md. Lutfor Rahman***, for his marvelous supervision, guidance, and encouragement. Sincere gratitude is extended to his generous participation in guiding, constructive feedback, kind support, and advice during our graduation. Thank you very much. ***Md. Lutfor Rahman****, sir*.

Many thanks to all of the members of staff at ***''Sonargaon University''*** for their kind support during our research. Also, we extend our thanks to our parents for their continuous encouragement and support, as well as to all of our friends from ***Sonargaon University*** and outside for their time, advice,
And moral support.

Last but not least, our warm and heartfelt thanks go to our family for the tremendous support and hope they have given us. Without that hope, this thesis would not have been possible. Thank you all for the strength you gave us.

ABSTRACT

Narayangonj is one of the largest industrial zones in Bangladesh, making it crucial to investigate any potential enterprises to see whether they have an effective and well-maintained ETP. We chose the pulp and paper industry because there haven't been many studies done on it, so we could assess how the ETP's chosen pulp & paper industries were performing.

We conducted research to find out pulp and paper industry’s production process, wastewater sources and ETP performance. Result shows all the industries we visited meet the DoE limits.

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CHAPTER 1
INTRODUCTION

1.1 Background and Motivations

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 quantities of wastewater. Yearly, approximately 14 million m^3 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 m^3/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. [1]

1.2 Research Overview

Objective of our research on Sludge Management of Paper & Pulp Industry ETP is to find how one Pulp & Paper industries differ from one another in terms of wastewater Management and which one is most effective. The idea is to Define the most ideal sludge management system in Narayanganj, production capacity, and output capability. Also, how each manufacturing process impacts waste production and how those wastes are managed.

1.3 Research Objectives

The main objectives of the research are:

- Aware about sources of waste water of Paper and pulp industries
- Compare the performance of ETP of Paper and pulp industries
- Compare operation phases of ETP of Paper and pulp industries

1.4 Organization of the thesis

This thesis consists of five chapters as described below**:**

Chapter 1: Background, motivation, Objectives, and overview.

Chapter 2: Importance of Pulp & paper industry. Overview of the related works in the Wastewater Management of Paper and Pulp Industrial ETP. The field with a special focus on the ETP process and the variation of different ETP parameters also understands the P&P industry production process.

Chapter 3: Methodology. This chapter describes the methodology adopted to carry out the research. Describe our process of data collection and the treatment phase of ETP and its operation.

Chapter 4: Results and Discussion. Here we compared Different industries data and processes and expressed our findings.

Chapter 5: Conclusions and Future Work.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

The pulp and paper industry is a large and growing portion of the world's economy. Pulp and paper production has increased globally and will continue to increase in the near future. Most of the pulp and paper mills are located near the major waterways and have access to a large, uninterrupted supply of water. [2]

Beginning in the mid-1980s, Bangladesh has imported increasing amounts of pulp and paper. The paper industry in Bangladesh went into operation during the late 1950s when Daud Group had established the Karnaphuli Paper Mill (KPM) at Chandragona in Chittagong using local bamboo as raw materials. Following that, Bangladesh's private sector paper mills started with the setting up of Khan Md Iqbal Board Mill in early 1980s in Narayanganj. [3]

Bangladesh has more than 100 paper mills with a capacity of producing more than 15 lakh tons of paper and paper products annually. Bangladesh imports about 250 thousand tons of paper and paperboard a year, which amounts to about US$300 million. Local known demand for paper products is around 0.6 million (six lakh) tons despite there being a capacity of producing 1.5 million tons annually. According to the Export Promotion Bureau (EPB), paper product exports totalled USD 920,488 in the last fiscal year (2016-2017). [4]

2.2 Literature Review Overview

The major pulp and paper industries in the private sector in Bangladesh have grown in Dhaka and Chittagong regions. Pulp and paper industry is the core sector of the economy of Bangladesh. The most inmost inputs are water, energy, chemicals and fibers but input consumption rate is high compare to output products. The per capita paper and board consumption in Bangladesh is about 3.5~4 kg and that in advanced countries is more than 300 kg and the world average is around 50 kg while the Asia

average is around 30 kg. Every industry's growth is depending on resources, capital, energy, filters, public perception and demand. [5]

The paper industry has become a successful sector in Bangladesh and it has a great potential to become one of the country's major foreign currency earners, experts say. After meeting the local demand, they have started exporting to 40 countries, bringing in large amounts of foreign currency.

At present, there are about 100 private paper mills in the country, with production capacity of 1.5 million (15 lakh) metric tons a year on average, said Mustafizur Rahman, chairman, the export standing committee of *Bangladesh Paper Mills Association (BPMA)*. [4] By implementing modern technology, new entrepreneurs are investing a huge amount of money in the sector, and foreign buyers are also coming to Bangladesh to import paper products because of their good quality.

Pulp industry, the four state-controlled pulp mills are: Karnafuli Paper Mills (KPM), Sylhet Pulp and Paper Mills (SPPM), North Bengal Paper Mills (NBPM), and Khulna Newsprint Mills (KNM). These are run by Bangladesh Chemical Industries Corporation. Four other mills operate in the vicinity of Dhaka under private management. These are Bashundhura Paper Mills, Amber Pulp and Paper mills, Sonali Paper Mills, Magura Paper Mills, and Tongi Board Mills.

Locations of pulp and paper industries in Bangladesh: Keranigonj, Narayanganj, Bogra, Dhaka Savar, Munshigonj, Norshingdi, Gazipur, Chittagong, Bagerhat etc. We are working in the Narayanganj region.

The pulp and paper industries play a vital role in our economy. As a producer of paper products, we are hopeful of this industry. In the COVID-19 situation, some industries are closed down due to economic and other's support. Now the condition of the sector is not good, and it is undergoing huge problems.

We hope that they will overcome this bad situation and the government should take care of this industry and give more importance to this section. [4]

2.3 Production overview of Pulp and Paper mils

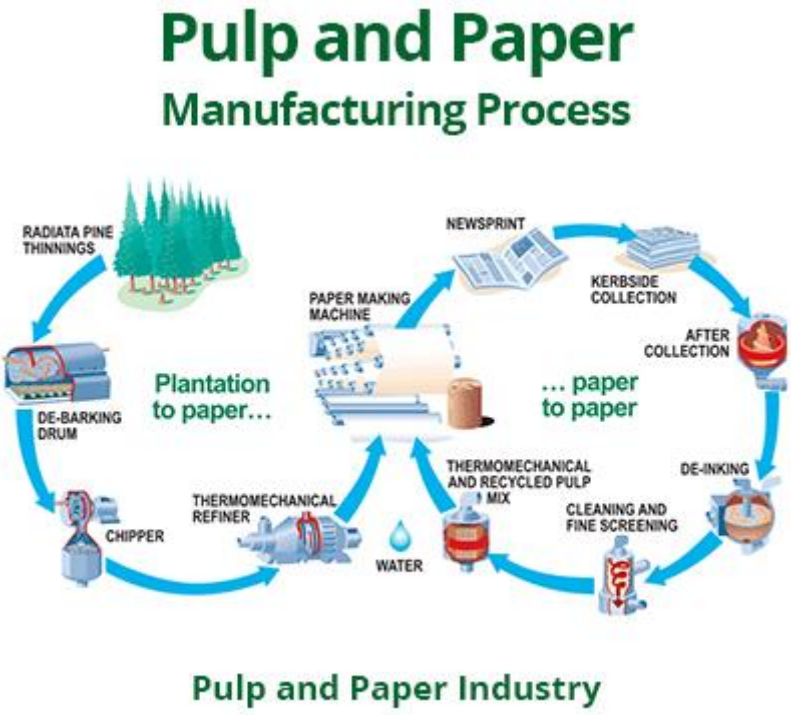

Figure 2.3(1): Manufacturing Process of pulp and paper [6]

Paper is made through the following processes:

1) Pulping procedure will be done to separate and clean the fibers

2) Refining procedure will be followed after pulping processes

3) Dilution process to form a thin fiber mixture

4) Formation of fibers on a thin screened

5) Pressurization to enhance the materials density

6) Drying to eliminate the density of materials

7) Finishing procedure to provide a suitable surface for usage [6]

2.4 ETP Overview

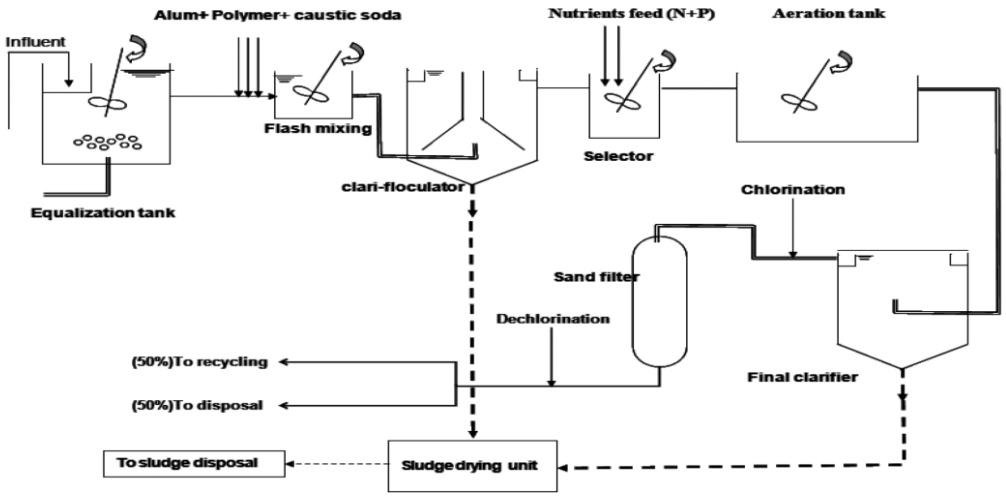

Figure 2.4(2): Effluent Treatment Plant (ETP) [1]

Equalization Tank: Effluent from the collection tank comes to the equalization tank in wastewater treatment. The main function is to act as a buffer. To collect the incoming raw effluent that comes at widely fluctuating rates and position the rest of the ETP at a steady (Average) flow rate. During peak hours, ETP comes at a high flow rate.

Flush Mixing: The guidance of a water treatment specialist to calculate the retention time based on the amount of liquid per hour from the system. The primary flash mixing stage determines the process as too short a retention time will result in not enough distribution of the chemicals in the liquid in the flocculation tank, whilst too long a retention time will result in too much chemical being utilized.

The process of "flash mixing" in water treatment, also known as "rapid mixing," involves adding chemicals to the effluent stream to create coagulation. Coagulants like ferric chloride, PAC (poly aluminum chloride), or other chemicals like aluminum sulphate are used to attract flocculent particles. During the flocculation stage, these substances aid in particle aggregation. [7]

Clari-flocculation: Clariflocculator is a combination of flocculation and clarification in a single tank. It has two concentric tanks where inner tank serves as a flocculation basin and the outer tank serves as a clarifier. In the Clariflocculator, the water enters the flocculator, where the flocculating paddles enhance flocculation of the feed solids. [8]

Selector Tank: The purpose of the selector tank is to control and limit the growth of filamentous bacteria, and then to enhance the sedimentation ability of the sludge. [9]

Aeration tank: The aeration tank consists of the bio media suspended in the water and agitated by aeration. Aeration is performed through fine bubble diffusers fitted in sets at the bottom of the tank. [10]

Final Clarifier: Final Clarifier While clean water is released to the receiving stream; sludge might settle in the Final Clarifiers. There are three finals, and they take place simultaneously. There is a splitter that uniformly divides the stream, much as the aeration basins. [11]

Chlorination: Water chlorination is the process of adding chlorine or chlorine compounds such as sodium hypochlorite to water. This method is used to kill bacteria, viruses and other microbes in water. In particular, chlorination is used to prevent the spread of waterborne diseases. [12]

Sand filter: Sand filters are used as a step in the water treatment process of water purification.

Rapid (gravity) sand filters, upward flow sand filters, and slow sand filters are the three main categories. In the water sector around the world, all three techniques are widely used. The first two requires the use of flocculants chemicals to work effectively while slow sand filters can produce very high quality water with pathogens removal from 90% to >99% (depending on the strains), taste and odor without the need for chemical aids [13]

2.4 Performance of ETP

Pollutants from pulp and paper mills can be treated using a chemical, biological, or mix of the two methods. Anaerobic and aerobic biological treatments are further divided into these categories.

Changes in mill's internal processes and management efforts have been claimed to have resulted in a big decrease in pollution load and wastewater volume. By using screening, coagulation, flocculation, sedimentation, flotation, adsorption, etc., physicochemical treatment techniques eliminate suspended particles, colors, and even BOD and COD. Using chemical methods, dissolved materials and heavy metals can be removed.

2.5 Legislation and Policy to protect Environment

National Environmental Policy 1992 (Policy) [14]

National Environmental Management plan 1995(Policy) [14]

Environment Conservation Act 1995(Law) [14]

Environment Conservation Rules 1997(Law) [14]

Environment Conservation Act 2000(Law) [14]

Environmental Impact Assessment Guidelines for Industry (Guideline) [14]

2.6 Summary

The management of industrial wastes (Solid waste & Waste water) ETP (Effluent Treatment Plant) is mandatory. Pulp and paper industries should have maintained specific rules and processes according to DoE, EIA, ECR, ECA, CASE, The Environment Conservation Rules, etc. DoE supervises this process every month. The maximum industries are located beside the rivers. So that DoE also observes rivers water quality which was polluted by industrial wastes and wastewater. Some industries are concerned about this and they maintain proper rules and procedures to sound river water quality.

CHAPTER 3
METHODOLOGY

3.1 Introduction

The pulp paper industries release wastewater containing very complex organic and inorganic pollutants. These pollutants are discharged mainly from the pulping and bleaching process during paper manufacturing. The main gaseous pollutants hydrogen sulfides, sodium sulfide, methyl mercaptan, sulfur, and chlorine dioxide are reported for chronic, respiratory disorders and irritation to the skin, eyes, and cardiac problem along with nausea and headache. Thus it is really important to treat wastewater before releasing it into the river.

So we observed many paper and plump mills in Narayanganj and saw how they affect the environment. We conducted our analysis on many Paper and plump mills and looked at the treatment process of the waste. We collected various data from various points and input and output. We compared all of the paper and plump mill's treatment processes. We compiled all data to understand the impact of wastewater from the paper and plump mills on the environment.

3.2 Methodology Overview

We visited three pulp and paper mills and we also collected Different data to analyze the Sources, Processes, and Quantity, and observed checked requirements to see if they are okay to be released on the water body.

Below we briefly discussed our findings on 3 industries we visited.

1. **Amber Pulp and paper mills**

Location: Hatabo, Rupshi, Narayanganj.

Source: On site visit [15] [16] [17]

Wastewater Sources from Production: Scanning, washing, bleaching.

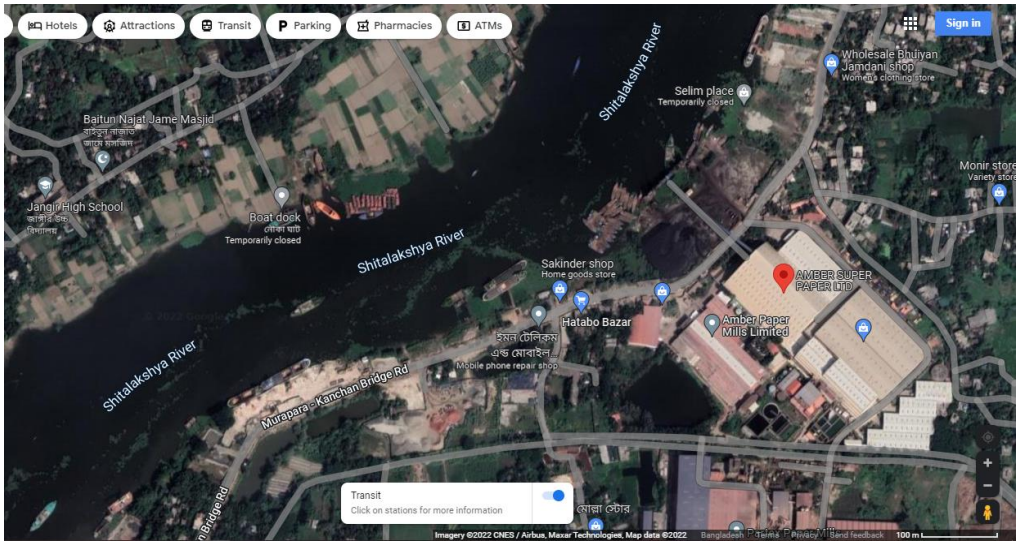

Figure 3.2(1): Location of Amber Pulp and paper mills Ltd (Google Map)

Source: From visiting site.

Operations:

Screening Unit: It is the first stage of wastewater treatment. It screens fiber from wastewater and separates fiber substances to reuse to produce paper.

Equalization tank 1: The major purpose of the equalization tank is to ensure homogeneous mixing of water and other substances that are present in water by aeration in the Dissolved Air Flotation (DAF) process.

Equalization tank 2: Repeat the process described in Equalization tank 1.

Reaction Tank: It is also known as a chemical dressing reaction tank. The wastewater from *equalization tank 2* made gravity fall into the reaction tank. There is also added polymer (chemical) in this tank to hasten the floc formation process and add Poly Aluminum Chloride (PAC) coagulants process.

Reservoir: Water was reserved here, mixed with air by gravity fall and then pumped to the primary clarifier wastewater.

Primary clarifier: It is a large tank that provides enough time to settle down the suspended particles (sludge). Then sludge passes through into a sludge thickener by a mechanical process and water passes into the oxidation tank by overflowing its scum baffle. It also removes other floating substances like oil and grease.

Oxidation Tank 1: It consists of an extended aeration (by mechanical systems) type of activated sludge process. In this process activated sludge removes organic substances and also increases DO value.

Oxidation Tank 2: Repeat the process described in Oxidation *tank 1*.

Oxidation Tank 3: Repeat the process described in Oxidation *tank 1*.

Secondary Clarifier: Bacteria getting lost and blowing sludge and increasing return activated sludge day by day. It will be found at the bottom of the secondary clarifier by aeration. Then sludge goes through in the sludge thickener. On the other hand, water passes into the post-oxidation tank.

Post-Oxidation Tank: Increasing the DO level in the Post-Oxidation Tank by the Dissolved Air Flotation (DAF) process. At this stage, the water's turbidity was good and the pH was about 7.

MGF: The water from the post-oxidation tank passes through the MGF and transfers to the drain.

Drain: Drain is connected to the river. The water is sound and safe at this stage, and we won't find any toxic substances in this water.

Here are some of the images for field visit.

Figure 3.2.1(4): Clarifier

Figure 3.2.1(5): Equalization tank

Figure 3.2.1(6): Oxidation tank

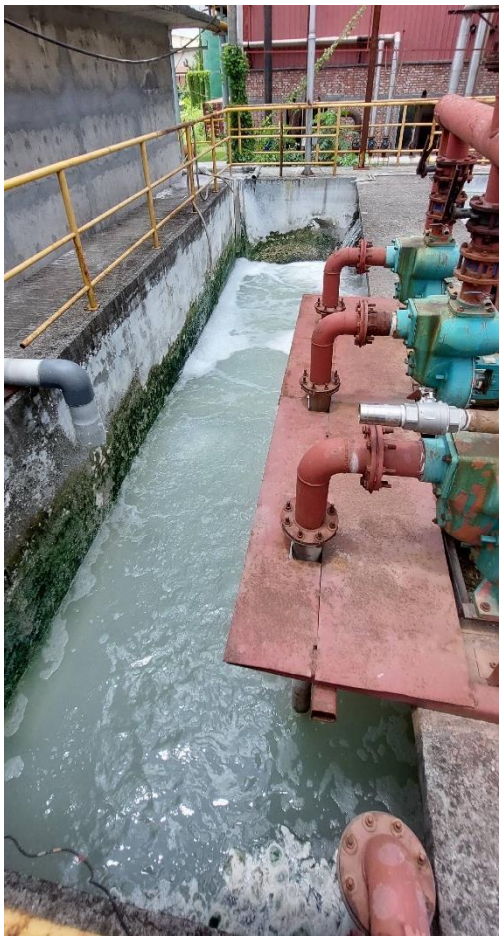

Figure 3.2.1(7): Reaction tank

Figure 3.2.1(8): Sludge thickener

Comments: We are satisfied with comparing the output results ECR-1997 parameters. Also, the suspended solid collected from the treatment plant is actually being used to make other things like hardboard or Mosquito coil etc.

2. Seam Paper Mill

Location: 14 Dhaka - Sylhet Highway, Tarabo

Source: via person to person communication [18]

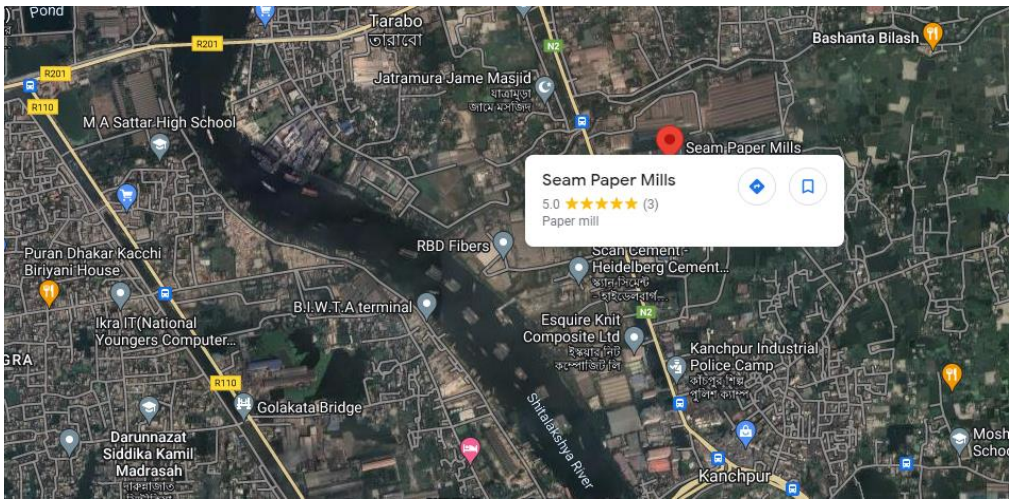

Figure 3.2 (9): Location of Seam Paper Mills (Google Map)

Wastewater Sources from Production: Scanning, washing, bleaching.

Operations

Screening Unit: It is the first stage of wastewater treatment. The screening device has uniform openings and a rotating device inside to separate all the big floating or non-floating solids.

Lifting Station: A wastewater lift station is a pumping station that moves wastewater from a lower elevation to a higher elevation. It plays an integral role in moving sewage to a wastewater treatment plant.

Homorganic Tank: Equalization is the process to make the waste water homogeneous. That's why an equalization tank is also called a homogeneous tank or homogenous tank.

Neutralizer: Neutralization tanks are used to alter the pH level of corrosive waste drainage by chemical neutralization. Here, acid or alkali is mixed to neutralize.

Cooling towers: Cooling towers are essentially large boxes designed to maximize the evaporation of water. To do this, they contain material, typically PVC plastic sheets that create large surface areas for water evaporation to occur. Cooling tower systems are required to minimize the risk of corrosion, scaling, and microbiological buildup.

Selector: selector tank is to control and limit the growth of filamentous bacteria, and then to enhance the sedimentation ability of the sludge. Sulzer provides a number of solutions for creating optimal conditions in the selector. [11]

Oxidation tank: Oxidation treats wastewater through the interaction of sunlight, bacteria, and algae. Algae grow using energy from the sun and carbon dioxide and inorganic compounds released by bacteria in water.

Sludge recycling tank: It separates sludge particles and wastewater. Transferring sludge into the sludge thickener and wastewater pumped to the sedimentation tank.

Sedimentation tank: This is a tank in which suspended solids are allowed to settle out of a liquid under the influence of gravity.

Filtration tank: This tank traps and filters the silt, eliminating it from the water supply and reducing the risk of contamination or pollution.

Post-Aeration tank: It is mixed with activated sludge. This contains countless microorganisms, such as bacteria, that are able to break down the colloidal, organic contaminants dissolved in the wastewater. It maintains DO in effluent and high-solids wastewater prior to disposal in the river.

Comments: We are satisfied with comparing the output results ECR-1997 parameters.

3. Hussain Pulp & Paper Mills Limited

Location: Ponchobati, Link, Fatullah

Source: via person to person communication [19] [20]

Figure 3.2(10): Location of Hussain Pulp & Paper Mills Limited (Google Map)

Wastewater Sources from Production: Scanning, washing, bleaching.

Operations

Screening Unit: It is the first stage of wastewater treatment. The screening device has uniform openings and a rotating device inside to separate all the big floating or non-floating solids.

Lifting Station: A wastewater lift station is a pumping station that moves wastewater from a lower elevation to a higher elevation. It plays an integral role in moving sewage to a wastewater treatment plant.

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Comments: We are satisfied with comparing the output results ECR-1997 parameters.

3.3 Summary

We have seen the variation in its phrase and production capacity in different industries besides the two rivers (Dhaleshwari and Shitollokha).

CHAPTER 4
RESULTS AND DISCUSSION

4.1 Introduction

We conducted our research on selected three pulp and paper industries and compared all the data. Looking at data analyzed. We get the general idea of paper and plump mils have almost alike sources from where wastewaters are generated. But size and capacity are different between different industries and output from ETP varies depending on those things but also based on those ETP's design a bit differently based on them. But in most cases, they do pass the requirements to release treated water into rivers. Some do it better than others, but most follow the rules and standards well.

4.2 Differences in water treatment plants

Since raw components are almost the same in the treatment plants for those the same pattern also almost alike technology can be found.

But there are differences in terms of sizes and units and also how well they are maintained. Then there are a few key differences we see in the field where Amber paper mills do seem to go one step beyond to do more efficiently in terms of reusing water and excess fiber / pulps that are found from preliminary scanning go back to production to mix with the pulp.

Here is the Standard for Sector-wise industrial effluent or emission

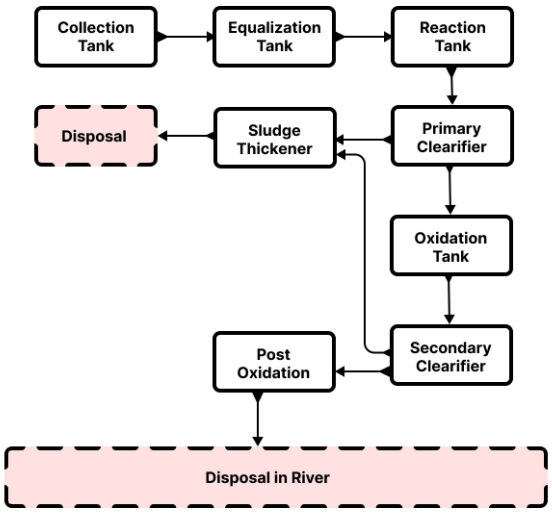


Figure 4.2.(1): Standard for Sector-wise industrial effluent or emission

According to Environmental Conservation Rules 1997 [21]

Parameter	Standard and presence in a unit of mg/l, except pH	
	Large plant with production capacity of above 50 tons per day.	Small plant with production capacity of less than 50 tons per day.
pH	6 – 9	6 – 9
Suspended Solids	100	100
BOD5 20oC	30	50
COD	300	400
Wastewater flow	200 cubic meter per ton of paper.	200 cubic meter per ton of paper produced of agricultural raw materials. 75 cubic meter per ton of paper produced of wastepaper.

Table 4.2 (1): Standard for Sector-wise industrial effluent or emission

Waste generation source from production, Amber Pulp, and Paper Mills Ltd.

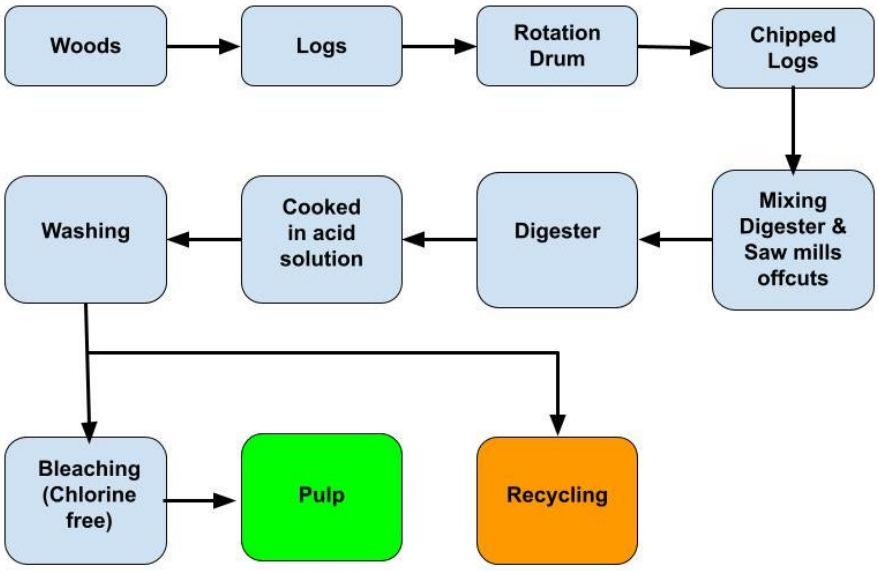


Figure 4.2 (2): Pulp Production process

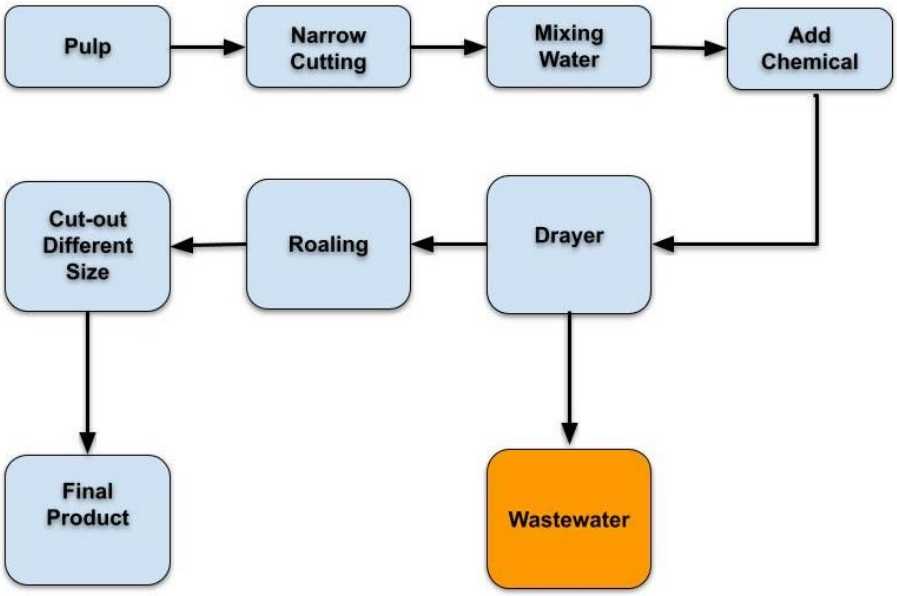


Figure 4.2 (3) : Paper Production process

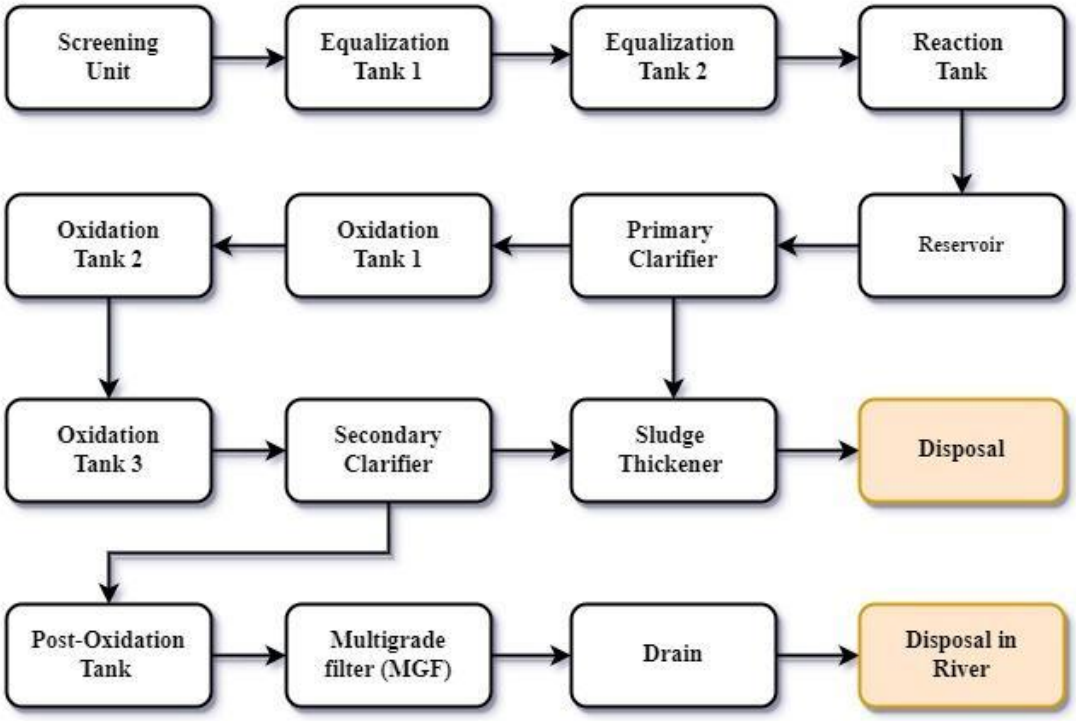


Figure 4.2(4): ETP of Amber Pulp and Paper Mills Ltd

Parameters

Name of Industry: Amber Pulp and Paper mills limited.

Industry Location: Hatabo, Rupshi, Narayanganj.

Production capacity (Ton/hrs)	Waste generation (Ton/hrs)
80	163 m^3 /hrs

Parameters	Inlet	Outlet
BOD (ppm)	50-60	25-30
COD (ppm)	200-300	120-150
TSS (ppm)	250-300	20
TDS (ppm)	350-400	250-300
DO (ppm)	4-5	5-7
pH	7.5-8.5	7.5-8.5
Wastewater flow	100-130 m^3/hr	100-130 m^3 /hr

Table 4.2 (2): Data of ETP of Amber Pulp and Paper Mills Ltd

Waste generation source from production, Seam Paper Mills.

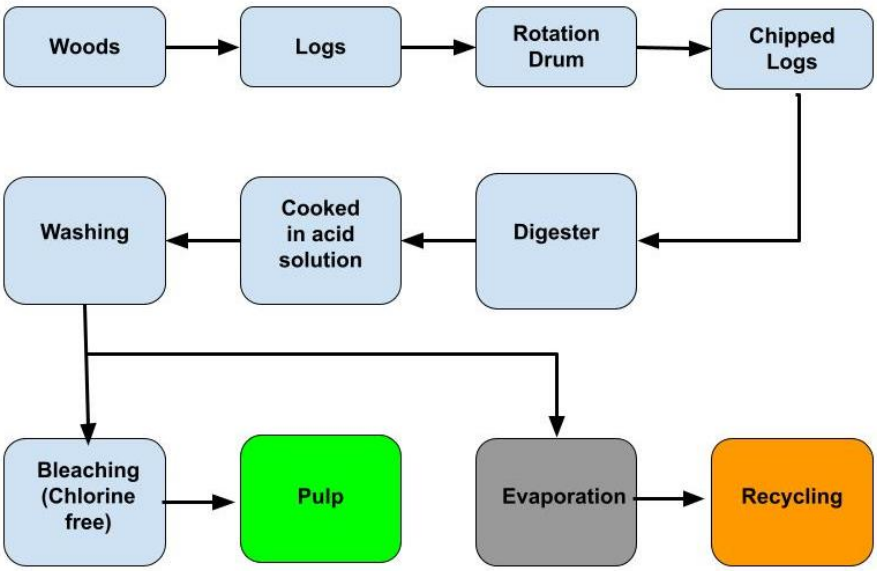


Figure 4.2 (5): Pulp Production of Seam Paper Mills.

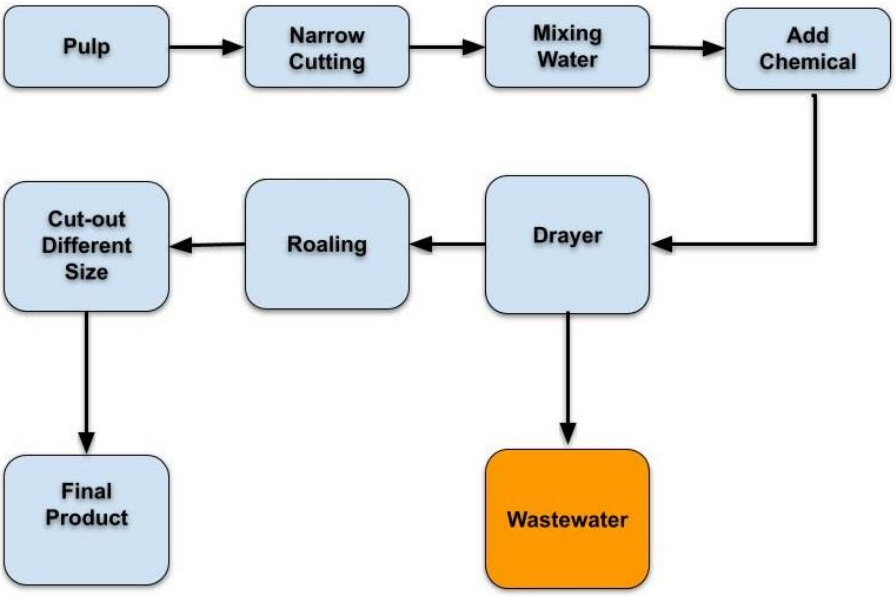


Figure 4.2 (6): Paper Production of Seam Paper Mills.

Treatment Phrase of ETP, Seam Paper Mills.

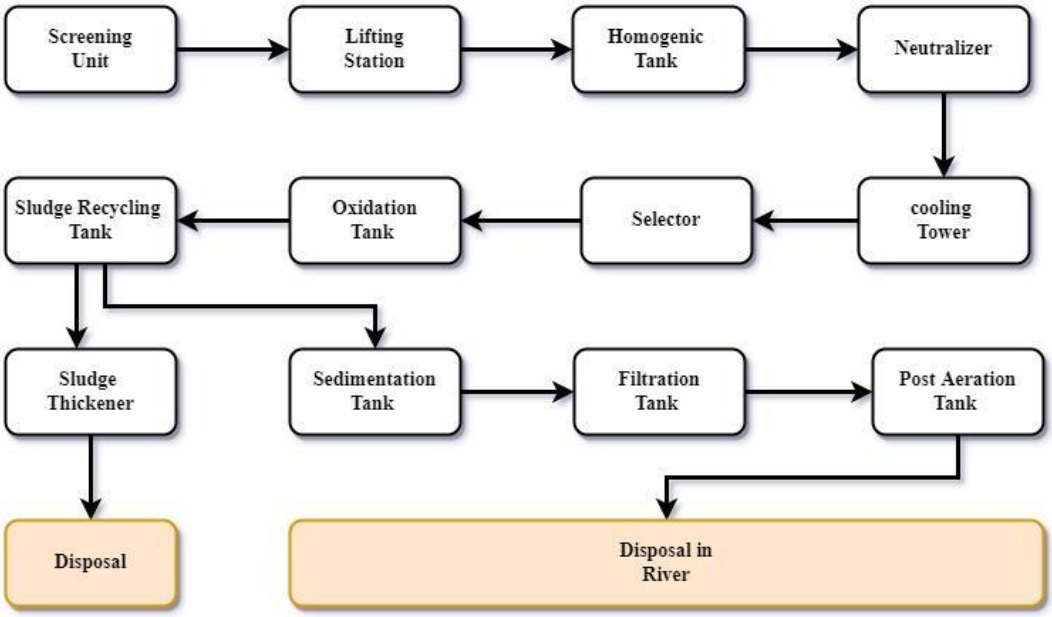


Table 4.2 (7): ETP of Seam of Pulp and Paper Mills Ltd

Parameters

Name of Industry: Seam Paper Mill

Industry Location: 14 Dhaka - Sylhet Highway, Tarabo, Narayanganj.

Production capacity (Ton/hrs)	Waste generation (Ton/hrs)
60	120m^3 /hrs

Parameters	Inlet	Outlet
BOD (ppm)	55-60	20-25
COD (ppm)	200-300	150-200
TSS (ppm)	250-300	24
TDS (ppm)	300-400	220-350
DO (ppm)	4-5	5-6
pH	6.5-8.5	7-8
Wastewater flow	90-100 m^3/hr (2150 m^3/day)	90-100 m^3 /hr (2150 m^3/day)

Table 4.2 (3): Data of ETP of Seam Paper Mill Ltd

Waste generation source from production, Hussain Pulp & Paper Mills Limited.

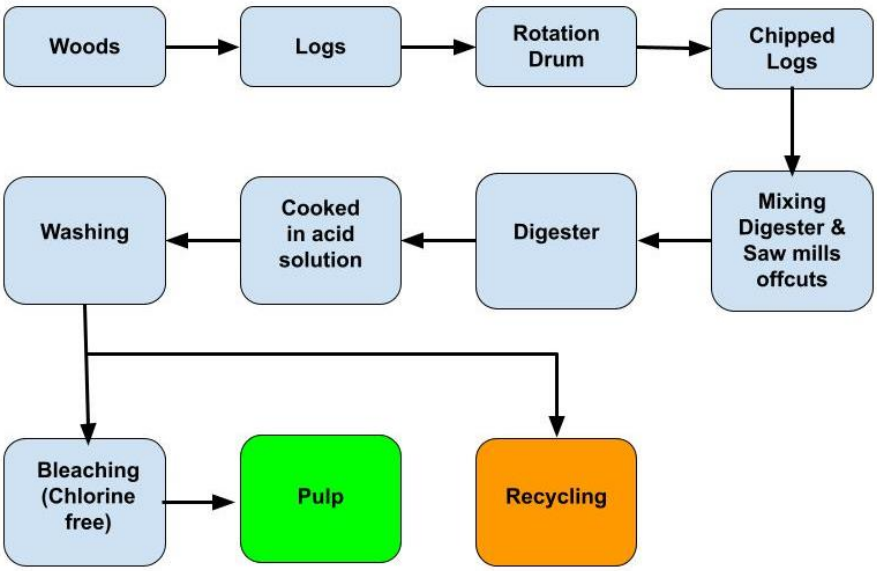


Figure 4.2 (8): Pulp Production of Hussain Pulp & Paper Mills Limited.

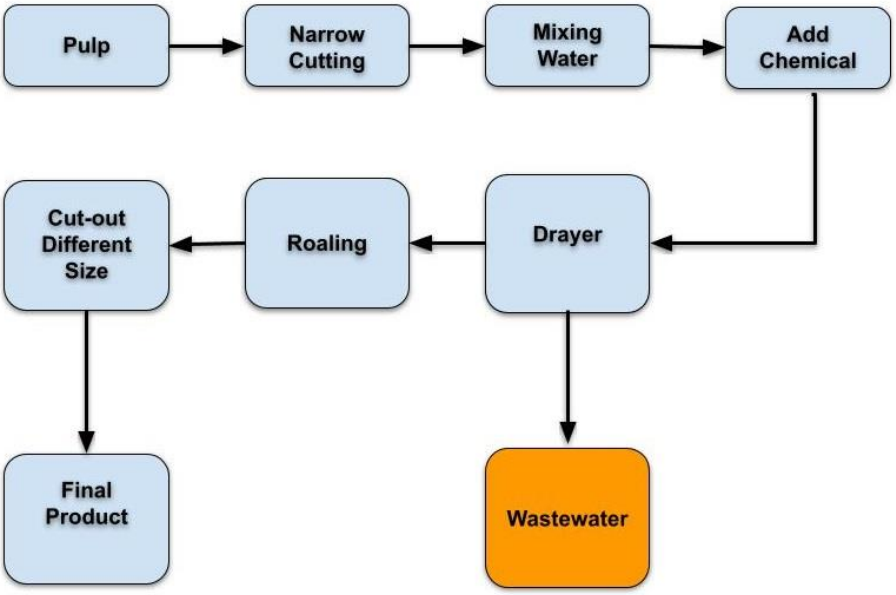


Figure 4.2 (9): Paper Production of Hussain Pulp & Paper Mills Limited.

Treatment Phrase of ETP, Hussain Pulp & Paper Mills Limited.

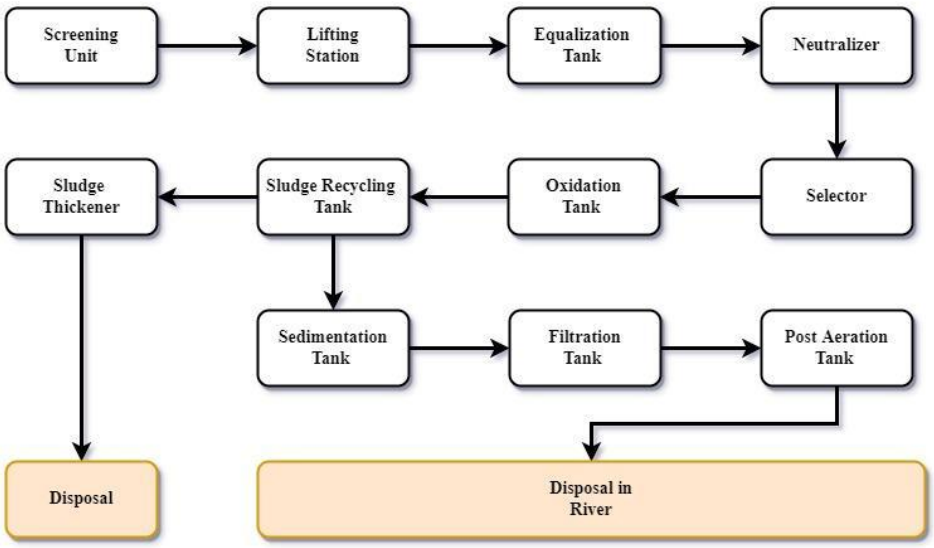


Figure 4.2 (10): ETP of Hussain Pulp & Paper Mills Ltd

Parameters

Name of Industry: Hussain Pulp & Paper Mills Limited

Industry Location: Ponchobati, Link, Fatullah.

Production capacity (Ton/hrs)	Waste generation (Ton/hrs)
55	100 m^3 /hrs

Parameters	Inlet	Outlet
BOD (ppm)	57-65	15-20
COD (ppm)	250-320	180-200
TSS (ppm)	250-300	32
TDS (ppm)	300-400	230-280
DO (ppm)	4-6	4.5-7.5
pH	6-8.5	7-7.85
Wastewater flow	100-110 m^3/hr (2300 /m^3/day)	100-110 m^3 /hr (2300 /m^3/day)

Table 4.2 (4): Data of ETP of Hussain Pulp & Paper Mills Ltd

And now here is side by side comparison of effluent data of selected ETPs

	Standard for Sector-wise industrial	Amber paper mill	Seam paper mill	Hussain Pulp & Paper Mills Limited
Production capacity (Ton /hrs.)	-	80	60	55
BOD (ppm)	50	25-30	20-25	15-20
COD(ppm)	400	120-150	150-200	180-200
DO(ppm)	4.5-8	4-5	4-5	4.5-7.5
pH	6.5-8.5	7.5-8.5	7-8	7-7.85

Table 4.2 (5): Variation of ETP's Data

From that comparison we can see all of them are managing to be at required specification. Some are managing better than others but all are under the specification.

4.3 Learning about ETPs in general also P&P plants

We also learned that a widely used type of treatment plant is Biochemical. For cost-related reasons, most use the Biochemical treatment plant. Installing the biological system can be higher upfront. It needs tanks, mixers, and pumps for your chemical reactants, but that is usually a lower capital cost than a biological system that has aeration, pH control, temperature control, maybe some packing media, etc. Therefore, while biological systems will have a higher capital cost to install and get started, they generally have a much lower operating cost than chemical wastewater treatment. Amber paper mills do have a biological treatment ready but it is not yet been used for the main operation.

4.4 Impact on nearby rivers and environment

We get to know the current condition of pulp and paper industries where we can see in the Narayanganj area as they do operate and maintain their ETP, wastewater is not a problem in the pulp and paper industry. Even the suspended solid that can be found after treatment is usable for other purposes. But it's also true that if it remains untreated, it is harmful to the environment.

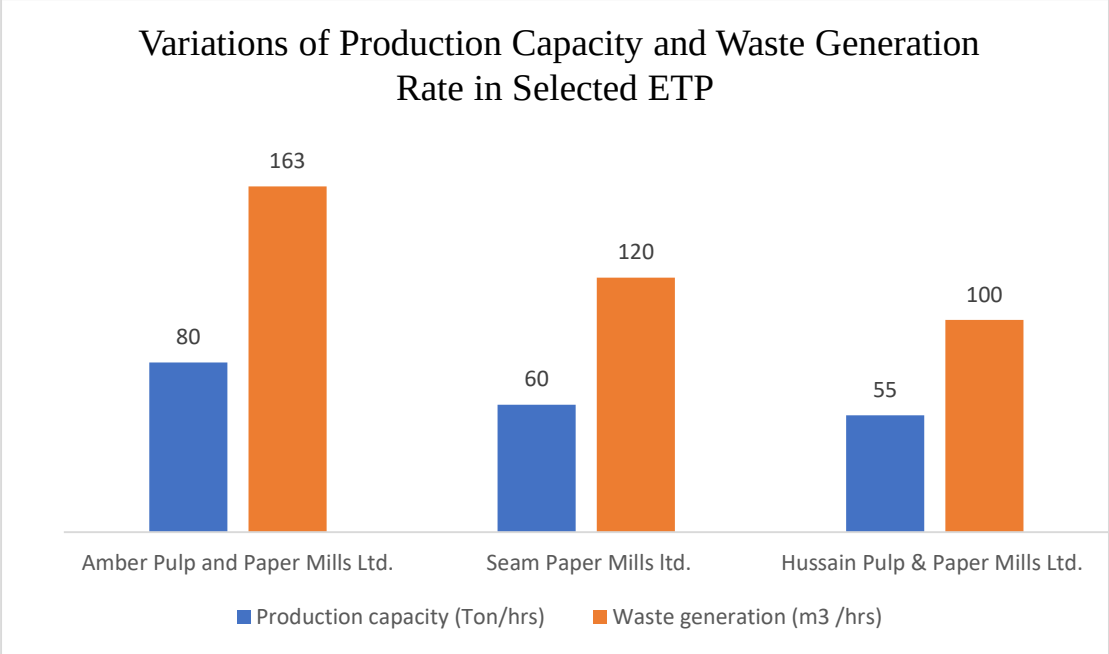


Figure 4.4 (1): Variations of Production Capacity and Waste Generation Rate in Selected ETP.

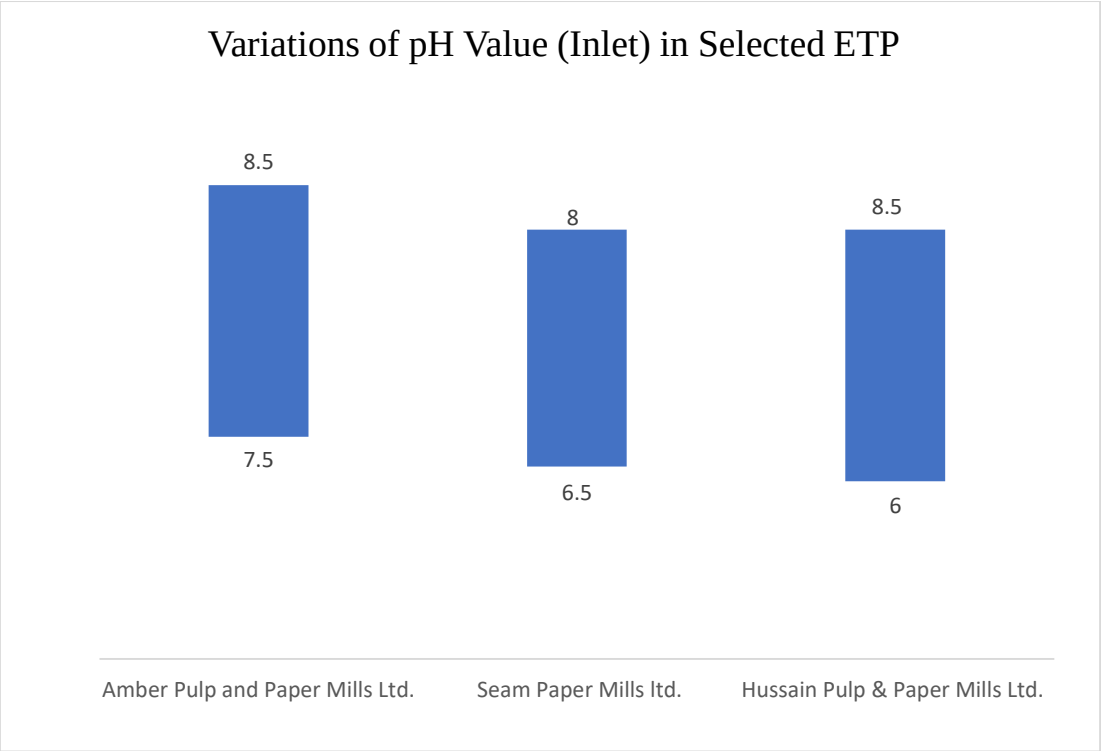


Figure 4.4 (2): Variations of pH Value (Influent) in Selected ETP.

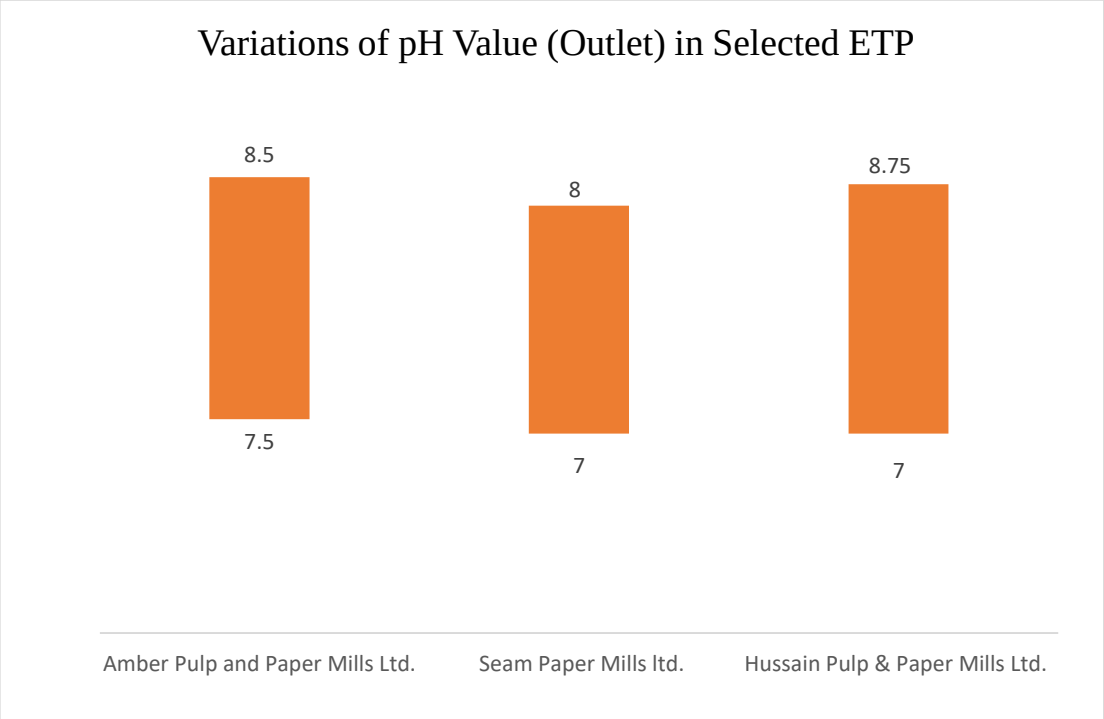


Figure 4.4 (3): Variations of pH Value (effluent) in Selected ETP.

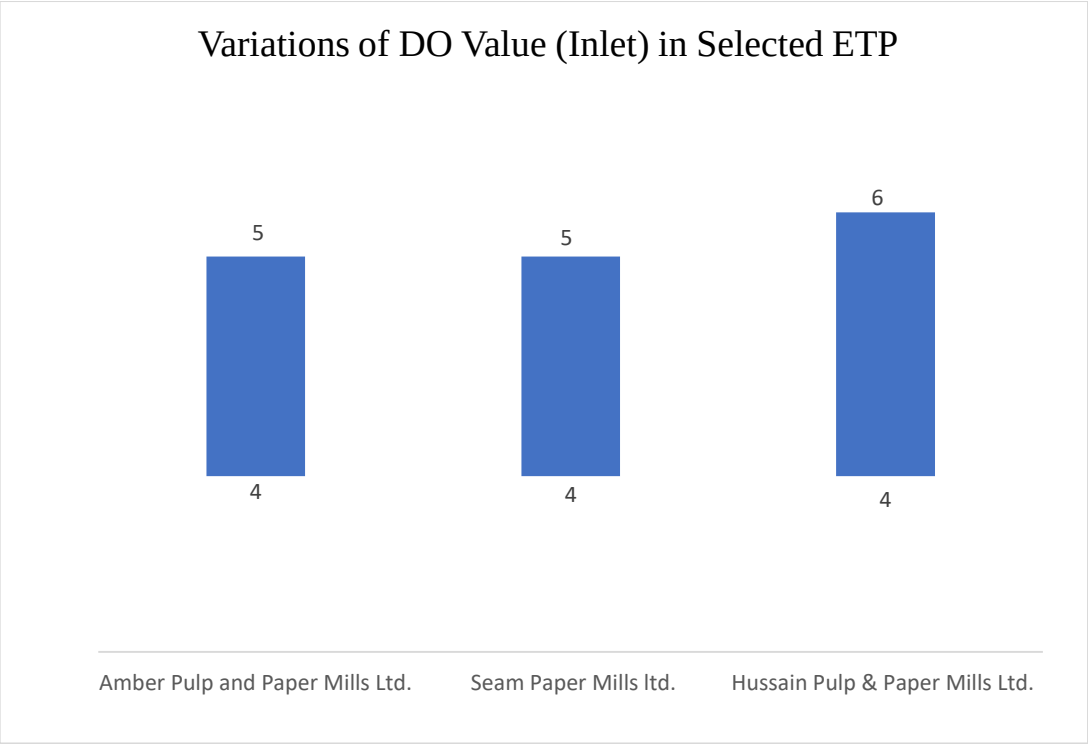


Figure 4.4(4): Variations of DO Value (Influent) in Selected ETP.

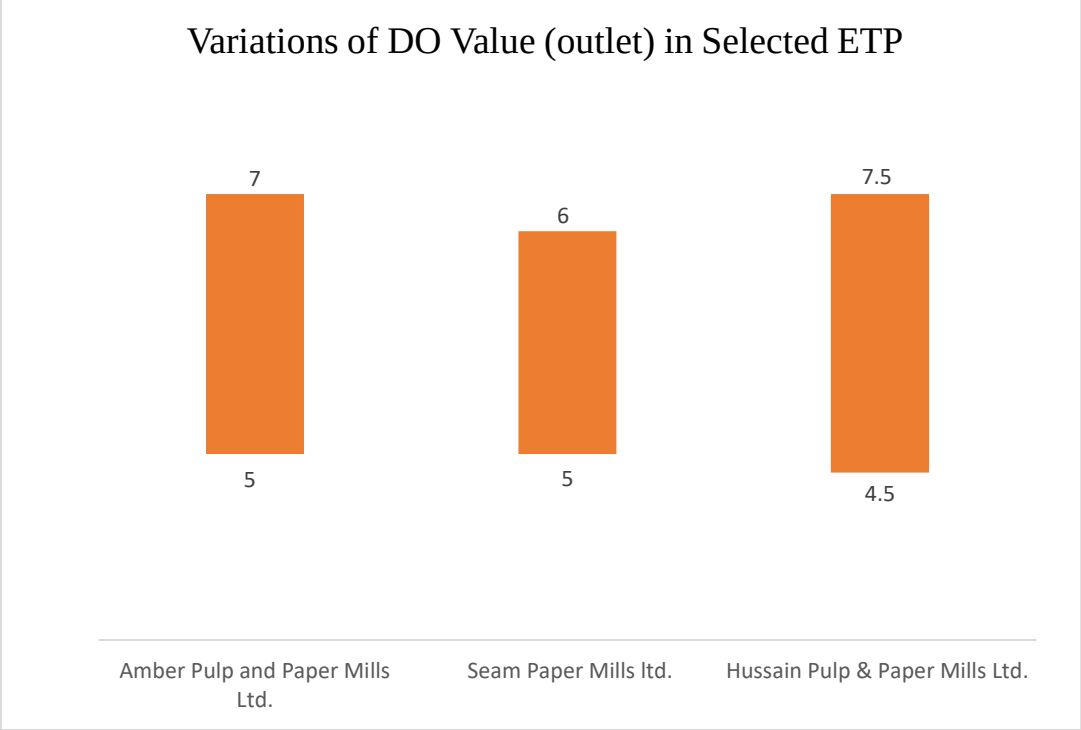


Figure 4.4(5): Variations of DO Value (effluent) in Selected ETP.

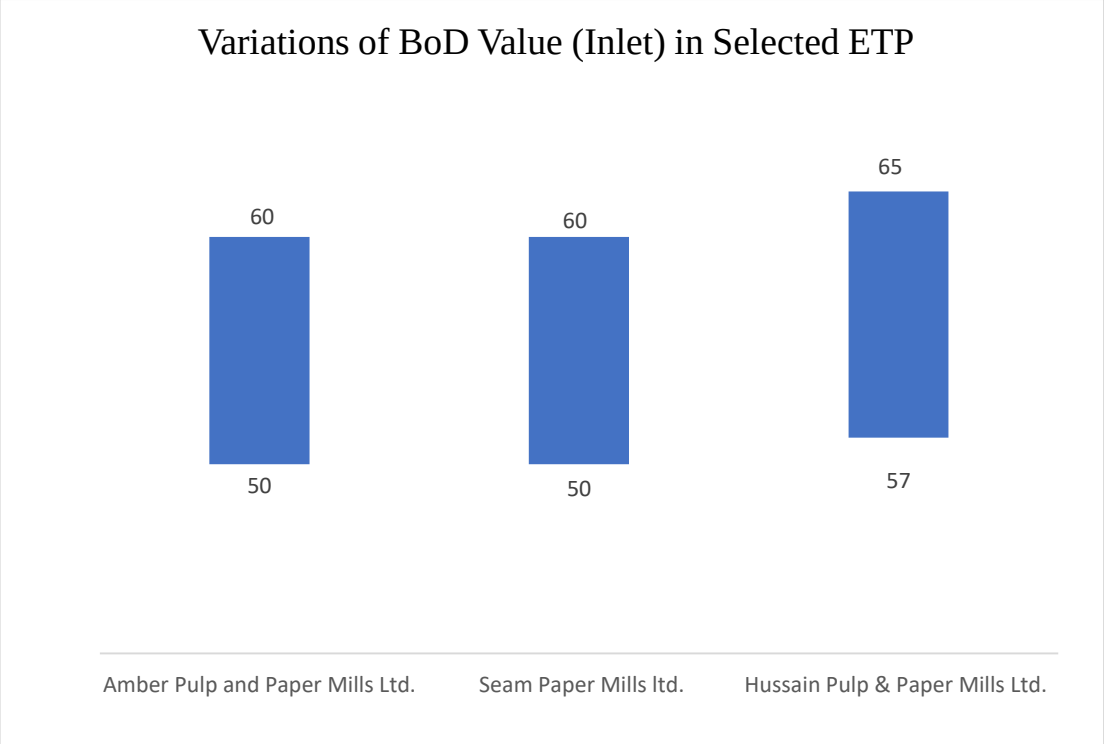


Figure 4.4(6): Variations of BoD Value (Influent) in Selected ETP.

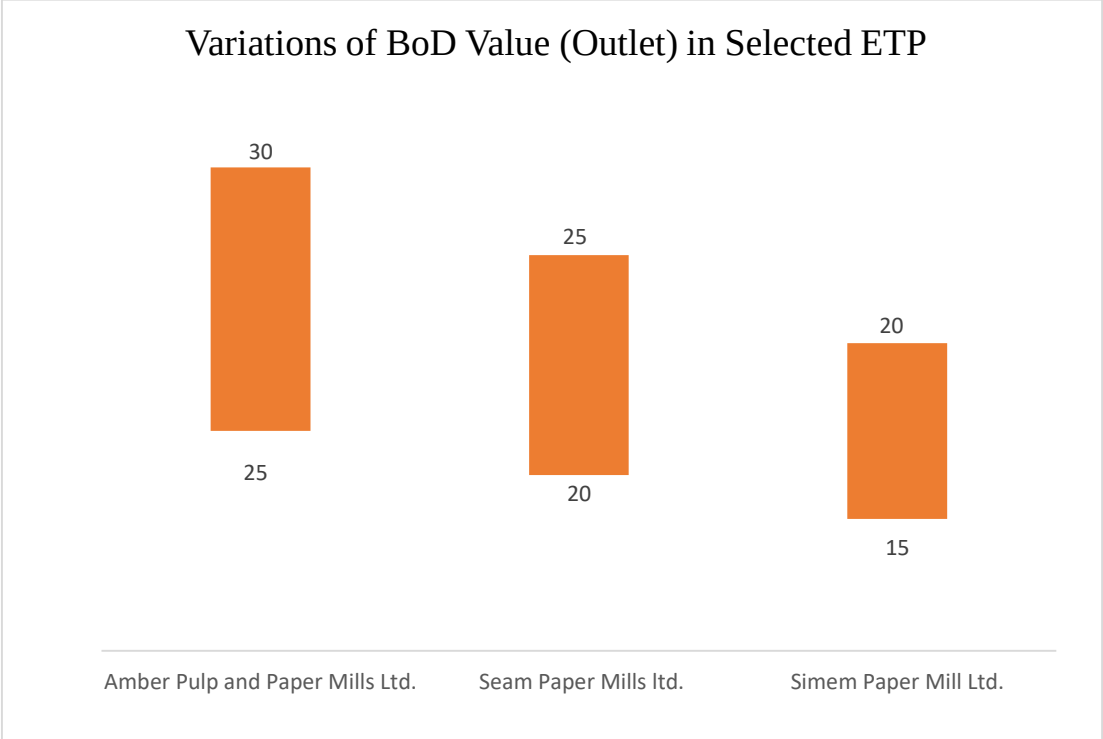


Figure 4.4(7): Variations of BoD Value (effluent) in Selected ETP.

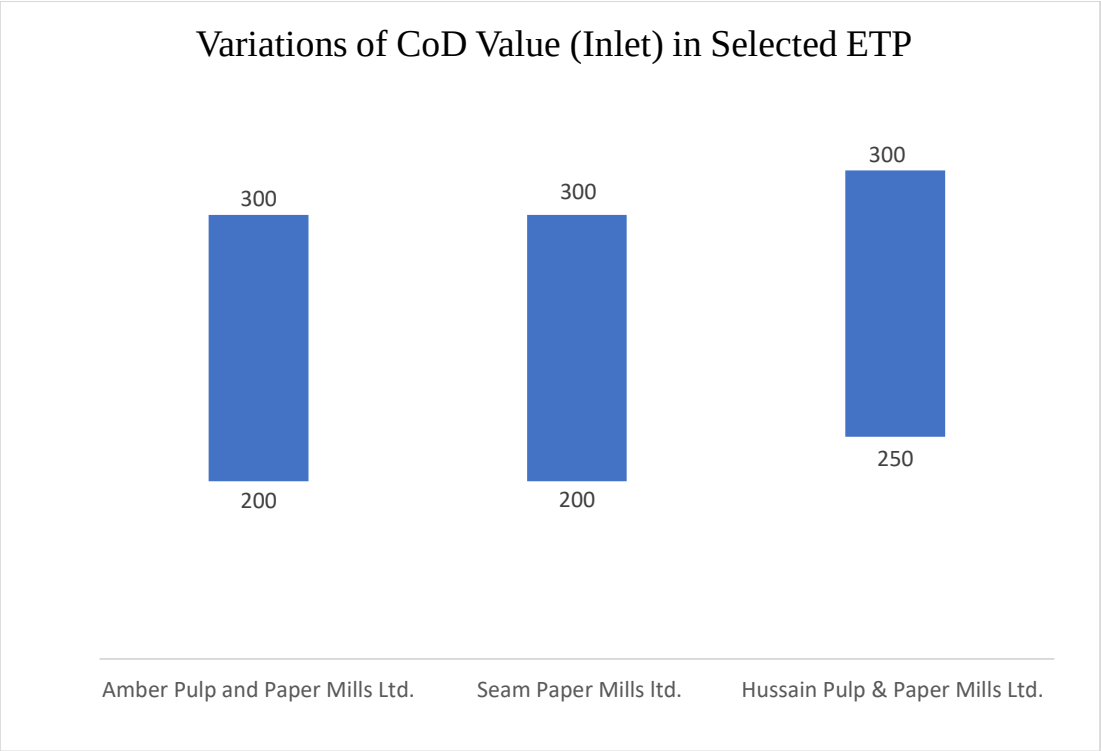


Figure 4.4(8): Variations of CoD Value (Influent) in Selected ETP.

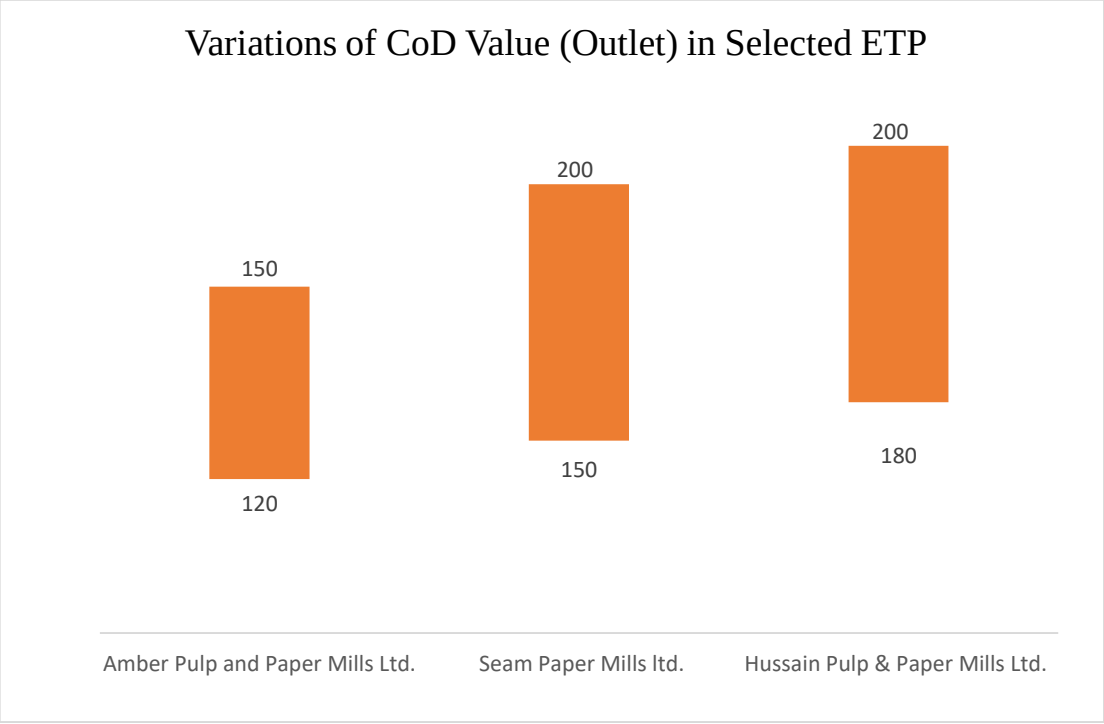


Figure 4.4(9): Variations of CoD Value (effluent) in Selected ETP.

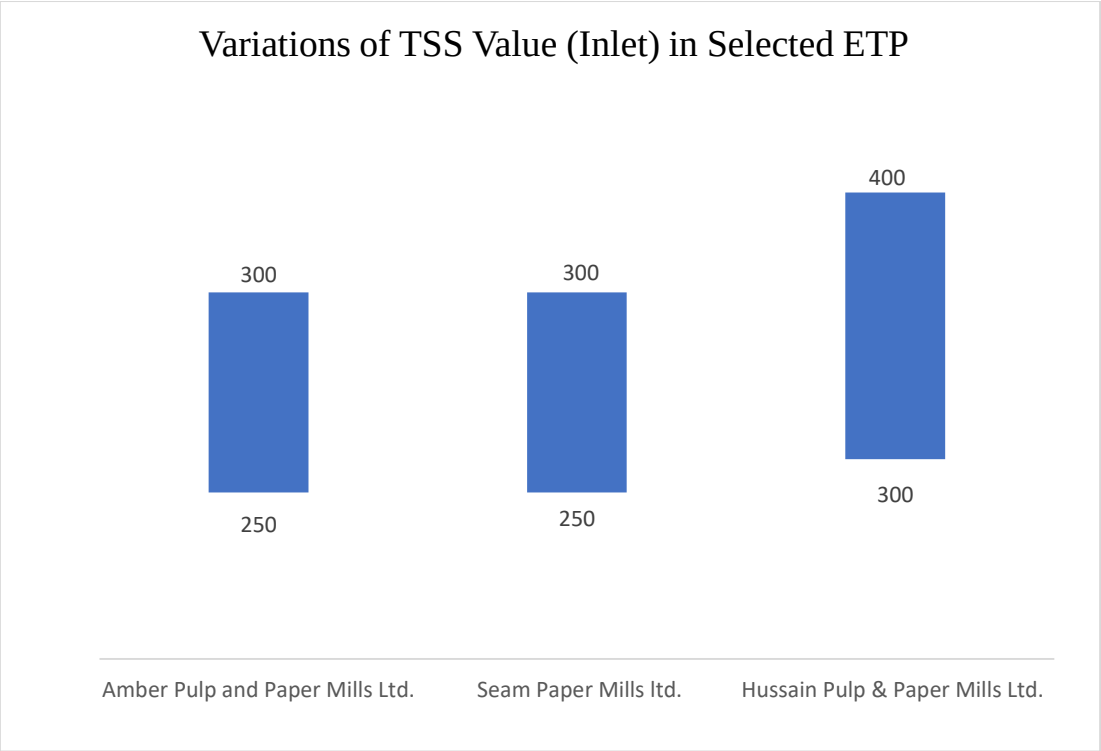


Figure 4.2(10): Variations of TSS Value (Influent) in Selected ETP.

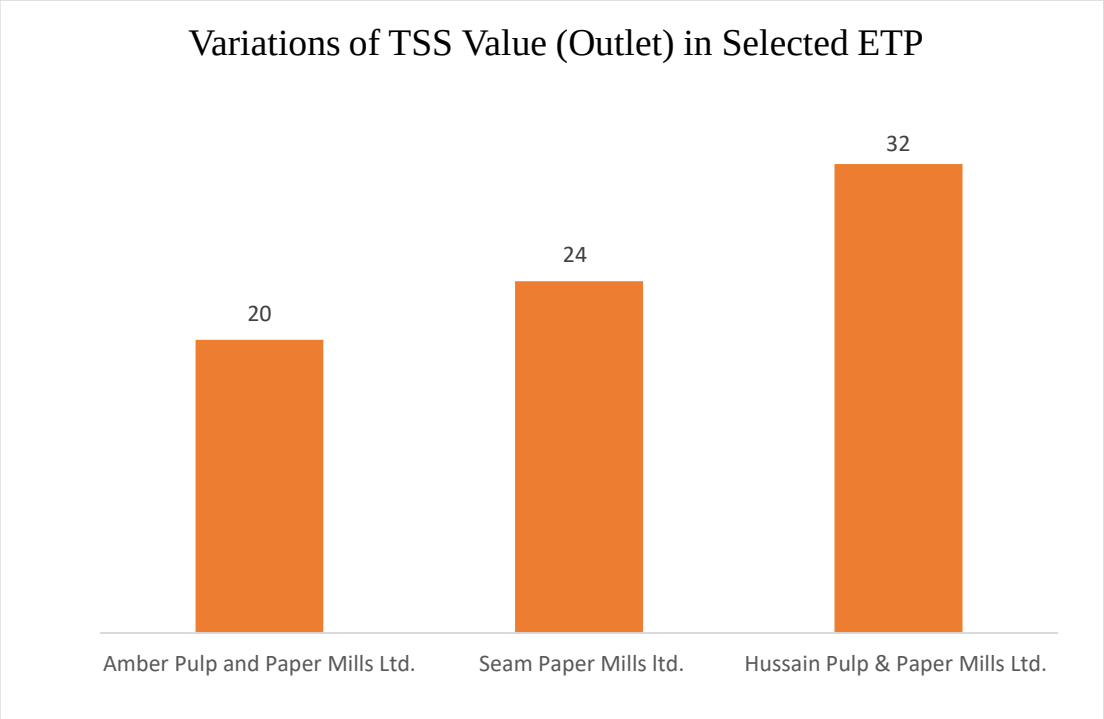


Figure 4.4(11): Variations of TSS Value (effluent) in Selected ETP.

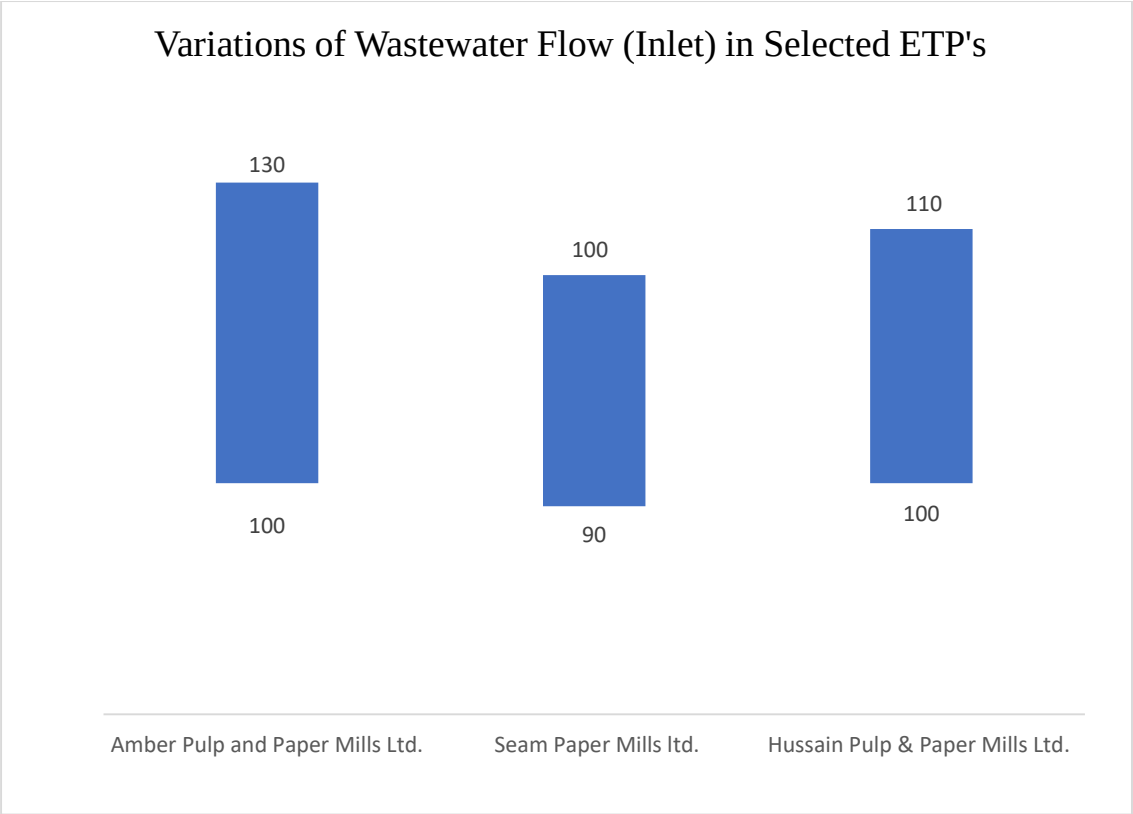


Figure 4.4(12): Variations of Wastewater flow (Influent) in Selected ETP.

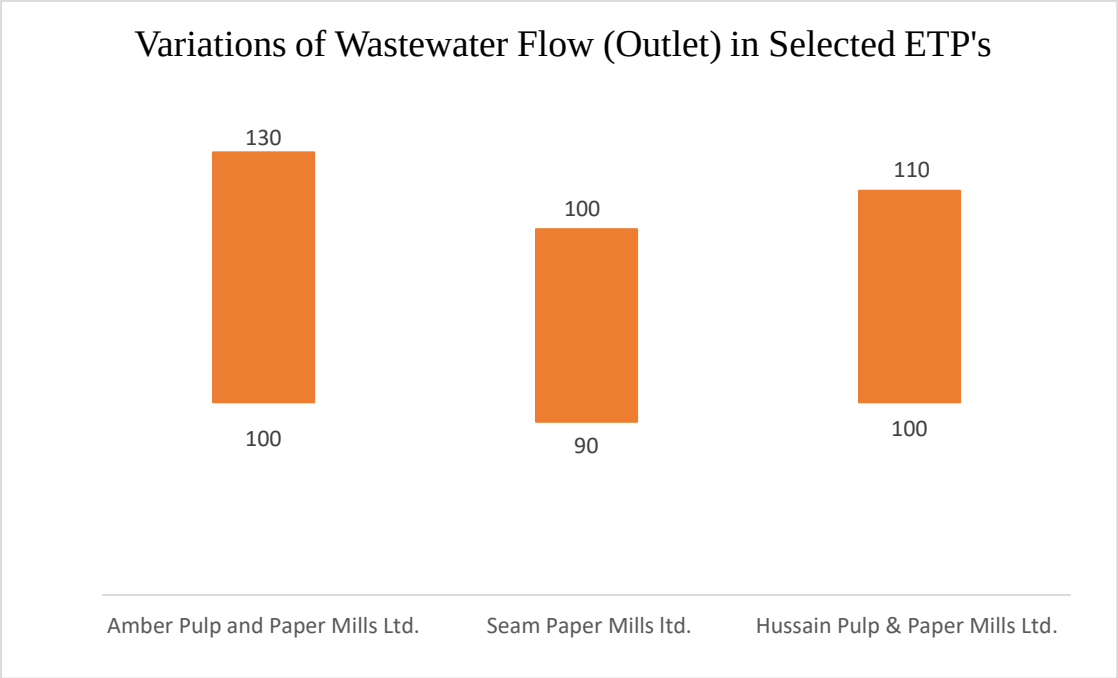
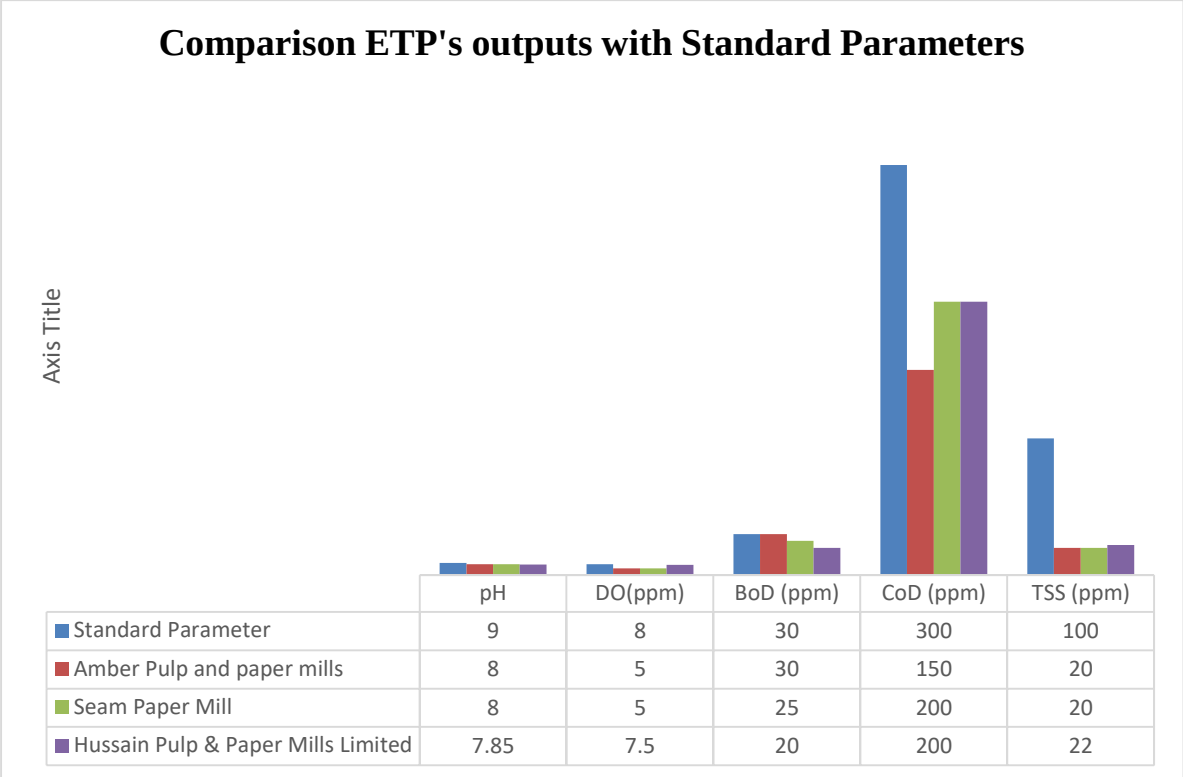


Figure 4.4(13): Variations of Wastewater flow (effluent) in Selected ETP.



	pH	DO(ppm)	BoD (ppm)	CoD (ppm)	TSS (ppm)
Standard Parameter	9	8	30	300	100
Amber Pulp and paper mills	8	5	30	150	20
Seam Paper Mill	8	5	25	200	20
Hussain Pulp & Paper Mills Limited	7.85	7.5	20	200	22

Figure 4.4(14): Comparison ETP's outputs with Standard Parameters

4.5 Summary

If we summarize, we can see the pattern of treatment plants are alike but depending on size and capacity, they tend to have few differences or smaller units to either get shorter cycle run or cost-effective capacity depending on needs.

CHAPTER 5
CONCLUTIONS AND FUTURE WORK

5.1 Conclusions

At the end of our thesis work, we find out that the variation of production capacity in different industries is significant. We also find that there is variation in the treatment phrases of ETP and also variation in ETP 's parameters such as BOD, COD, DO, TSS, TDS, pH, wastewater flow etc. Our selected industries are located beside two different rivers (Shitalakshya and Dhaleswari). All values of ETP's parameters satisfy the ECR1997 and DOE Standards. We found that if Production increases then waste water generation is also increases. So, the wastewater from selected three industries disposal in the river is safe for the environment. However, performance of Amber ETP is the best among three industries depending on COD removal.

5.2 Limitations and Recommendations for Future Works

The small number of pulp and paper industries that have active treatment plants that are currently active and allow on-site visits. But, our research was limited due to time limitations and other factors. Having data for several months could give us rich data, more unknown factors and more knowledge about the performance of ETP.

Over longer time 3~6 months' worth of data can give us performance over time and progressive impact.

Alongside that, we can get the best and optimal treatment systems from different sizes of industries.

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