

Pulping Process.

Lecture

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W.A.S.D.

Mechanical or Ground Wood Pulping process.

This process involves no chemical treatment of wood prior to grinding.

Thus, the process is purely mechanical.

Some pre-treatment with steam, etc.

may be helpful in easy grinding.

The energy requirement are purely mechanical.

The only chemical change that may occur is

the hydration of cellulose

fibres due to prolonged

contact with water during the

process

* This process is applied where the isolation of fibres in the pure state is not the aim. Instead ^{major} high air yield is the aim.

Thus the pulp fibres are associated with much of their non-fibrous material. Thus, the pulp is low in quality from the point of view in colour, strength, standard of cleanliness, lasting quality, etc. Their presence of course helps in

MECHANICAL PULP: That is why the mechanical pulp is widely used in the manufacturing of paper. It is also applied to make cheap wall tissue and wrapping papers.

In general, mechanical pulp is used to make papers and boards where durability and permanency is not required.

The deterioration is not only due to the initial strength but also due to the presence of non-fibrous material which decomposes with the passage of time.

STAGES:

The different stages of mechanical process are given below: (Pre-Pulping Process)

1 Supply of Wood

The wood usually round is soft or coniferous. Usually Spruce and Balsam.

wood is ground by mechanical process. These trees abundantly grow in Sweden, Norway, USA, Finland and Canada; the chief suppliers of pulp in International market.

Spruce is usually processed as it gives comparatively whiter pulp. These trees have advantage that they being lighter may be floated down to the pulp mills through the river streams. The trees are felled in the Autumn, trimmed off and trunks cut into logs of convenient length and supplied to the mills through routes of minimum transport cost.

2. Debarking

Debarking is the Removal of Bark and may be done on the site by manual and mechanical methods or either in the farms or in the mills.

Usually the drum debarkers are applied.

They are fed into large revolving drums open at both ends with large slot shaped openings along the length. Water is showered in the drums in the form of jets under high pressure. When the heavy logs tumble against one another, the bark is removed. It is subsequently collected & used as fuel.

3

Removal of Knots

Knots (Joints of a plant)

The knots are exposed after debarking and are removed by quaging out with mechanical drills.

4

Grinding

The grinding purpose is to produce fibres. It is done by means of mechanically revolving stones in the presence of water to remove ^(the heat) friction.

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2
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Different Types of grinding

equipped are applied.

(i) Conventional Grinder

It is a large rotating grind stone mounted in much the same way as a knife grinder. The logs are pressed against the stone at an acute angle. Their length is used to produce fibre by tearing rather than by right angle cutting.

(ii) Pocket Grinder

These are applied for small tonnage of product. It consists of a central grindstone mounted on a steel shaft and its chambers called pockets are three around its periphery that are surrounded by a hydraulic cylinder ram to force the logs against the revolving stone.

(iii) Continuous Grinder

It works with same principle. It has highest output and is less labour intensive due to being automatic controls. A large rectangular cover opens at the top from where the

To
feed is added by conveyor and it is closed by the rotating stones from the bottom.

5 Screening:

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(device which has holes to separate different sized particles)

The stock from the sieves is passed along to the silver screen. The screens retain the large material and let the fine material fall into the screened stock pit from where it is pumped to the fine screens.

The over sized material is disintegrated in the rebiners.

6. Thickening:

The fine material are concentrated in thickeners which squeeze out water mechanically to produce commercial pulp.

white water:

The outflowing water contains 15 - 20% fibres and thus called white water. It is recycled for grinding and aiding the flow ~~in~~ in stock sewer.

To keep control the temperature
while water is removed as fresh
cold water addition is essential.

+ Bleaching

It is done by ClO_2 , Fe^{3+} .
low grade paper much whitening
is not required. Therefore bleaching
is not done of great extent.

Manufacturing of wood Pulp

Chemically:

The basic principle involved in the
manufacture of wood pulp is the
digestion of wood chips by
different chemical methods.

The choice of process depends
upon the nature of wood.

For soft wood is digested by
Acid-Sulphite process and

both soft & hard woods are
digested by Kraft Pudding

ACID SULPHITE Process:

The stages of Acid Sulphite Process are given below:

a) Source of wood:

Woods supplied by the natural or man's made forests located at an adequate distance.

from pulp and paper mill.

Trees are harvested and cut to make logs of different sizes. Large logs are used for wood work while small logs are used in paper or pulp production.

b) Transport to the mill

The wood is transported to the mill in the form of debarked (un-barked) logs. The mode of transport varies from place to place. The logs are transported by the trucks,

✓ Tractors driven trolleys, Railways and ships etc.

The mill operating the 200-250 t.p.d receives about 10000 tons of unbarked logs per day.

C Unloading and Storage:

The logs are unloaded and by means of cranes and conveyors and stored in the open.

From the storage, the logs may be manually transferred to the conveyors after weighing.

D Debarking:

In drum debarkers, the logs hit against the walls of drum as a result of which the bark is loosened.

In U.S.A **Jet debarkers** are used. In this the bark is loosened by water jets under high hydraulic pressure.

In Pakistan, Debarking may also be accomplished by farmers to get babool bark used in the leather tanneries.

It is done at harvesting site. The bark is loosened when it hit with a blunt wooden hammer and removed.

Chipping: The logs after debarking are conveyed to the chipper after passing through splitters which cuts them into smaller pieces.

The logs are chipped in the chippers and the chips are subjected to differential screening to remove the undersized and oversized chips so that only uniform sized chips ($\frac{1}{2}$ " length) may be supplied for digestion process for uniform cooking. The big sized chips are re-chipped and process again.

✓ Chips storage:

The chips are stored in the open for 8 weeks.

+ Two major aims for storage are:

- * Eight weeks inventory of chips keeps the mill working for this period without a break.

(1) Effects

The resinous material present in the wood is oxidized as a result of atmospheric exposure to moisture and air and thus the formation of dark pitch in the pulp is minimized.

Supply to the digester

The chips are conveyed to and removed from the pile in the open with the help of an air blowing system (pneumatic transport).

The chips are digested discharged in the open atmosphere and pushed into air intake air blows which blows them into the digester.

Digestion

The digestion of chips are by acid Sulphite process is carried out in a series of digesters.

For

200-250

t.p.d

12

digesters are required.

The digesters are stationary vertical cylinders of very high capacity made of steel and lined inside with special acid.

Proof material

Rotary continuous digesters are also in use. Because it reduces the digestion time. The digesters are installed in a separate building and fitting with an automatic control system.

The digestors are fed with three Inputs

* chips from pile

* cooking liquors from a storage tower

* steam from boiler house

Conditions :-

The conditions of working

In the digestor are given below;

Temperature $185^{\circ}\text{F} - 320^{\circ}\text{F}$ / $80 - 176^{\circ}\text{C}$ on high

pH 4.5

Pressure 4-110 PSI

Yield = 45%

Time = 3-12 hours

(Bleached Pulp)

As a result of cooking chips
are turned into pulp.

The cooking liquor contains
✓ bisulphite and dissolved sulphur
dioxide.

Reactions Involved in

The preparation of cooking liquor
of course, are very simple.

- 1) $\text{S} + \text{O}_2 \rightarrow \text{SO}_2$
- 2) $2\text{SO}_2 + \text{H}_2\text{O} + \text{CaCO}_3 \rightarrow \text{Ca}(\text{HSO}_3)_2 + \text{CO}_2$
- 3) $\text{Ca}(\text{OH})_2 + 2\text{SO}_2 \rightarrow \text{Ca}(\text{HSO}_3)_2$
- 4) $2\text{SO}_2 + \text{H}_2\text{O} + \text{MgCO}_3 \rightarrow \text{Mg}(\text{HSO}_3)_2 + \text{CO}_2$
- 5) $2\text{SO}_2 + \text{Mg(OH)}_2 \rightarrow \text{Mg}(\text{HSO}_3)_2$
- 6) $\text{Na}_2\text{CO}_3 + \text{H}_2\text{O} + \text{SO}_2 \rightarrow \text{NaHSO}_3 + \text{CO}_2$
- 7) $\text{NaOH} + \text{SO}_2 \rightarrow \text{NaHSO}_3$
- 8) $\text{NH}_4\text{OH} + \text{SO}_2 \rightarrow \text{NH}_4\text{HSO}_3$

The digestion occurs due to the
effect of sulphite on lignins
and hemicelluloses.

- 1) Lignin are dissolved due to
✓ sulphonation with bisulphite
 $\text{R}_3\text{C}=\text{CR}'_2 \cdot \text{Mg}(\text{HSO}_3)_2 \rightarrow (\text{RCH}=\text{CR}'_2)_2\text{SO}_3^- \cdot \text{Mg}^{2+}$

are hydrolyzed.

5. Hemicelluloses are hydrolysed to simpler components.

6. Extraneous wood components are attacked.

$MgSO_3$ is used not $CaSO_4$ because $CaSO_4$ is not decomposed and the chemical will be lost so $MgSO_3$ is used because it decomposes and MgO is formed hence the chemical can be recovered and it also results into greater concentration and more active SO_3^- .

Pulp storage

The pulp from digesters is dumped into storage chests and blow tanks from where it is sent to multistage screening.

Multistage screening & washing

The undigested chips and knots are removed here and washed out in Rotary Vacuum washers.

Bleaching:-

The unbleached pulp is bleached with Cl_2 and hypo-chlorites.

Chlorine is purchased in liquid form. Bleaching is done in chlorination tower. Colouring matter is partially oxidized.

Next stage is Caustic

Extraction stage where pulp is treated with caustic soda in caustic extraction tower

The [function] is to remove the lignin & dissolving of more colouring matter. Third stage is the Whitening stage

It involves treatment with chlorine dioxide (ClO_2).

Finishing:-

Finishing involves following automatic operations

1. Mechanical squeezing to 50% water. This is called Thickening

- I. ~~Thickening~~
- II. Rolling & Drying on steam heated cylinder. (16)
- III. Cutting into sheets with help of automatic guillotins or choppers.
- IV. Bundling
- V. Weighing
- VI. Compressing
- VII. Wrapping
- VIII. Tying or wiring
- IX. Conveying To Loading Bay or to storage.

Chemical Recovery

The spent sulphite liquor is called weak red liquor. It is stored

in weak red liquor storage. It is concentrated in Multiple Effect

Evaporators and the resultant concentrated liquor called heavy liquor is stored in heavy liquor storage. It is then evaporated in a

Direct Contact Evaporator.

The concentrated liquor is treated

and its organic matter burnt in the Recovery Furnace of the Boiler. The steam formed is utilized in the processes and to generate power. The material left after burning is $\checkmark \text{MgO}$. MgO is leached to get $\checkmark \text{Mg(OH)}_2$, which is mixed with H_2O to make up $\text{Mg(OH)}_2 \cdot \text{H}_2\text{O}$ that is pumped to cooling and acid tower. In which is passed SO_2 to make fresh sulphite liquor which is filtered & stored in cooling Acid storage.

✓ Manufacturing Pulp - 4

OKRAFT PROCESS

(Sulphate Pulping Process)

- ✓ \Rightarrow It is alkaline process.
- ✓ \Rightarrow It is applied to digest soft and hard wood.
- ✓ \Rightarrow The pulp is formed has high strength in this process.
- ✓ \Rightarrow It is not of fine quality.

Digestion

Wood chips + 12% soin
18% NaOH, of
Na₂S
Na₂CO₃

The digestion by Kraft process is based upon the principle that wood chips when heated under pressure with an alkaline cooking liquor which is 12% solution of NaOH, ✓ Na₂S and Na₂CO₃ large quantities of resins and oils are removed as a result of which the fibres are set apart.

The hydrolysis of dignins to alcohols, acids and mercaptans (CH₃SH) occurs.

The dissolving action is due to NaOH and Na₂S while Na₂CO₃ in the causticising process.

The sulphides and mercaptans are also cause of bad smell which is typically of Kraft Pulp Mill.

The cooking conditions are:

✓ Temperature (T) 170-175°C

✓ Pressure (P) 100-135 PSI

✓ Time (t) 2-3 hours

The typical analysis of the cooking liquor solids is given below.

<u>NaOH</u>	✓ 58.6%] 12%
<u>Na₂S</u>	✓ 27.1%	
<u>Na₂CO₃</u>	✓ 14.3%	

Input / ton dried Kraft pulp:

Wood	1.5-2 tons	Materials
✓ New Lime	500 lb	Required
✓ Soda Ash	250lb	
✓ Steam	13000lb	
✓ Electricity	250kw	
✓ Direct Labour	5 men	
Yield - 42% ✓		

2 Chemical Recovery: Black liquor

It (Process) is forms ^{on} the basis of if favourable process.

The black liquor obtained from the pulp washer and diffusers contains 05- 98% of the chemical charged to the digester. The chemicals present are organic sulphur compounds + Na₂S, Na₂CO₃ etc.

Small amount of Na_2SO_4 , salts, silica etc., lime, Iron oxide and Potash are present in traces.

Stages

i. Weak liquor storage:-

The weak liquor from the washers and diffusers is stored in a tank.

ii. Evaporation:

The primary concentration of liquor is accomplished in Multi-effect evaporation.

iii. Black liquor storage:-

The concentrated liquor is stored in a storage tank.

iv. Direct Contact Evaporation:-

Secondary concentration is done here in a secondary direct contact evaporator.

v. Salt Cake Mixing:-

Na_2SO_4

Salt cake (Na_2SO_4) is mixed here in a mixing tank.

It is First Make up chemical $\text{Na}_2\text{S}_2\text{O}_3$

vi = Recovery Furnace:-

The concentrated liquor is burnt in the furnace.

The organic matter burns and thus burning continues due to involvement of exothermic reaction.

Na_2SO_4 decomposes to Na_2S



vii = Leaching:-

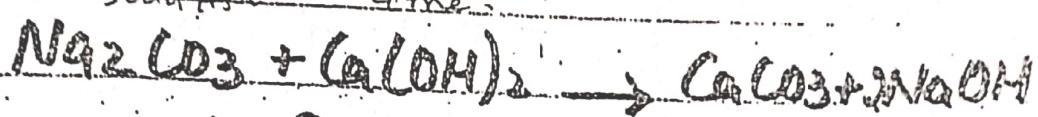
The burnt residue is leached with water and green liquor formed.

viii = Causticizing:-

The green liquor is stirred with Lime. / Second Make up.

Chemical) — and transferred to settling tank.

Lime React with Soda Ash and forms CaCO_3 and NaOH



Net Result:



ix Cooking liquor storage

The cooking liquor after fortification is stored here for fresh supply to the digesters.

Semi-Chemical or Chemi-

Mechanical Pulping Process

It is the combination of Chemical and Mechanical

pulping processes to prepare pulps of intermediate quality b/w chemical pulps.

It is two stage process.
When applied to wood in cold Soda process, the chips are treated with NaOH at room temperature or by hydrostatic pressure and then disintegrated in refiner.

The resulting pulp cannot be easily bleached.

Instead of NaOH, the Sodium Sulphite may also be used.

In hot process, the chemical treatment with soda or neutral sodium sulphite may lead to 85 - 95% yield if it forms upto 60-65% in case of latter i.e. Soda Sulphite only.

All the processes do not employ chemicals to bind materials of wood fibre.