CHAPTER 2.0
PROJECT DESCRIPTION

2.0 INTRODUCTION

M/s. Kohinoor Pulp & Paper Pvt. Ltd. (KPPPL), Assam belongs to the Kohinoor Group which is a joint venture of T.M. Dugar Group of Nepal and Bothra group of India. As Assam is a rich source of raw material (Bamboo) for Pulp & Paper industry, it is natural to think about this industry for any industrial group. With this view the group has decided to diversify their activities to the Pulp & Paper industry.

The proposed Greenfield Project is being considered to manufacture bleached pulp from bamboo as raw material and using the pulp to manufacture paper. The Project would be set up in the Industrial Growth Centre (IGC) of Assam Industrial Development Corporation at Plot Block C, Village Mornoi, Matia in Goalpara District of Assam. The capacity of project would be 250 Air Dried TPD finished saleable quality pulp and 250 TPD writing, printing, copier and newsprint paper. Process of manufacturing would adopt well proven technologies to maintain the compatible quality of final product with minimum environmental impact. Co-generation Power Plant would be the integral part of proposed project.

2.1 PROJECT HIGHLIGHTS

The principal features or highlights of the proposed Project of KPPPL under study are as follows:

Location	Industrial Growth Centre (IGC), Plot Block C, Village Mornoi, Matia, District Goalpara, Assam.
Land requirement	The proposed project shall be accommodated within already procured land (200 acres) within the Industrial Growth Centre of Assam Industrial Development Corporation (AIDC).
Raw water requirement & source	Make up water requirement for the project is around 18,480 cum/day (14,780 m^3/day for Pulp Plant, 2,500 m^3/day for Paper Plant, 720 m^3/day for Boiler & 480 m^3/day for domestic purpose). Water will be sourced from river Brahmaputra/

	Bore well.
Power requirement	Requirement of power for the proposed project is around 15 MW, which will be sourced mostly from the proposed 10 MW Captive Co-generation Power Plant and the balance from Assam State Electricity Board.
Effluent generation, treatment & disposal	521 m^3/hr. liquid effluent will be generated, which will undergo treatment in the proposed Effluent Treatment Plant (ETP) with the design capacity of 600 m^3/hr. Treated effluent meeting relevant effluent discharge standards will be let out into river Brahmaputra.
Air pollution control	Adequate control measures like installation of bag filters, electrostatic precipitators, dust suppression system and stacks of adequate height at relevant points.
Manpower	750 persons
Project cost	₹ 585 Crores

2.2 UNITS IN THE PROPOSED PROJECT

The proposed units and its capacity are presented in Table-2.1.

Table – 2.1
PROPOSED UNITS

Sl. No.	Facilities	Proposed Capacity
1.	Natural Fiber / Wood based Pulp Plant	250 TPD
2.	Paper Plant for Writing, Printing and Copier Paper	250 TPD
3.	Co-generation Power Plant	10 MW

2.3 REQUIREMENT OF RAW MATERIALS & CHEMICALS

2.3.1 Pulp Making

This project is primarily based on Bamboo as the main raw material. Composition of raw material will mainly depend on the availability of particular type of species. Technically, in all the cases it will not affect the proposed equipments for pulping.

To estimate the quantity of raw materials, it would be relevant to mention the concept of project. Proposed furnish would be as follows: -

Proposed finished Air dried Saleable production	-	250 TPD
No. of working days per year	-	345
Annual saleable production, Air Dried	-	86250 TPA
Bamboo Pulp	-	100%
Annual Bamboo requirement (100% on Air dried basis with 10% moisture)	-	209633 TPA

<u>CHEMICALS</u>

The various chemicals required for proposed plant are Chlorine Di-oxide, Caustic Soda, Oxygen, Hydrogen Peroxide, Sodium Sulphate, Lime, Alum etc. These are used at various stages of Pulping and pulp sheet making process. Almost, all the chemicals are readily available in the market and no special arrangement would have to be made for procurement of any chemical. Only economics of procurement would have to be monitored from management side.

Basis of estimation and estimated quantities of various chemicals are given as follows: -

Chlorine Di-oxide

At the conceptualization stage of proposed project, ECF process is being considered for bleaching. Quantity of ClO_2 has been estimated according to widely adopted norms of the Pulp & Paper industry.

Average consumption on the O.D. bleached pulp	-	1.8 %
Quantity of Chlorine Di-oxide	-	1500 TPA

Caustic Soda

It is used in cooking process of bamboo. In proposed project, major part of cooking liquor would be recovered from spent liquor / black liquor through chemical recovery plant. Only about 6-10% make-up cooking chemicals would have to be added in the process. This make-up chemical would be converted from sodium sulphate. Therefore, no fresh caustic soda would be required in cooking section.

The main purpose of Caustic soda in bleaching process, is to raise pH of the pulp slurry, but it also activates Hydrogen Peroxide.

Average consumption on the O.D. bleached pulp	-	2.08 %
Quantity of Caustic Soda	-	1800 TPA

Oxygen

Oxygen consumption is estimated for extraction stage in bleaching process and ODL stage. The main purpose of oxygen is to catalyze the extraction process during the bleaching process.

Bleaching stage

Average consumption on the O.D. bleached pulp	-	2.5 %
Quantity of Oxygen	-	2156 TPA

ODL stage

Average consumption on the O.D. bleached pulp	-	2.8 %
Quantity of Oxygen	-	2217 TPA

Hydrogen Peroxide

This is also a bleaching chemical and would be used in proposed sequence. Generally it is available in liquid form with 50% purity. Quantity is estimated at 100% purity.

Average consumption on the O.D. bleached pulp	-	0.5 %
Quantity of H_2O_2	-	450 TPA

Sodium Sulphate

As mentioned above, it will be used as a make-up chemical for cooking liquor. It will be used in powder form and would be added in black liquor in chemical recovery section. During the process, it will also maintain the sulphidity in cooking liquor. Quantity is estimated on the basis of requirement of caustic soda in cooking and in ODL process (reaction 80%, purity 95%) and alkali recovery of 95%.

Quantity of Sodium Sulphate - 5400 TPA

Lime

Lime is required in causticizing of chemical recovery section. It converts sodium carbonate into sodium hydroxide. Quantity is estimated as per standard consumption norms (with 60% available CaO).

1.25 Tonne / tonne of recovered caustic soda in causticising section - 42514 TPA

Miscellaneous Chemicals

There are many other chemicals like Sulphuric Acid, Sodium Thiosulphate, Kerosene oil, Urea, Phosphate, etc. Quantity of these chemicals is not fixed and requirement is not continuous. Although, quantities of individual chemicals is very less, but these chemicals play important role in smooth functioning of the plant.

2.3.2 Paper Making

The principal raw material for manufacturing Paper for this unit will be Bamboo Pulp. Other than the Pulp some assorted Chemicals like Alum, Rosin etc. are also required. Requirement of pulp for this unit will be around 250 TPD while other Chemicals account for 45 TPD.

List of major raw materials required and source along with mode of transportation is as follows:

Sl. No.	Major Raw Materials	Source	Mode of Transport
1	Bamboo	Goalpara and the neighboring districts Upper Assam, and other NE States Garo Hills and adjacent areas and other NE States	Road/Rail
2	Coal	Khasi & Garo hill districts of Meghalaya Marghrita Assam	Road Rail

3	Lime Stone	Khasi & Garo hill districts of Meghalaya and other NE States	Road
4	Shop Stone Powder	Meghalaya and Rajasthan	Road/Rail
5	Fortified Rosin	Guwahati & Nowgong districts of Assam and Kolkata	Road

The mass balance of the proposed project is presented in Figure – 2.1.

2.4 PROCESS OF MANUFACTURING

2.4.1 GENERAL

Indian Pulp & Paper Mills can be categorized based on their raw materials i.e., Wood, Agro-residues and Waste paper. It is generally recognized that all raw materials of Pulp & Paper making are composed primarily of cellulose and other carbohydrates, lignin and resins. From the standpoint of pulp making it is the cellulose in the raw material which is of primary interest. The principal object of the pulping is the separation of celluloses from lignin and other undesirable components of raw materials.

Integrated Bamboo based Mill

The Pulp & Paper made by these mills use virgin fibre from wood or bamboo as their raw material. Wood contains fibre from which Pulp & Paper is made and significant amount of lignin which is not desired for Pulp & Paper is separated out. Wood or bamboo is cut into small pieces in chippers. Bamboo chips, steam and chemicals are added in the digester to separate unwanted lignin from fibre. Pulp is then screened and washed. While the pulp is washed the Black Liquor is produced containing Liqnin which is sent to Soda Recovery Plant to burn in Recovery Boiler. The smelt produced in Recovery Boiler is subjected to Causticising to produce Caustic which is reused in the plant. Thus the Pollution Load is reduced very much. The washed Pulp is further subjected to Oxygen Delignificaation to remove more lignin and finally subjected to Bleaching by Chlorine Dioxide, Oxygen, Hydrogen Peroxide to produce high brightness pulp.

So overall, by use of Chlorine Dioxide and Oxygen as primarily bleaching agents the AOX, BOD and COD levels are reduced to minimum with

Effluent Water from Pulp Mill going to ETP where further clarification, oxidation and treatment is done.

2.4.2 MANUFACTURING PROCESS

2.4.2.1 PULP MAKING

Raw Material Preparation

The mode of preparation of raw material plays an important influence on the quality of end product. Proper chips can be produced from bamboo in the chipper, making it possible for pulping in a stationary vertical digester. Length and thickness distribution is very similar to normal wood chips, and chip weight corresponds to that of eucalyptus, an important factor for cooking. Because bamboo belongs to grass family, the silica (SiO_2) content is much higher than in wood. Silica, acting as a “skin”, protects annual plants from the environment like bark protects trees. The high silica content must be taken into account while designing bamboo-based mills, because it causes scaling problems in the cooking plant and in black liquor evaporation as well as producing good quality lime in reburning plant. Therefore, if the silica content in bamboo is 2%, a large amount of the lime must be purged to maintain an acceptable SiO_2 content of 650 mg/l in the white liquor.

Proper conveying system is required for transporting bamboo / bamboo chips from yard to chipper to digester. Bamboos are cut into small pieces by feeding it into a chipper through conveyor belts. After chipping, the chips are carried to vibrating screens where the accepted chips are sent to chip bin while the oversized are reprocessed in Rechipper and fines are sent to fines bin. The chips are stored in the chip silo followed by processing through chip washing system and finally fed to digesters. During the process some dust from raw material is generated which is used mainly for land filling or burning in power boiler.

Pulping, Washing and Screening

Although the modern pulp industry is more than 100 years old, the development in the field of pulp making has been gradual and has undergone several changes due to systematic research in the field of fibre chemistry and morphology and general engineering practices. New knowledge on morphology and structure of fibres, chemical reactions in pulping and bleaching has been available. During the last 50 years or so, the acid sulphite pulping process has been replaced by the alkaline sulphate process (Kraft) due to several drawbacks such as longer cooking time, expensive effluent treatment and disposal, escape of sulphur compounds into the atmosphere and limitations of using different varieties of wood species.

There are several modifications of the alkaline pulping process starting from soda cooking to the polysulphide cooking but sulphur still remains the most indispensable ingredient in the major pulping methods. The Kraft or the sulphate pulping process is still the most dominant pulping process. Nearly 80% of global chemical pulp is made by the kraft process. The kraft process gives higher strength properties with easy bleachability.

For larger capacity of pulp mills, continuous digesters have been used, while for smaller capacity, batch digesters are used. In batch digesters, steam can be introduced directly or indirect heating is carried out by means of a liquor circulating pump through a heat exchanger heated with steam. Indirect heating produces improved pulp quality.

Pulping:

The purpose of pulping is to dissolve the inner fiber bonding materials of raw material by means of heat and alkaline liquor, leaving pulp as a fibrous residue. In pulping process, all constituents of the raw material are simultaneously attacked under the conditions of digestion. Thus some of the non-cellulosic materials remain in the pulp while at the same time the cellulose itself has been subjected to some attack.

Cooking processes can be divided into two main categories. They are the batch method and the continuous method. For batch process, stationary vertical or spherical rotary digester is used while for continuous cooking tube type cylindrical digester with conveying screw is used. Modern continuous digesters for wood and bamboo have a continuous operation in a vertical digester having different zones.

Ratio of chemicals to the raw materials, temperature of cooking, time of cooking, bath ratio etc. are the important parameters for pulping process. Lignin left in fibers is expressed in terms of kappa number. Lignin causes pulp to turn brown during alkaline cooking. Kappa number after cooking has been decreasing during the last decades in order to minimize environmental load. Because the residual lignin goes to bleaching line effluents, it is beneficial for reducing the effluent load to continue cooking as long as possible. However, there is no use to decrease the kappa number too much during the cooking because the pulp strength properties and yield will decrease considerably after a certain point. Rapid development of oxygen delignification has caused that instead of trying to reach very low cooking kappa numbers in the digester, a part of residual lignin is removed outside the digester in the so called oxygen-alkali delignification stage.

Kraft or sulfate cooking method is proposed. Chemicals which dissolve maximum lignin and little cellulose as possible are used in the pulping process. Sulfate process uses white liquor, a mixture of sodium hydroxide (NaOH) and sodium sulfide (Na_2S). Sodium hydroxide degrades lignin and sodium sulfide increases cooking reaction rate and decreases cellulose degradation caused by sodium hydroxide. Temperature in sulfate pulping is normally 150 - 170 °C.

Because bleaching chemicals are much more expensive than cooking chemicals, a major part of lignin is removed during the cooking process. However, too extensive lignin removal causes cellulose degradation. This decreases pulp strength and yield. Kappa number for pulp to be bleached is in the range of 14 – 15 with a Pulp yield of 50 - 53%.

A new cooking technology, similar to the Beloit's Rapid Displacement Heating (RDH) is proposed. In this system, the following are the sequences:

- Combined chip fill with steam packing and cool pad liquor fill
- Warm liquor fill from warm liquor accumulator
- Hot liquor displacement with temperature controlled hot liquor
- Heating temperature control and cooking with continuous liquor circulation
- Wash liquor displacement to wash and cool down the pulp
- Discharge pulp with low temperature
- Wait and spare time to equalize cooking plant

The advantages of this batch process (also called superbatch / Enerbatch / RDH) are

- Well proven excellent cooking chemistry and optimized cooking cycle resulting in uniform high quality pulp.
- Improved yield and bleachability as well as improved pulp and paper technical properties.

- Low energy consumption due to effective displacement processes
- Gentle pulp discharge at low temperature preventing malodorous TRS gases
- Effective collection of odourous gases

Since continuous digesters are suitable for large pulping capacity, they are not considered for capacity below 300 TPD pulp. Hence the batch type digester with improved pulping technology has been adopted in this project.

Deknotting:
Pulp from cooking invariably contains undercooked chips. Some of the chips may not have been cooked completely. Knots in bamboo are dense and are uncooked. Bark, sand, etc. need to be removed before washing. These impurities are removed by means of screens. Deknotting takes place immediately after the blow tank. Rejects (knots) cannot pass through the perforated screen plate / basket. The main concern in deknotting is to reduce the fibres going with knots. The task of deknotting is two-fold: first to separate the knots in a reject stream and to wash the good fibres from the knots (fibre-free knots). The deknotting system is provided with dewatering of knots for return to the digester.

Knotter screen is a modern pressure screen type with 8 – 10 mm hole. Pulp slurry from the blow tank is pumped to knotter screens which are located before the brown stock washers. Knots and fiber bundles in the pulp slurry result in poor cake formation and non-uniform washing operation. Removal of these knots and other uncooked material results in a uniform and dense cake. It is easy to wash and it results in improved washing efficiency. The deknotting is operated at 3.5 – 4.0 % consistency. The dry solids content (2% maximum) of knots is in the range of 25-35% consistency. Accept pulp from this screen goes to washer and knotter reject goes to digester house for re-cooking.

Pulp Washing
Pulp washing is the operation where dissolved organic materials and the spent inorganic chemicals are separated from pulp fibres. One of the purposes of washing is to recover the dissolved substances of value for further processing, eg. Spent liquor organics for fuel and inorganics for regeneration of cooking chemicals. Another objective is to clean the pulp of

dissolved impurities so that it is ready for treatment which follows. A third purpose is to minimize liquid effluents and hence pollution.

Two types of washers are generally considered. One is rotary drum vacuum type and second is double belt press type. Vacuum drum washers are normally used. It is done by using a series of single stage drum filters. This equipment consists of the wire-cloth-covered cylinder rotating in a vat, each constructed of a proper material (usually welded steel with stainless steel or Ni- resistance fittings) to withstand the higher temperature and chemical action of the pulp. Wash shower pipes are located across the top of the drum so that the wash water / liquor can be applied to the pulp mat on the drum after it has emerged from the vat. In the vat, consistency is about 1% and on drum it is about 10 to 12 %.

In the proposed process, rotary drum vacuum type washers are considered. The pulp slurry is diluted to 1% consistency and led over a weir into a vat containing a rotating perforated cylinder (drum). The drum is covered with a filtering medium usually a metallic wire. A partial vacuum inside the drum extracts liquor from the pulp suspension as it forms a mat on the drum. The mat leaves the filter at a consistency of 10-12 %. Wash water or dilute liquor is used as spray on the fibre mat. Three stage counter current brown stock washing arrangement is proposed for this project. Fresh water is applied at last stage and filtrate of each stage is pumped to previous stage and is used for dilution and washing. Filtrate of 1st stage is known as black liquor (15-16 % BL solids) and removed from the system and pumped to Chemical Recovery Area.

Screening & Cleaning

The general purpose of screening and cleaning is to reduce the amount of rejectable material from the pulp. There are two main principles applied: screening which separates the debris by size and cleaning, which separates based on density difference of fibres and debris. Cleaning is based on gravitational separation in hydrocyclones. Considerable amounts of good fibre escape with rejects as one aims at achieving maximum purity. Hence screening and cleaning are arranged as multistage cascading operations, where a primary stage purifies the accept stream and the secondary, tertiary and quaternary stages reclaim good fibres which are recirculated back to main stream.

Pressure screens for brown stock pulp are operated against a positive back pressure and hence can be directly connected to the following screens in series or cascade. Further, pressurization eliminates drop leg discharge; so control is better. Foaming in screening is also avoided. Screening in conventional operation is after the brown stock washing. Brown stock screening is done at low consistency (1-2%). The cross sectional geometry of screen plates affects the screen capacity. Perforations clogging are avoided by having conical holes (grooved). A slotted plate with a given open area gives higher separation efficiency than a plate with round holes. Slotted screens are located after the screens with holes.

Low / medium consistency Pressure screen are considered for screening of pulp. In two stage primary screening, 1^{st} stage should be hole type and 2^{nd} stage should be slot type. To avoid the fiber loss in screening operation, reject from primary stage is fed to secondary stage. This cascade arrangement will clean the fibre on the basis of their size. Screening is done in pressurized screens at 2-3% consistency to have completely closed liquid circulations and operate with a minimum of air entrainment.

Oxygen-DeLignification (ODL)

Lignin is the main contributor to pulp color. In chemical pulp, lignin has the highest light absorption coefficient of all fibre components. The residual lignin has to be reduced before bleaching so that bleaching chemical cost is reduced and pollution (BOD, COD, AOX) load is reduced in the effluent. ODL enhances the brightness ceiling of bleached pulp. There is a limit to lignin removal by cooking without loss of carbohydrate (pulp yield loss). Oxygen in an alkaline medium under pressure and at an elevated temperature can remove lignin without loss of pulp yield.

The MC-pump is required before the stage-2 to increase the pressure in stage-2 to upto 6 bar at the reactor top, an important factor for kappa reduction.

The Project proposal includes the ODL stage. ODL proposed here consists of two stage oxygen reactors. Pulp is mixed with oxygen and steam in a heater mixer and pumped by MC Pump to the bottom of first reactor (upflow) under pressure and discharged at the top. Pulp from first reactor is again pumped to the bottom of second reactor (upflow) and discharge from the top of the tower to the top of blow tank. The consistency of pulp is 10-15% (medium). First stage of Oxygen delignification is of approximately 30 minutes and second stage is of 60 minutes retention. The pulp is washed and the dilute liquor is sent to chemical recovery. Post oxygen delignification washing is carried out in two stage washers operating in series. Kappa after cooking is 14-15 and after oxygen delignification in the neighbourhood of 8-9.

Normal operating conditions in ODL are

	Units	Reactor - 1	Reactor - 2
Consistency	%	12	12
Pressure	Bar	8 – 8.5	3.5
Temperature	^oC	85 – 90	100 – 105
Retention time	Min	30	60
NaOH charge	kg/t	25 – 30	Nil
O_2 charge	kg/t	20 - 25	3.0

The advantages of ODL are:

- Lower cost of bleaching chemicals (Oxygen is a comparatively cheap bleach chemical)
- Lower environmental loads in the bleach effluent (lower BOD, COD, AOX and color)
- Lower cost of Effluent Treatment Plant and its operation
- Improvements in Pulp brightness ceiling

Bleaching

Bleaching is a method of pulp purification; it is also called extension of cooking process. The purpose of bleaching is to increase the pulp brightness. Brightness is a measure of how much light is reflected by paper under specified conditions and is usually reported as a percentage of how much light is reflected, so a higher number represents a brighter or whiter paper. The international community uses ISO standards. The bleaching chemicals are chlorine, chlorine compounds (Hypochlorite and chlorine dioxide), oxygen, peroxide and ozone. Chlorine and chlorine compounds generate organochlorides which are harmful to human and aquatic life.

Nowadays bleaching sequence trends are changing mainly due to environmental awareness. Chlorine is highly polluting chemical and increases AOX level in effluent from bleaching section which is not desirable. The new trend is to go away from chlorine to oxygen, peroxide, chlorine dioxide and even ozone. One can go for elemental chlorine free (ECF) or Total chlorine free (TCF) bleaching. It is generally believed that ECF bleaching can reduce the AOX level, acceptable to river water stream.

In India, although chlorine and hypo chlorite are still the most common bleaching chemicals in older mills, new mills or large mills have switched over to ECF bleaching. Process parameters for each stage are different and success of bleaching depends upon the effectiveness of controlling of these parameters. Main parameters are consistency, temperature, and pH and retention time at each stage.

The ECF bleaching sequence proposed here for manufacturing bamboo based pulp is D_0-E(op)-D_1. Chlorine dioxide, hydrogen peroxide and oxygen are the main bleaching chemicals, which are used in the bleaching process. ECF bleaching requires a special quality of material of construction and is taken care of from the very inception. Provision of oxygen in extraction stage is proposed to be considered along with ODL system for which necessary provision during engineering of the project are being made.

The pulp from ODL washer at 10 % consistency goes to heater mixer. The temperature of the pulp is raised to 85^oC by injecting steam in the heater mixer. The pulp goes to the stand pipe and is pumped through MC Pump via MC mixer to the bottom of the upflow Dioxide Tower D0. The Tower is designed for pulp retention time for chemical reaction of 3 hours. The pulp from the top of the tower is diluted to 1% consistency before it enters the D0 washer. The pulp from the washer again goes to heater mixer where pulp temperature is raised from 60 to 70^oC by injecting steam. Caustic is added in the heater mixer whereas peroxide is added in the standpipe. Oxygen is added in the MC mixer. The pulp from standpipe through MC pump via Mc mixer goes to upflow Oxygen reaction tube. The pulp from the top of the oxygen tube goes to the top of the down flow extraction tower E(op). The Tower is designed for pulp retention time for chemical reaction of 1 hour. The pulp from the bottom of the tower is diluted to 3 % consistency before pumping to the E(op) washer. The pulp is further diluted to 1 % consistency before entering the washer. The pulp from the E(op) washer goes to the D_1 Tower in the same way like D_0 Tower. All conditions in D_1 tower are maintained similar to the D_0 tower. In this project targeted brightness is 88 – 89 ^{o} ISO. Finally pulp from D_1 washer goes via MC pump to the HD Bleached storage Tower.

Chemical Recovery

The Chemical Recovery cycle is a complex series of chemical processes. For compliance of pollution control norms, setting up of chemical recovery plant is a must. It mainly consists of following 3 sections.

1. Storage and evaporation of dilute black liquor.
2. Burning of black liquor solids in recovery furnace.
3. Recovery of caustic by recausticising.

In the proposed project Lime Reburning Kiln has not been considered. But at later stage it will be included. As a part of the sound environmental management it is must to recover lime from lime mud by installation of Lime Kiln. The planned installation of a lime kiln to process 60% of the lime mud will result in an increase of silica in the system, but effect on the operation of the green liquor and white liquor clarifiers should be small. The loss of alkali in the unrecovered spent liquor is an economic burden because of the cost of chemicals as well as otherwise lost energy content of the spent liquor. It is possible to raise the profitability of a mill by lowering the chemicals and energy inputs to a totally different level by installing a chemical recovery plant.

The spent liquor generated during pulping, which contains organic and inorganic matter is first concentrated in evaporators and then processed in a chemical recovery boiler to recover inorganic chemicals and generate steam. Required makeup chemicals such as salt cake etc are added in concentrated liquor before firing in the recovery boiler. The inorganic chemicals are collected at the bottom of the recovery furnace as smelt which is dissolved in the weak wash liquor. The liquor thus formed is called green liquor. The green liquor is further reacted with burnt lime (produced in rotary lime kiln) to recover cooking chemicals. The process is called Recausticisation Process. The lime sludge generated is reprocessed in lime kiln to produce lime. Major chemical reactions which occur in causticising section are:

1. $CaO + H_2O \rightarrow Ca(OH)_2$
2. $Na_2CO_3 + Ca(OH)_2 \rightarrow 2NaOH + CaCO_3$

Dilute black liquor coming from brown stock washing is collected in storage tanks in evaporation sections. Multiple effect falling film evaporator is used for the evaporation of water from black liquor. A multiple effect evaporator line consists of several units, connected in serious by vapour piping, in which the water vapour boiled off the liquor in one effect acts as heating steam in the steam chest of the next effect. The steam is supplied to the steam chamber of the first effect only. Inlet concentration of dilute black liquor solids is expected about 15 % while outlet concentration from the evaporator would be about 45 – 50 % black liquor solids (BLS). From the last effect, vapours are condensed in a surface condensor. Vacuum for operation is created by means of a steam jet ejector assembly. The semi concentrated black liquor (45-50 % BLS) from the evaporator plant is first taken to a direct contact cascade evaporator to further concentrate to about 65 – 70 % of BLS.

In case the black liquor solids is concentrated to 65 % concentration in a 7 effect evaporator with 9 bodies, the steam economy would increase to 5.9 from 4.9. In this case the direct contact cascade evaporator is not required and the high pressure steam generation would increase in Recovery Boiler from 40.5 to 46.8 TPH. In addition the LP steam consumption as well as cooling water requirement would be reduced. Although the cost of the evaporator and recovery boiler will increase, the profitability of the recovery system would improve. Roughly payback period would be 4 years. The first effect i.e. finisher effect will be provided with 3 units called 1A, 1B & 1C with online washing system. It is then sprayed into the recovery furnace, where the black liquor gets dehydrated and drops to furnace hearth as dry solids. The combustion of organic compound of black liquor is controlled by the temperature of black liquor and air flow at primary and secondary levels. Auxiliary fuel oil, if required, is used to commence furnace operation or to support combustion. Inorganic compounds come out from the bottom of furnace in the form of molten smelt. This smelt is dissolved with weak white liquor to form green liquor.

The heat generated in combustion zone, goes in boiler zone with flue gases. In the boiler zone, steam is generated. After the boiler zone, flue gases pass through direct contact evaporator where balance heat is used to concentrate the black liquor.

Proposed recovery boiler is matched with pressure of power boiler i.e. 65 kg/cm^2, 490^oC temperature. Therefore, its steam would be combined with power boiler and would be used for power generation. Green liquor is converted into white liquor after the reaction with lime in causticising section. From causticising section white liquor (NaOH) goes to pulp mill. The mud or lime sludge ($CaCO_3$) from mud washer after proper washing goes to Lime kiln to generate lime which is sent to causticising section. Foul condensate from evaporator condenser goes to vacuum filter. The water which comes out from vacuum filter is known as weak white liquor and is used again in mud washer. If the process is properly controlled, recovery of chemicals can be as high as 98 % on the total inputs of chemicals.

Pulp Sheet Drying Machine

The Approach Flow system ahead of the head box of the sheet dryer consists of the fan pump, centricleaners, the pressure screens and the deculator (air removal from the pulp stock).

The fourdrinier type sheet making machine has a head box, wire part with breast roll, foils, press part to achieve a dryness of 45-50%, the multi-group dryer part with steam heated cylinders, sheet cutting and piling equipments.

Dryer section is provided with pocket ventilation and closed hood to improve drying. The auxiliaries of the sheet dryer are the vacuum pumps, the condensate and steaming system and the AC sectional drive.

Pulp from approach flow enters the Head Box of Sheet Drying machine at a low consistency. From the Head Box the pulp is drawn onto an end - less wire. This wire is normally referred to as Fourdriner part. In this area de-watering of pulp is done. The pulp is then subjected to further de-watering utilizing no. of presses in series. The pulp is then dried on a series of steam heated drying cylinders to the desired final moisture content of about 10%.

The press section of Pulp drying machine increases the consistency of the sheet by removal of portion of free water contained in the sheet. There are various type of press section are available and its selection depend upon machine design, furnish and speed of the machine.

Dryness after press section should be in the range 45 – 50 %. Pulp after press section enters the dryers where remaining water is removed from the sheet by the means of heating. The method of sheet drying is by the use of drying cylinder generally in two tiers, of cast iron and steam heated. Now a day's diameter of these cylinders particularly for high capacity machines have been increased from 1500 mm to 1800 mm which have some advantages like less space requirement and better heating efficiency.

Condensate removal and use of flash vapours in drying section are necessary for better performance.

This Machine will be only be used if there is excess pulp.

Chemical Preparation Plant

The mill requires a ClO_2 generation plant. This plant also includes a process water chiller for efficient absorption of ClO_2 gas into a solution for use in the bleach plant.

Other chemical plants are Caustic, Oxygen generator, Peroxide preparation plant

2.4.2.2 PAPER MAKING

The plant is designed for producing superior grade Writing, Printing, Copier and Newsprint Paper. The raw material for writing, printing, Copier and Newsprint papers shall mainly comprise of Bamboo based Pulp.

a. Refining & Chemicals Blending

The pulp in the refining chest is pumped through a disc refiner. The cleaned and refined pulp is transferred to the final chest (Machine Chest) before the paper machine.

b. Approach to Paper Machine

The stuff from the machine chest is passed through a brushing refiner to a constant level regulating box. The solids content (consistency) of the pulp in the machine chests is kept constant through suitable instrumentation. Final opening of the fibers and control of the fiber lengths is achieved in the brushing refiner. A regulated quantity of stuff from the constant level box is fed to the screening cleaning system ahead of the paper machine as per the substance (g.s.m) of paper produced.

For final cleaning before entering the paper machine head box the metered quantity stuff is diluted to about 0.6% solids by mixing with white water drained while forming the paper sheet and passed through 3 stage centricleaners and a pressure screen having basket with 0.2 mm slots to remove fine sand, specs and other contraries.

c. Paper Making

1. Sheet Forming – The dilute pulp slurry is fed in to the head box of the paper machine where it is evenly distributed across the width of an endless wire cloth stretched between 2 rolls viz. the breast & couch rolls and supported on drainage elements. The sheet is formed by drainage of water first through stationary foils and rotating table rolls and then by application of vacuum through suction boxes placed below the wire cloth and a perforated suction couch roll. To assist in the drainage of water and achieve fiber orientation and bonding, the portion of the wire table before the suction boxes is kept shaking. The sheet is taken off the wire section with about 22% solids content through a suction roll covered by felt (suction pick up) to the press section. The water drained through the wire cloth containing fine fibers and chemicals is re-circulated by dilution of pulp from the machine chest and at other points. The wire cloth is continuously cleaned by high pressure water showers. The excess water from the wire part is passed through a fiber recovery system (Save-all) where the fine fibers and talcum powder etc are recovered and re-circulated. The clarified white water is used in showers, vacuum pump seal water etc. in the paper machine and the balance is used in the pulp mill is showers and washing the pulp.

   The edges of the paper sheet trimmed on the wire are collected in a pit below the couch roll (couch pit) provided with an agitator. Also, in case of paper breakage the entire paper sheet is dumped in the couch pit. The water from some of the wire cleaning showers are also collected in the couch pit. The dilute pulp slurry is pumped to a broke thickener and the thickened pulp is stored in a stuff chest (broke chest).

2. Pressing The sheet is dewatered to about 45% solids content by passing through 3 sets of presses. The first and second press consist of 3 rolls (one rubber covered perforated which is both suction pick up and press roll with 3 suction zones, the centre roll with harder cover like ebonite or microrok and the 3rd blind drilled rubber covered,) pressed against each other by pneumatic loading. The third press comprises of 2 rolls, the bottom blind drilled rubber covered and the top ebonite or microrok covered. The paper sheet is passed through the presses supported on endless felts running

between the pair of rolls. Due to the lower strength of the paper sheet in the first press nip, it is provided with double felting and the sheet is pressed between 2 felts. The water from the paper sheet is transferred to the felts from where it is removed by suction tubes connected to vacuum pumps. The felts are continuously cleaned by high pressure water showers and through suction tubes connected to vacuum pumps.

3. Drying The sheet is passed through groups of drying cylinders which are heated from inside by steam. The cylinders are covered with endless screens of synthetic material which keep the heat pressed against the cylinders. Most of the residual water in the sheet is evaporated while passing through the dryers and the sheet leaves with solids content of about 95%. The dryer section is covered by a vapour hood and the evaporated water vapour is removed by exhaust fans connected to the hood.

4. Surface sizing While producing superior grade surface sized papers for offset printing, copier use etc. the paper sheet shall be passed through a size press located between the dryer groups. Solution of starch and other chemicals shall be sprayed on the dry paper sheet and the excess solution shall be squeezed out in the press. The rewetted sheet shall then be dried in the subsequent dryer groups. The first 2 drying cylinders after the size press shall be hard chrome plated to eliminate sticking of the wet paper sheet to their surface. The surface sizing reduces the ink absorbency of the paper and improves the printing properties.

5. Calendaring & Reeling The sheet is passed through a calendar stack with chilled iron rolls to even out the surface and impart the required polish. The sheet is then reeled on steel shells on a drum reel.

d. Finishing

The finishing operation comprises of unwinding the reels of paper from the paper machine and slitting and rewinding them to reels of smaller width of market size, in a slitter rewinder. For paper to be supplied in sheets, the rewound reels are cut in to sheets of the required size in sheet cutters. The cut sheets are manually sorted to remove the defective ones, counted and packed.

Simplified process flow diagram of Pulp & Paper making process is presented in Figures – 2.2 & 2.3.

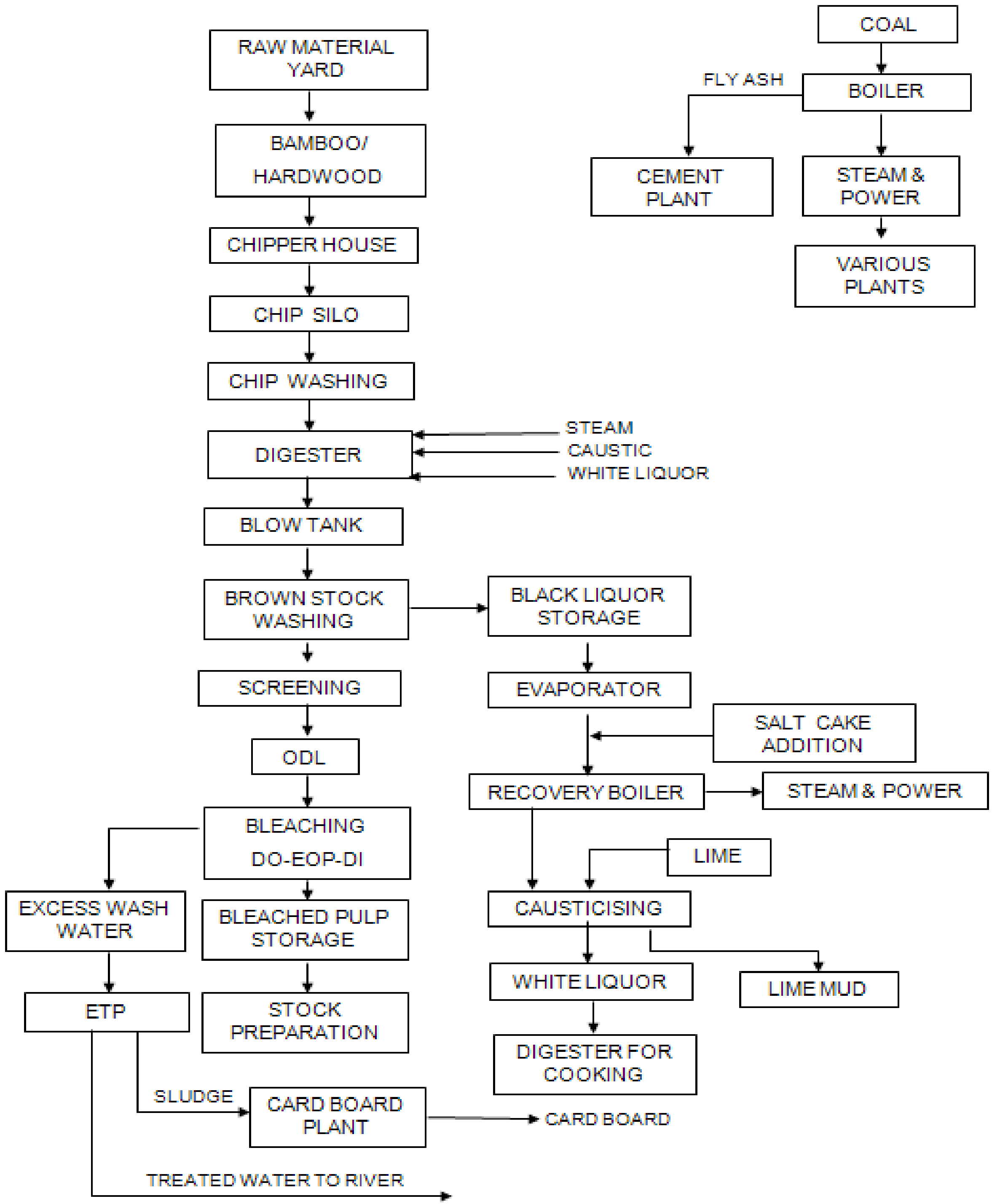


FIGURE – 2.2 : PULP MAKING PROCESS

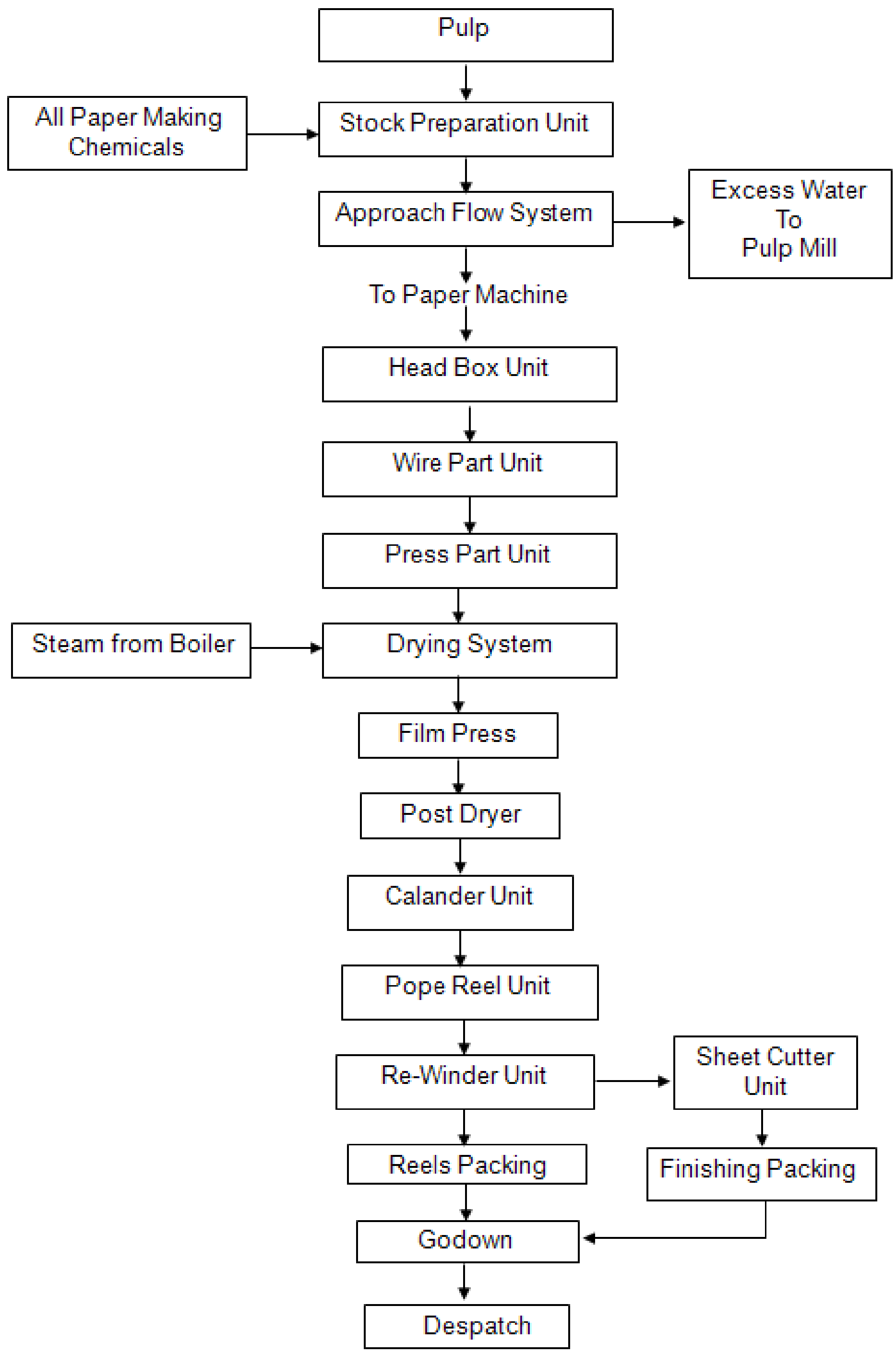


FIGURE – 2.3 : PAPER MAKING PROCESS

2.4.2.3 Co-generation Power Plant

Co-generation is the concept of producing two forms of energy from one fuel. One of the forms of energy must always be heat and the other may be electricity or mechanical energy. In a conventional power plant, fuel is burnt in a boiler to generate high-pressure steam. This steam is used to drive a turbine, which in turn drives an alternator through a steam turbine to produce electric power. The exhaust steam is generally condensed to water which goes back to the boiler. As the low-pressure steam has a large quantum of heat which is lost in the process of condensing, the thermal efficiency of conventional power plants is only around 35%. In a cogeneration plant, a higher efficiency levels can be reached. This is so, because the low-pressure exhaust steam coming out of the turbine is not condensed, but used for heating purposes in plants. Since co-generation can meet both power and heat needs, it has other advantages as well in the form of significant cost savings for the plant and reduction in emissions of pollutants due to reduced fuel consumption.

The project also includes a captive 10 MW Co-generation Power plant with a high pressure steam-turbine configuration. The project involves the installation of two high-pressure 65 kg/cm^2 & 490^{o}C temperature Boilers with capacity of 30 TPH each and one high pressure 60 TPH recovery boiler. These Boilers supply steam to the double extraction cum condensing type of 10 MW capacity turbine. The generated steam will be used to run turbine to generate power and low pressure extracted steam is supplied to the process. The use of high pressure system allows for increased efficiency levels for electricity generation. Power generated from the turbine will be generated at 11 kV. Brief design parameters of 10 MW turbine are as follows.

1	Process requirement			
a)	Flow at 5 ata			58 TPH
b)	Flow at 10 ata			13 TPH
2	A.F.B.C	64 kg/cm^2	490^{0}C	28 TPH
3	Recovery Boiler	64 kg/cm^2	490^{0}C	60 TPH
4	Steam required for De-areation			10 TPH
5	Steam required for condenser			07 TPH
6	Condensate recovery (60%)			40 TPH
7	Make up Water			45 TPH
8	Power generation, double extraction cum condensation			10.0 MW
a)	Power generation with 5 ata			8.00

		M.W
b)	Power generation with 10 ata	1.00 M.W
c)	Power generation with condenser	1.00 M.W

It is suggested 60 TPH for Recovery Boiler and 60 TPH for Power Boiler (or 2X30 TPH). One power boiler will run at 28 TPH during the full capacity operation of the plant. During the time when Recovery Boiler is down for maintenance or breakdown for a longer period, than the 2nd power boiler will also run at full capacity of 30 TPH and the mill capacity will be around 85-90 % matching the power generation capacity of the power boiler alone and any grid power available. In this case it will synchronize with grid supply. The Pulp mill will consume 980 KW/Hr per ton of pulp. Such power will be obtained from the co-generation power plant of the unit.

Indicative process flow diagram of co-generation power plant are presented in Figure – 2.4.

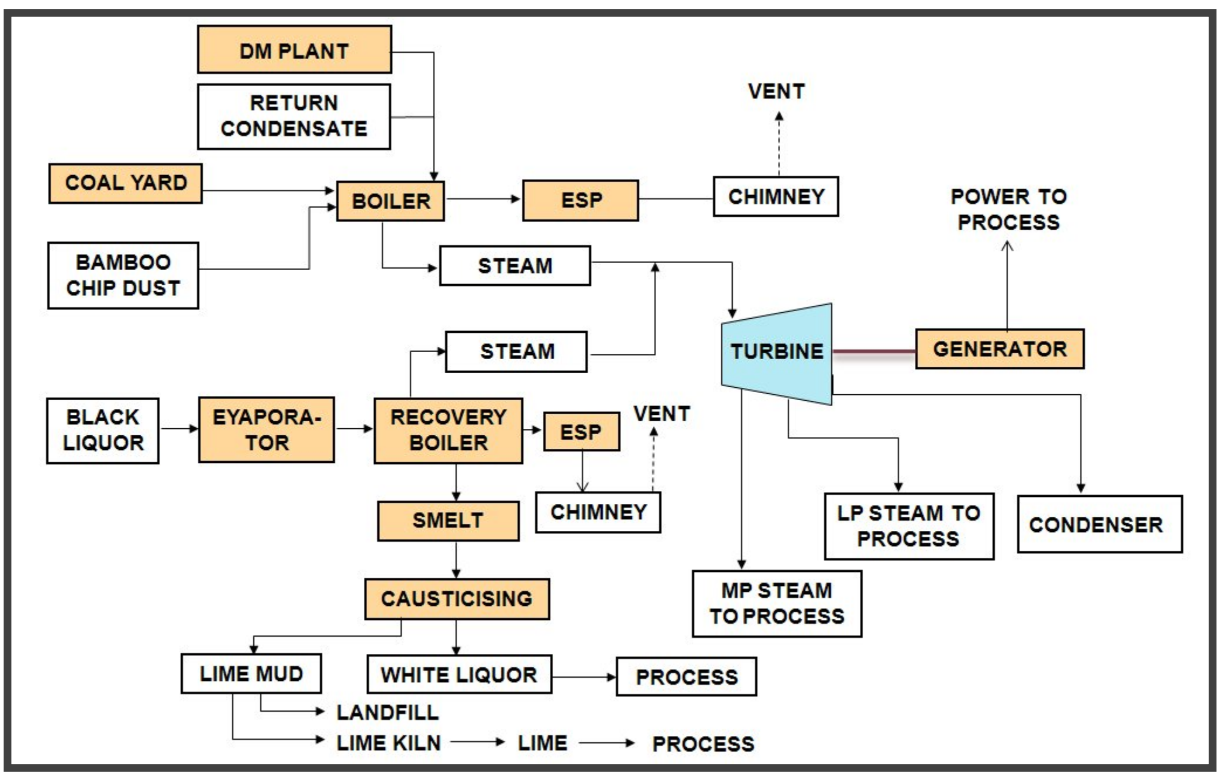


FIGURE – 2.4: 10 MW CO-GENERATION POWER PLANT – BLOCK FLOW DIAGRAM

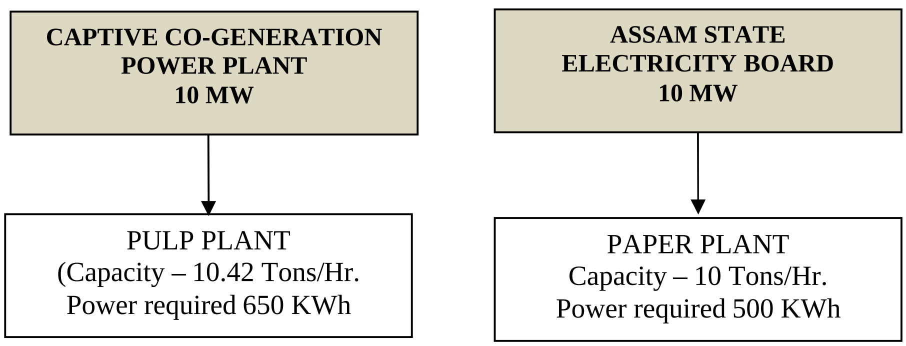
2.4.2.4 Energy Balance

Energy requirements, its source and distribution is presented in the following statement.

Electrical Energy Balance

Total Electrical Power

A. Pulp Plant – 650 KW/Hr per ton of Pulp from 10 MW Captive Co-Generation Power Plant
B. Paper Plant – 500 KW/Hr per ton of Paper from 10 MW on 33 KV from Assam State Electricity Board.



2.5 UTILITIES

2.5.1 Storage Facilities

The raw material will be stored in the raw material yard from where they will be conveyed to the process house.

2.5.2 Fuel

For operation of the boiler, Coal (with GCV of 3000 Kcal/Kg) will be required as fuel. The consumption of coal for the Boiler will be approximately 400 Kgs./Ton of Paper. The required coal will have the following properties:

Carbon	32.26 %
Hydrogen	2.78 %
Nitrogen	0.95 %
Sulphur	0.71 %
Moisture	3.36 %
Ash	49.15 %
Oxygen	10.79 %

The company proposes to procure coal from North East Coal Field Marghetita.

Diesel will also be required as fuel for running the DG Sets which is available locally.

2.5.3 Air Conditioning system

The air-conditioning system is proposed to be designed to maintain the following conditions in the spaces serviced:

25$\pm$2°C dry bulb temperature and 55$\pm$5 percent relative humidity for control rooms, control pulpits, computer rooms, PLC rooms, laboratory etc.

To meet the above requirement, air handling units using chilled water, package type air conditioning unit complete with compressor, condenser and ductwork are envisaged. AC units/AHUs shall be installed in separate rooms adjacent to various conditioned spaces served. Conditioned air from AC units to the spaces served shall be provided by plenum/ductwork. Wall mounted window model air conditioners have also been envisaged in some areas for the purpose of air conditioning.

2.5.4 Power requirement

Requirement of power for the proposed plant is around 16 MW out of which a portion of power will be sourced from the proposed 10 MW Captive Co-generation Power Plant and rest will be sourced from Assam State Electricity Board. The unit-wise power requirement will be as under:

Unit	Power Consumption (in MW)
Pulp Unit	6.77
Paper Unit	5.23
Power Plant, ETP etc	2.00
CLO_2 Auxiliaries	1.00
Total	15.00

2.6 WATER SUPPLY FACILITIES

The plant will be needing water for different purposes including processing units, power generation, domestic sector etc.

Water from river Brahmaputra / Bore well will be used for meeting various industrial demands of the unit. The indicative demand of different units of the plant are as follows:

Pulp mill demand	…	14,780 m^3/day
Paper plant demand	…	2,500 m^3/day
Boiler demand	…	720 m^3/day
Domestic Demand	…	480 m^3/day
		18,480 m^3/day

Proposed water distribution in different sectors in the Mill is presented in Figure – 2.5.

RAW WATER TREATMENT

Borewell / River is the main source of water for the mill. Availability of water should be sufficient to meet the demand of the Pulp & paper mill. Quality of the feed water to process, drinking purpose and feed to boiler is maintained by treatment depending on quality. From Borewell the water is stored in large tanks and supplied to Mill.

From the river, raw water goes to a clarifier where some chemicals and flocculants like Alum and Flocculation chemicals (Polymers) etc. are added. Chlorine is also added in water to purify it. After this brief treatment, water goes to the process and drinking purpose. For steam generation, process water will be again treated in a DM Plant.

DM PLANT : - CATION --> DEGASSER--> ANION--> MIXED BED

Process water will be fed to the Strong Acid Cation Exchanger where all mineral salts will be converted into their respective acids. The cationised water will then go to degassed tower where in carbonic acid will break into carbon dioxide and water, thus removing the carbon dioxide. Degassed water shall be stored in Degassed water sump and further pumped into a strong base anion column for the removal of anionic impurities present in water. For final reconditioning of the water to suit the requirement of the high pressure boiler, the water after anion resin exchanger will be passed through the Mixed Bed deionisation system for reduction in conductivity to < 0.2 micro simens /cm^2. All limiting conditions herein must be observed and strictly maintained during the plant operation for satisfactory performance throughout the plant life. Typical specification of feed water and boiler water for low & medium steam pressure boilers are given as below:

Characteristics of Feed water	Unit	High Pressure
Total hardness, max	ppm	Nil
pH value at 25°C	-	8.5 to 9.2
Oxygen, max	ppm	0.007
Iron, max	ppm	Nil
Copper, max	ppm	Nil
Silica (as SiO_2), max	ppm	0.02
Total CO_2, max		Nil
Permaganate, max	ppm	Nil
Total dissolved Solids, max	ppm	0.01
Total Suspended Solids, max		Nil
Oil, max		Nil
Specific electric conductivity at 25°C	µs/cm	0.2
Residual hydrazine, max	ppm	0.02

Fire fighting water system

The fire fighting water network will be provided with adequate number of yard hydrants and in-shop landing valves to combat fire hazards in the plant.

To ensure availability of water at designed pressure for fire fighting, electric motor driven and standby diesel engine driven pump sets will be provided. Main electrical driven fire fighting pumps and diesel engines driven standby fire fighting pumps will be provided for fire fighting purpose. In case of fire, the main firefighting pump will pump firefighting water to the hydrants. An independent piping network will be provided complete with pipelines, valves, hydrants, fittings and appurtenances for the said purpose.

Water Pollution Control

The liquid effluent generated in this plant after installation / erection will be from Boiler Cooling Tower, Clarifier and RO / DM plant blow downs. The total liquid effluent generation will be to the tune of around 521 m^3/hr.

All these effluents will be first neutralized in a neutralizing pit and then allowed to go to the Effluent Treatment Plant. The fibers collected in this process will be utilized as raw material for grey board making unit in the proposed plant.

Proposed Effluent Treatment Plant (ETP) has been designed to treat effluent of the Pulp & Paper Mill at the rate of 1150 m^3/hr. Treated effluent meeting relevant effluent discharge standards will be let out into river Brahmaputra.

Waste water generated from office areas will be discharged in to the septic tank soak pit system.

2.7 FIRE FIGHTING FACILITIES

Many working premises in a steel plant have hazardous and fire prone environment. To protect the working personnel, equipment and machineries, fire fighting measures have been planned for the proposed project.

Fire protection facilities

In order to combat any occurrence of fire in plant premises the following fire protection facilities have been envisaged for the various units of the plant.

Portable fire extinguishers

All plant units will be provided with adequate number of portable fire extinguishers to be used as first aid fire appliances. The distribution and election of extinguishers will be done in accordance with the requirement of IS: 2190-91.

Hydrant system
A fire hydrant network system has been envisaged for the proposed mill. Internal hydrants will be provided at suitable locations and different hydrants will be provided normally along the road and in the close vicinity of the units to meet the additional requirement of water for extinguishing fire.

Automatic system
For oil cellars control rooms and computer rooms, automatic fire extinguishing system has been envisaged.

2.8 MANPOWER PLANNING

Operation and maintenance of proposed plant will require human resources in different categories like managers, engineers of different disciplines like mechanical, electrical, electronics, computer, civil, structural, chemical, etc., highly skilled, skilled and semi-skilled work force in different disciplines, commercial, accountants and financial managers, unskilled labour force, clerical, security personal, etc.

In order to operate and maintain the plant facilities, including its technical and general administration needs, the estimated manpower requirement for the proposed project has been estimated as 750 persons, which include the top management, middle and junior level executives, other supporting staffs including contractual workers.

2.9 SOLID WASTE MANAGEMENT

Fly ash (around 40 TPD) is expected to be generated from the coal fired boiler. Fly ash will be used in cement making. The company will also try to dispose fly ash through competitive bids to local brickfields & others. Lime mud from lime kiln, will be used for land filling within the mill premises and/or will be disposed off in consultation with local authorities.

Solid waste generation and its disposal from the proposed units are presented in Table – 2.5. The characteristics of the generated solid wastes are presented in Table – 2.6.

Table - 2.5
Solid Waste Generation and Disposal for the Proposed Plant

S.N	Particulars	Quantity (in TPD)	Remarks
1.	Fly Ash from Power Plant	50	Fly ash will be used in cement plant.
2.	Bottom ash from Power Plant	9	To be disposed off in ash disposal area. Other usages shall be explored.

TABLE – 2.6
TYPICAL CHARACTERISATION OF SOLID WASTES

Unit	Type of waste	Typical Chemistry
CPP	Fly Ash	Color – Gray Sp. Gravity – 2.17 Surface Area – 380 m^2/kg Permeability - 2.50 × 10^{-5} cm/sec Silica as SiO_2 – 70% Fe_2O_3 – 7% $Al_2O_3+P_2O_5$ – 16.5% MgO+CaO – 3% LOI (Unburnt C) – 2% Others – 1.5% Trace Element in mg/kg: Cr : 80 -100 Mn : 60 - 120 Pb : 30 - 60 Zn : 60 - 120 Cu : 60 - 90 Ni : 30 - 60 Co : 10 - 20
CPP	Bottom Ash	Color – Blackish Gray Sp. Gravity – 2.25 Surface Area – 330 m^2/kg Permeability - 3.0 × 10^{-5} cm/sec Silica as SiO_2 – 68% Fe_2O_3 – 4.5% $Al_2O_3+P_2O_5$ – 9% MgO+CaO – 3.5% LOI (Unburnt C) – 11% Others – 4% Trace Element in mg/kg: Cr : 50 -75 Mn : 80 - 150 Pb : 10 - 20 Zn : 30 - 40 Cu : 40 - 50 Ni : 20 - 30 Co : 10 - 12

2.10 POLLUTION CONTROL MEASURES

Probable Pollution Sources	Mitigation Measures
Power Plant	
Unloading of Raw Material	Sprinkler / Fogging / Mist
Raw Material Handling System for Power Plant	Bag Filters / Water Sprinkling system
Boiler Flue Gases	High efficiency ESP for controlled of Particulate Matter within 50 mg/Nm^3. Stack of Adequate height.

With the implementation of all the above control measures, the gaseous emissions shall be contained within the acceptable limits, thus ensuring the full compliance to National Ambient Air Quality Emission Standards issued by the Ministry vide G.S.R. No. 826(E) dated 16th November, 2009.

2.11 CONTROL OF FUGITIVE EMISSIONS AT VARIOUS AUXILIARY FACILITIES INSIDE THE PLANT

SOURCES OF EMISSION	CONTROL MEASURES
Fugitive Emissions at Coal Handling System.	There will be Dust Suppression Systems / Dry Fogging system to control fugitive emissions.
Fugitive Emissions at Various Auxiliary Facilities inside the Plant.	There will be Dust Extraction / Dust Suppression Systems / Foggy Dust Arresters to control fugitive emissions at various facilities inside the plant. Besides, the dust, collected in the bag filters at the respective points will be used for developing the mound inside the plant boundary, simultaneously greening will be done by growing plants & trees.

2.12 WASTEWATER GENERATION AND TREATMENT

CAPACITY

Waste water treatment plant has been designed to treat the waste water of the Pulp & Paper Mill at the rate of 1150 cu.m/hr.

BASIS OF PLANT DESIGN

The waste water treatment plant has been designed considering the following characteristics of the waste water:-

Temperature	:	Ambient
PH Value	:	8 – 10
Colour	:	Brown
Suspended impurities	:	1100 PPM
BOD	:	750 PPM
COD	:	2100 PPM
TDS	:	700 PPM
Heavy Metal	:	Nil.
Oil & Grease	:	15 PPM

It is presumed that the characteristics of the raw waste water will be remaining constant throughout the year and any variation on the same will reflect on the output of the plant.

TREATMENT METHODOLOGY

The proposed treatment methodology is as follows:

Raw waste water from the Mills will be led into an RCC construction Effluent sump through surface drain where-in mechanically cleaned Bar screen will be installed for the purpose of removal of bigger sizes of particle. There will be two (2) nos. of Bar Screens placed in two (2) nos. of surface drains for action as “Working” and stand-by mode.

Waste water from the Effluent sump will be drawn by means of C.I. construction centrifugal horizontal type pump sets for transferring the same to the subsequent unit. There will be three (3) nos. of pump sets, two (2) working and one (1) stand-by.

Waste water will be collected in an RCC construction Equalisation tank having a retention time of about 8 (eight) hours for the purpose of flow equalization of treatment plant.

Waste water from the Equalisation Tank will be drawn by means of C.I. construction centrifugal horizontal type pump sets for transferring the same to the subsequent unit. There will be three (3) nos. of pump sets, two (2) working and one (1) stand-by.

Waste water will be fed in to the Grit chamber for the purpose of removal of heavy suspended material such as dirt, sand and stones by sedimentation. The primary purpose of grit removal is the protection of downstream mechanical equipment from excessive abrasion and water and to prevent deposition of grit in subsequent conduits and basins.
Waste water from the Grit chamber will be drawn by means of C.I. construction centrifugal horizontal type pump sets for transferring the same to the subsequent unit. There will be three (3) nos. of pump sets Two (2) nos. working and one (1) no. stand-by.

Waste water will be fed into clariflocculator unit of fixed bridge type for the purpose of
removal of suspended impurities thereby rendering the clarified water suitable for feeding into the subsequent unit. In the process of clarification of water, not only suspended impurities will be removed but BOD reduction will also be effected to some extent.

Alum solution and Polyelectrolyte solution will be dosed in the flocculation zone for the purpose of coagulation of suspended impurities. Flocculator paddles provided in the flocculation zone will assist formation flocs of higher neuclei thereby enhancing the sedimentation /clarification of waste water. Alum solution and Polyelectrolyte solution will be dosed by gravity. There will be two (2) nos. of solution tanks for each chemical designed for eight (8) hours operation of the plant. Electrically driven slow speed agitator will be provided in each tank for the purpose of preparation of homogeneous solution. Solution tanks will be located in the first floor of chemical house while ground floor will be utilized for storage of chemicals required for at least one (1) month operation of the plant.

The clarified water will next be gravitate to the Anaerobic lagoons. The wastes in the Anaerobic lagoon are broken down in the absence of dissolved oxygen. This anaerobic breakdown consists of two steps. First, a special group of acid producing bacteria (known as facultative heterotrophs) degrade organic matter into fatty acids, aldehydes, aleohols etc. Then a group of methane bacteria convert these intermediate products to methane, ammonia, carbon dioxide and hydrogen. The organic loadings used in anaerobic lagoons are so high that they are devoid of free dissolved oxygen throughout their depth. To conserve heat energy and to maintain anaerobic conditions, these ponds have been constructed with depths up to 4.5 m(although common practice is 3 to 4.5 M), thereby achieving a low surface area/volume ratio. Anaerobic lagoons are most frequently used for pretreatment of high strength organic waste followed by an Aerobic treatment process. Not only do they provide significant reductions in BOD5 and suspended solids, thereby permitting a reduced sizing of any subsequent treatment unit.

Partially treated waste water from the Anaerobic lagoon will be drawn by means of C.I. construction centrifugal horizontal type pump set for transferring the same to the subsequent unit. There will be three (3) nos. of pump sets: two (2) nos. working and one (1) no. stand-by.

Wastewater of the Aerobic lagoon i.e., Aeration unit for the purpose of removal of BOD of the influent waste water. Fine bubble membrane diffusers have been incorporated for this unit.

Advantages of using fine bubble membrane diffusers are :-

- Standard Oxygen Transfer Efficiency 5.0 – 7.6 kg 02/Kwh as against 1.2 - 3 kg 02/Kwh in fixed Aerator.
- Upto 50% Power Savings as against Fixed Aerator.
- Trouble free operation against Regular maintenance in Fixed Aerator.
- Non-clogging
- Membrane Heavy duty to withstand high pressure
- Can be installed at any depth.
- Non-corrosive
- Distributes higher quantity of air at uniform rates
- Easy to install and handle
- Non-moving parts – assures safety.

There will be two (2) nos. of Air Blowers each of 100% capacity.

Since the wastewater will be nutrient deficient, provision has been kept for feeding nutrient in the aeration unit for the micro-bial growth and to keep them alive. Urea and salt of phosphate will be dosed in the aeration unit, for this purpose. Initially nutrient will be required to dose regularly but as soon as required MLSS in the aeration unit, is attained, regular dosing of nutrient will not be required. Dosing of nutrients under such condition will be limited to once in a week/fortnight.

Overflow of the Aeration unit will next be gravitate to the clarified unit for the purpose of separation of solids, produced in the biological treatment unit, from the liquid effluent. This constitutes the final step in the production of a clarified effluent in a biological water treatment plant.

The suspended solids in effluent from the biological treatment unit are usually lighter and therefore, settle more slowly. To cape with this sludge characteristic, lower overflow rates and weir loadings are considered in designing the secondary clarifier. Solids loading is defined as the total solids applied per unit surface area of clarifier. Because the mixed liquor, entering the secondary clarifier, generally carries a high concentration of biological solids, it is essential to dosing the secondary clarifier at a solid loading of less than 125 kg/m^2 to prevent the loss of sludges in the effluent. In secondary clarifier, the concentration of solids is high enough that the particles settle collectively at nearly the same rate. Thus solids loading rate is an important design parameter.

Because of the high solids concentration, the mixed liquor, upon entering the secondary clarifier, tends to flow as a density current interfering with the separation of solids and the thickening of the sludge. To avoid this, the inlet baffle should have a diameter of 15 to 20 percent of the tank diameter and should not extend more than 1 M below the surface to avoid scouring of deposite sludges.

The overflow of the secondary clarifier will be taken into a polishing tank by gravity, wherefrom the treated waste water will be disposed-off into river Brahmaputra and this will meet the parameters stipulated in IS-2490.

Sludge slurry, obtained in the primary clariflocculator and excess sludge of the secondary clarifier, will be stored in a sludge tank where-from sludge slurry will be drawn by means of three (3) nos. (2 working + 1 stand-by) sludge slurry transfer pump for feeding into the thickener.

Sludge removed from primary clariflocculator, characteristically has solids concentrations of 2.5 to 5%, while that waste from the biological treatment stage generally has a solids concentration of about 1%. If this sludge is to be further treated or hauled away directly for disposal, significant savings in treatment and transportation costs can be realized by reducing the volume requiring handling. Simple sedimentation, referred to as gravity thickening, can usually increase the solids content of primary sludge to a concentration of 8 – 10%. Waste activated sludge can typically be thickened to a concentration of 2.5 to 4.0%.

Sludge thickeners are essentially identical to conventional clarifiers and similar design principles apply. Typical surface-loading rates are 24 to 54 m3/m3/day. The overflow from the thickener is returned to the equalization tank, with the underflow (sludge) being fed into the sludge drying beds.

Polyelectrolyte solution will be dosed in the inlet line of the thickener through simplex type metering pump set.

Sludge drying beds of appropriate numbers will be installed to treat the sludge slurry of the Thickener. Solid mass of the slurry will be retained on the top of the filter bed while more or less clear filtrate will be returned back into the equalization tank.

POWER CONSUMPTION

1.	Effluent sump pump	:	107.4 KW
2.	Equalisation tank transfer pump	:	107.4 KW
3.	Grit chamber transfer pump	:	107.4 KW
4.	Anaerobic lagoon transfer pump	:	107.4 KW
5.	Air Blowers	:	64.45 KW
6.	Agitators drives of all chemical solution tanks	:	9.85 KW
7.	Clariflocculators drive	:	12.48 KW
8.	Clarifier drive	:	3.6 KW
9.	Sludge transfer / recirculation pump	:	8.97 KW
10.	Sludge transfer pump to thickener	:	3.6 KW

11.	Thickener drive	:	5.37 KW
12.	Polyelectrolyte dosing pump	:	1.8 KW
13.	Filtrate / thickener overflow transfer pump	:	26.86 KW

A Card Board making plant is proposed to make Board from the sludge and use it in house and sell in the market.

CHEMICAL CONSUMPTION

Expected chemical consumption of the subject waste water treatment plant are furnished below:-

Alum	:	2025 kg/day
Polyelectrolyte	:	51 kg/day

The flow diagram of ETP is presented in Figure - 2.6.

2.12.1 STORM WATER MANAGEMENT

Storm water from paved area

This water will be normally routed through the regular oily water OWS (Oil Water Separator) manholes through the wastewater treatment facility in summer. Otherwise, in rainy season, the water will be stored and treated through storm water pond in the treatment plant. The floating oil from the Storm water pond will be skimmed off, while relatively clean water will under flow to normal Treatment Plant.

Uncontaminated storm water

This will be rain water from roads and other open offsite areas which are not susceptible to oil contamination. These drains normally are called open storm water channels and are routed to the storm water pond through oil catch pits. The collected rain water will be used in different purposes in the plant area.

Drainage System

The effectiveness of the drainage system depends on proper cleaning of all drainage pipes/channels. Regular checking will be done to see that none of the drains are clogged due to accumulation of sludge/sediments. The clogged drains will be cleaned as soon as possible, preferably the same day. The catch-pits linked to the storm water drainage system from the raw material handling areas will be regularly checked and cleaned to ensure their effectiveness. This checking and cleaning will be rigorous during the monsoon season, especially at the time of heavy rains forecast.

2.13 NOISE POLLUTION

The major noise generating equipment inside the plant area will be fans and air compressors. This can be abated by Low noise design and suitable enclosures will ensure that the noise levels are restricted well within the stipulated level (below 85 dB(A) at 1 m). The measures will include the reduction of noise at source, providing acoustic lagging for the equipment and isolating the noise producing equipment.

2.14 RAIN WATER HARVESTING

The entire land of the plant area has to be leveled in such a way that Rain Water flows down to the RCC constructed Rain Water storage pond. Water will enter into the storage pond through filter bed. Filter bed will be made with different size of gravels and core sand. The filtrate water will be stored in the pond. The same water will be rinsed for industrial as well as domestic purposes through water pump and motor. The residue of the filter bed will be removed manually from time to time. The storm water drainage channel passing through the site will also be connected to the said pond for conservation of the rain water, which shall be used for various purposed in side the plant.

Rain Water harvesting potential:
Average annual rain fall in the project area - 2500 mm
Average annual monsoon rain fall - 80% of 2500 mm = 2000 mm (say)
Volume of surface run off in the plant campus = 80.937 x 2.00 x 0.4 ham,
= 64.75 ham say 0.6475 mcm
Rain water harvesting potential of the plant campus – 0.6475 mcm

Conservation of harvestable rain water:
85% run off may be allowed to be drained through natural drainage system. For its sustenance and remaining 15% may be harvested and stored suitably. Around 0.0971 mcm of water therefore can be conserved within the proposed plant. Considering the average depth of 2.5 m in

storage tanks, area for surface storage involves around 3.885 ha (9.6 acres) which is 5% of the project area.

2.15 COMMISSIONING SCHEDULE

The implementation of a project depends, to a large extent, upon the method of procurement of Plant and Equipment, methods and materials employed for construction and Erection at site, availability of funds, etc. Therefore, a well defined and elaborate System of Project implementation has to be followed. The implementation plan will involve right from inception to completion and commercial Commissioning.

From the date of ordering of critical and long delivery items like Boilers and Turbine, total time for completion of the project is estimated to be 28-30 months.

2.16 LAND

The proposed project shall be accommodated within already procured land (200 acres) within the Industrial Growth Centre of Assam Industrial Development Corporation (AIDC).

To capture the fugitive emission, if any from the plant and to attenuate the noise generated from the plant machinery, and to improve the aesthetics of the plant site, a green belt around the Plant is proposed.

Company has earmarked 66 acres of land for Green Belt Development within its project site.

- Green belt development is planned to be completed within 5 years by planting about 500-600 saplings per acre.
- It is also proposed to build a green belt at the solid waste disposal sites.
- Plantation along the road will attenuate noise level, arrest dust and improve the environment in surrounding.
- This would improve the plant aesthetics as well as prevent the fugitive dust emissions
- The plant species will be selected as per CPCB guidelines.

Rehabilitation & Resettlement (R & R) issue is not an issue for the proposed project. The plant layout showing the proposed facilities with 33% Green Belt area has been shown in Figure 2.7.

2.17 PROJECT AND ENVIRONMENTAL COST

Total Capital Cost of the Project	₹ 585 Crores
Total Capital Cost for Environmental Pollution Control Measures	₹ 44 Crores
Recurring Cost/ annum for Environmental Pollution Control Measures	₹ 6 Crores