CH0204 Organic Chemical Technology

Lecture 6

Chapter 1 Natural Products

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Overview of topics

Chapter 1 NATURAL PRODUCTS

1. Pulp and Paper
2. Sugar
3. Starch and its derivatives

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Chapter 1 NATURAL PRODUCTS

1. Pulp and Paper
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3. Starch and its derivatives

Pulp and Paper

Definitions
History of Pulp and Paper
Global Pulp and Paper industries scenario
Indian Pulp and Paper Industries scenario
Raw materials
Manufacture of Pulp and paper
Process description
Paper products

Pulp and Paper – Raw materials

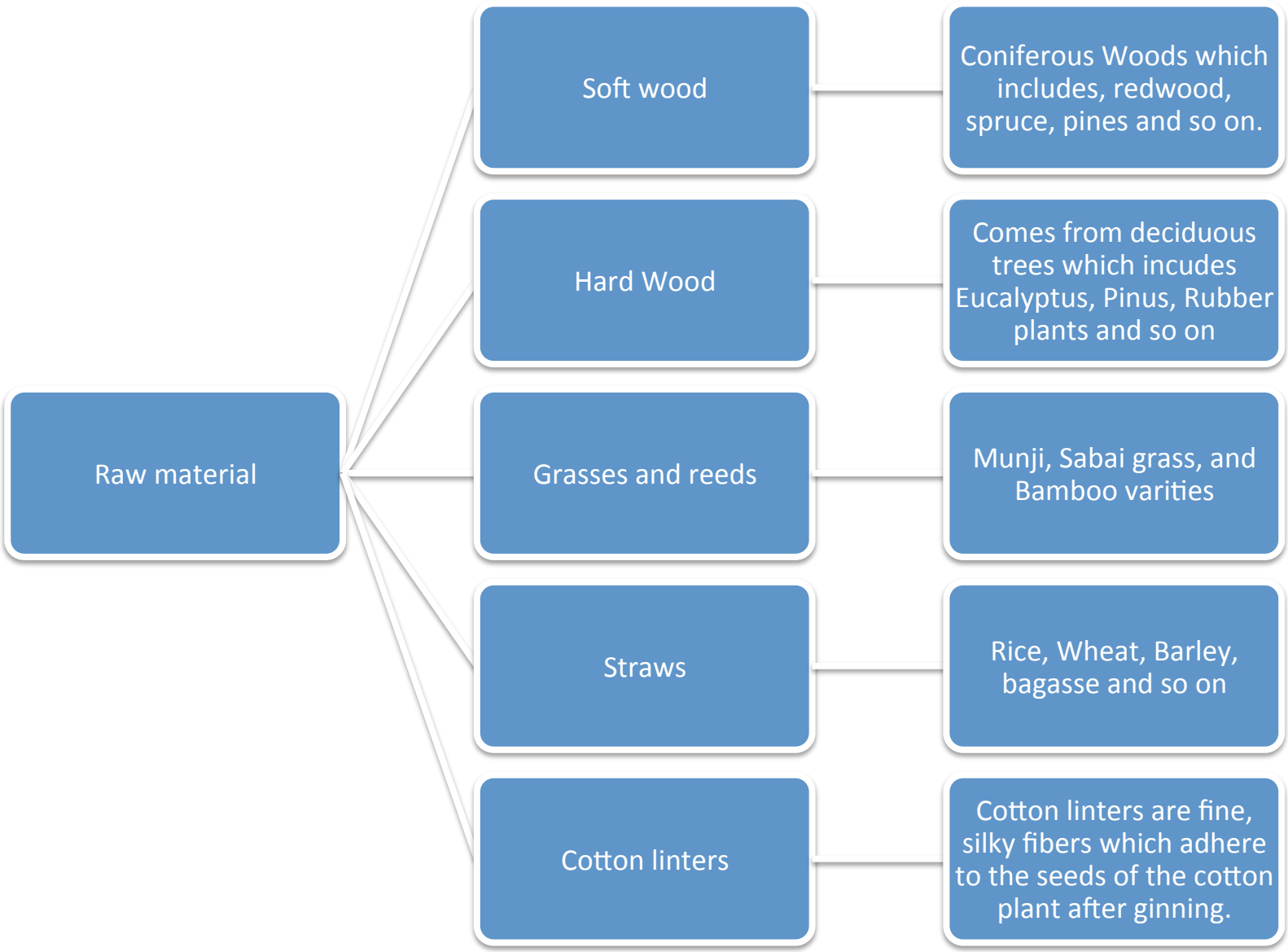
Pulping

Paper production requires a disintegration of the bulky fibrous material to individual or small agglomerate fibers. This is called *Pulping*.

The requirement of a good raw material for pulp and paper production,

1. The ideal fiber for high grade paper should be long i.e. fiber must be long
2. High in cellulose content
3. Low in lignin content

Pulp and Paper – Raw materials



Pulp and Paper – Raw materials

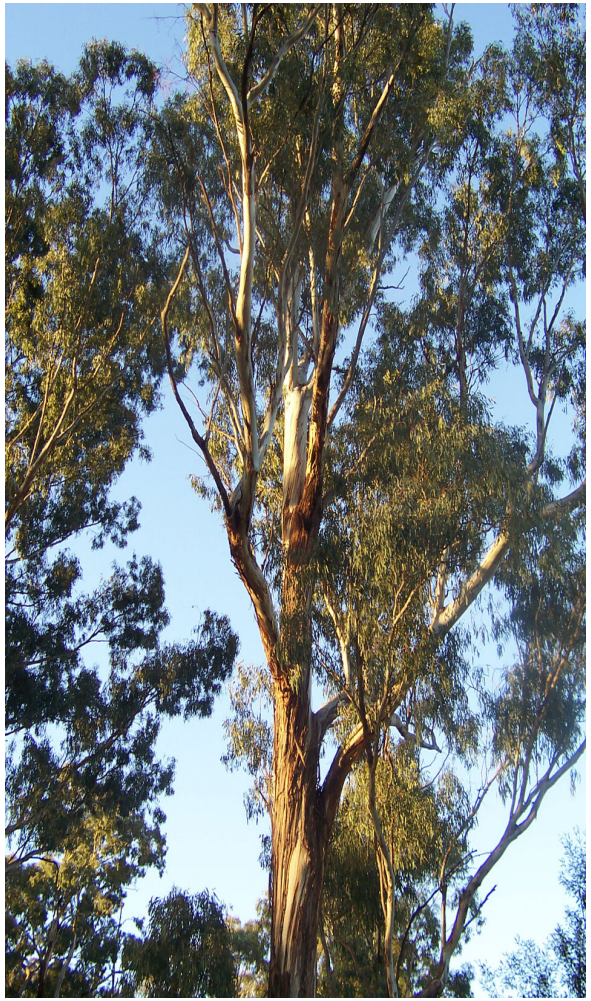
Soft wood

Coniferous Woods which includes, redwood, spruce, pines and so on.

Pulp and Paper – Raw materials

Hard Wood

Comes from deciduous trees which incudes Eucalyptus, Rubber plants and so on



Pulp and Paper – Raw materials

Grasses and reeds

Munji, Sabai grass, and Bamboo varities

Pulp and Paper – Raw materials

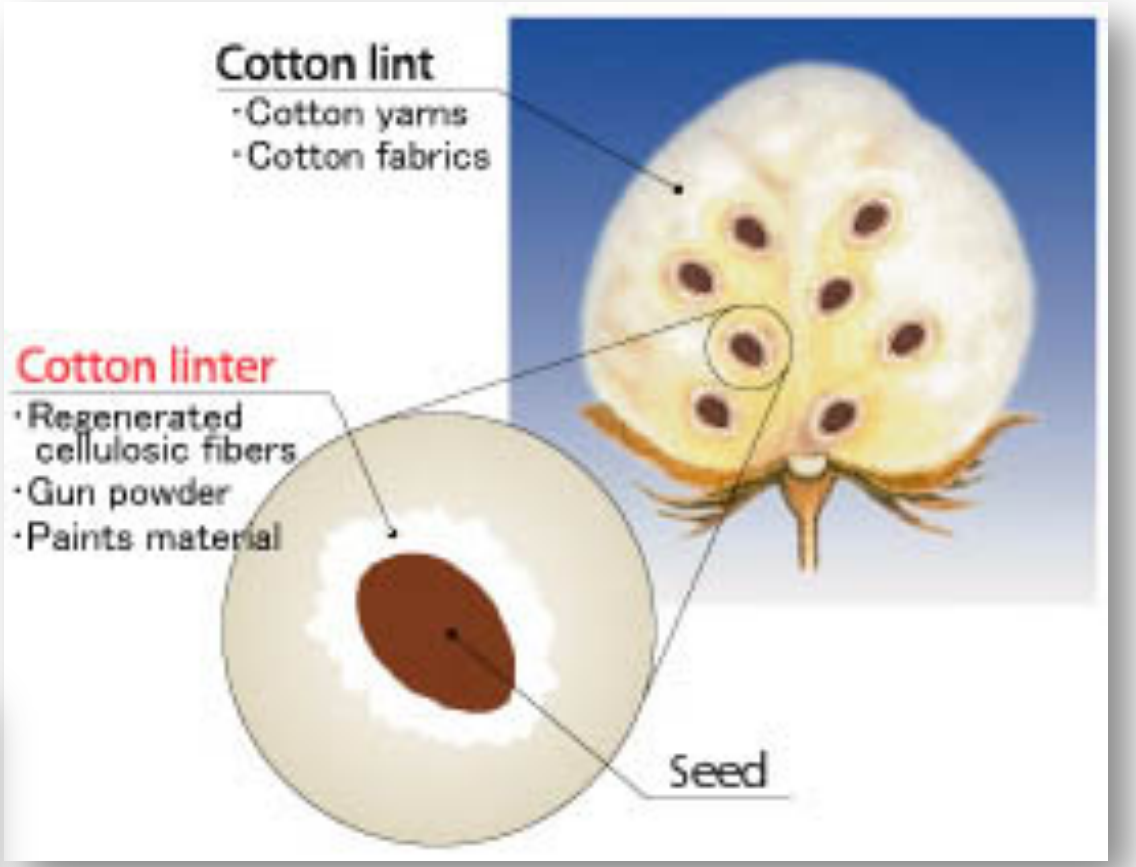
Straws

Rice, Wheat, bagasse and so on

Pulp and Paper – Raw materials

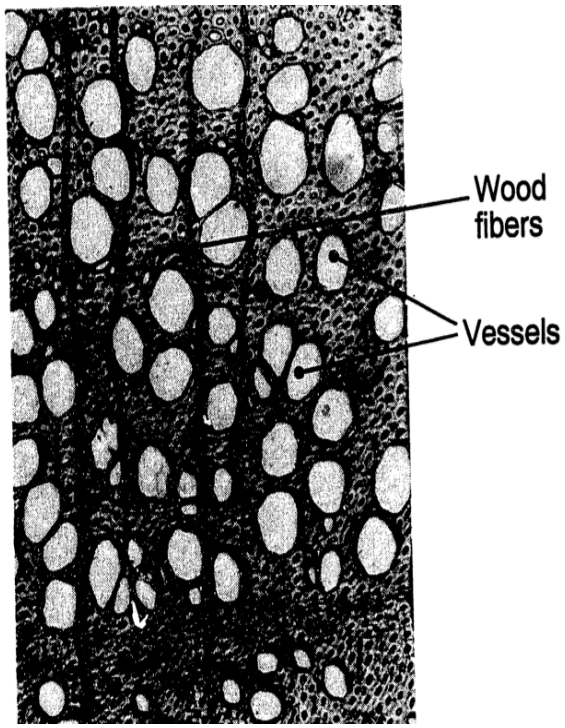
Cotton linters

Cotton linters are fine, silky fibers which adhere to the seeds of the cotton plant after ginning.

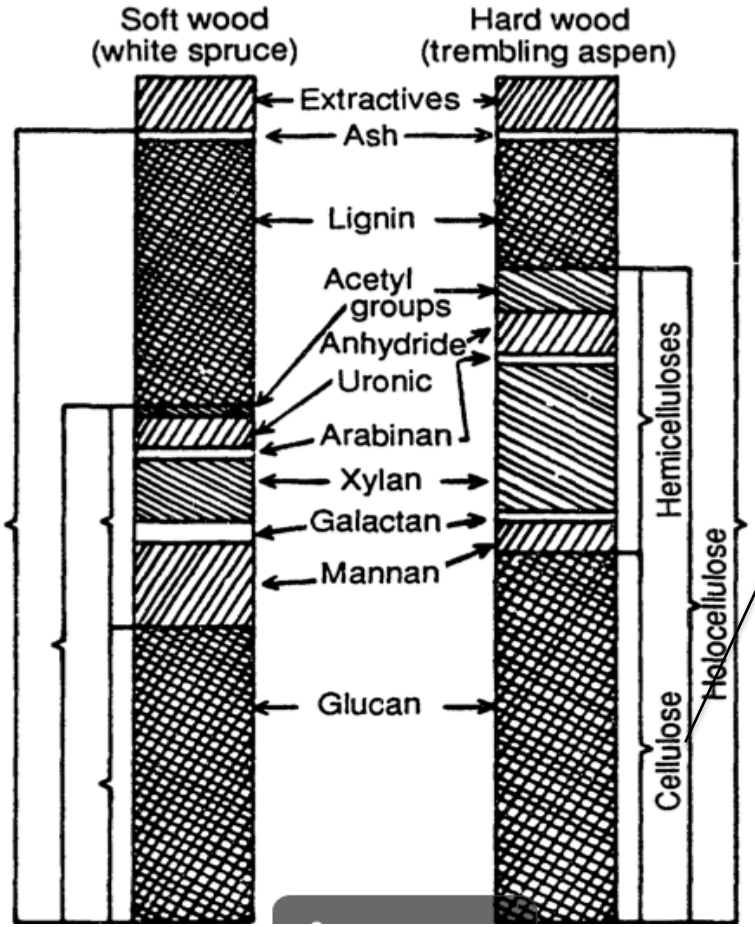


Pulp and Paper – Raw materials

Wood

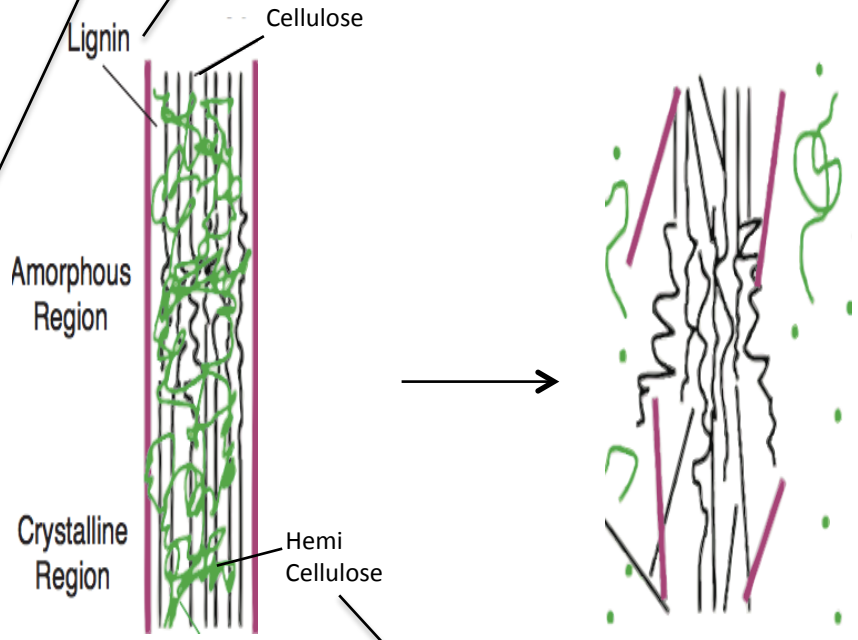


Pulp and Paper – Raw materials



Array of high molecular weight glucose polymer chains, currently more valuable as fiber

Binder for cellulose fiber and it is a complex amorphous poly phenol polymer



Disordered array of several sugar polymers

Pulp and Paper

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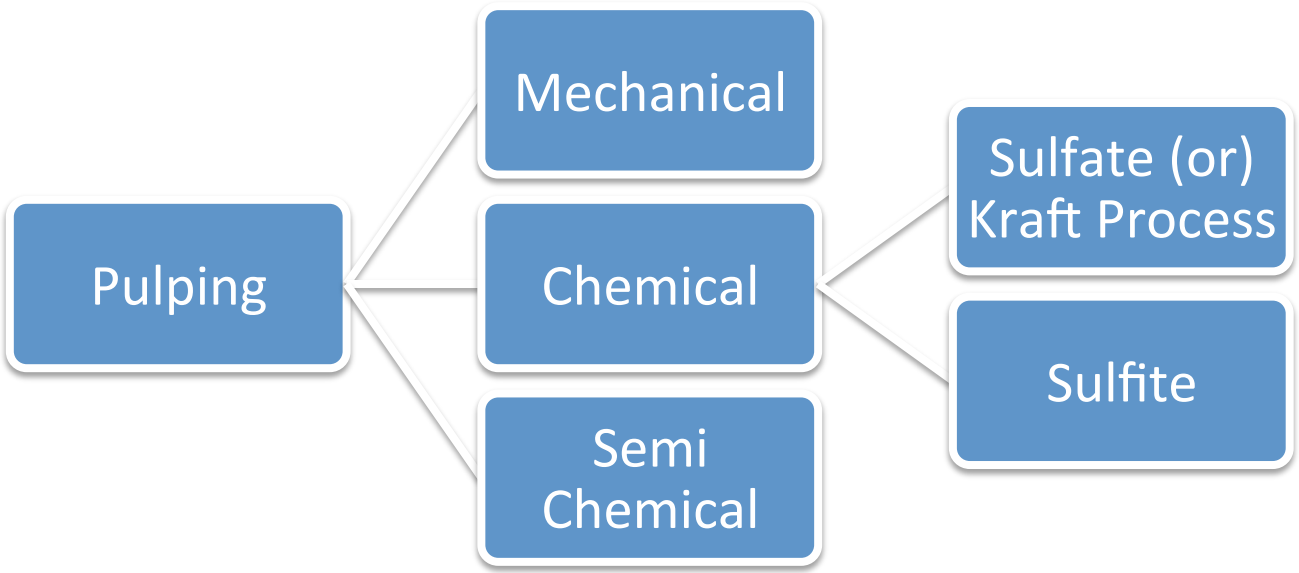
Pulp and Paper – Pulping Methods



Pulp and Paper – Pulping Methods

Mechanical	Chemical	Semi chemical
Wood is debarked and it is mechanically shredded to form fibers.	The cellulose from the wood is freed from lignin by chemical reagents.	Wood chips are given with mild chemical treatment with dilute mixture; of sulfite, sulfate, caustic soda, and or soda ash reagents.
Suitable for the production of newsprint, toweling, toilet tissues and cheap paper books where strength and ease of bleaching.	Pulp produced has high strength and fine texture. Suitable for the production of rayon, cellulose derivatives and high strength paper.	The wood is softened sufficiently to allow mechanical separation of fibers without excess power. Suitable for printing-writing and newsprint papers.

Pulp and Paper – Pulping Methods

Difference between sulfate (kraft) and sulfite process

Characteristics	Sulfate, or Kraft pulp(Alkaline)	Sulfite Pulp (Acid)
1. Cellulosic or fibrous raw material	Any kind of wood, soft or hard	Coniferous; must be good color and free from phenolic compounds
2. Cooking liquor or white liquor composition	60% NaOH 25% Na_2S 15% Na_2CO_3	Composition depends on process modifications, but all use SO_3 (a)Magnifite process: Mg(HSO3)2 + free SO2 in acid media (b)Neutral Sulfite process: Na_2SO_3, Na_2CO_3, $NaHCO_3$ (c)Acid Sulfite process: $NaHCO_3$, Na_2CO_3

Pulp and Paper – Pulping Methods

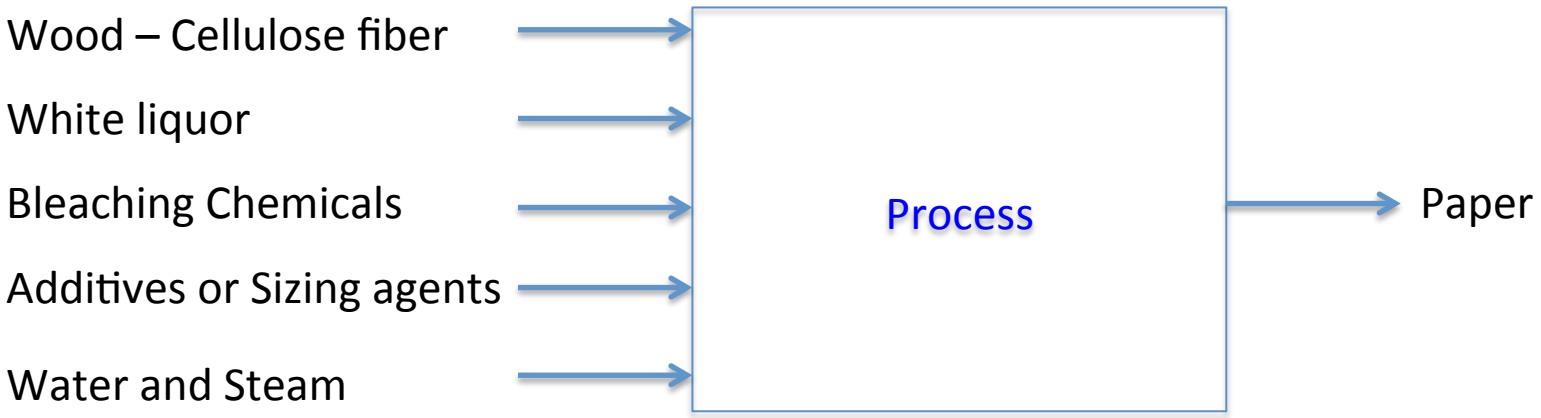
Characteristics	Sulfate, or Kraft pulp(Alkaline)	Sulfite Pulp (Acid)
3. Cooking conditions	Time 2 – 5 h, temp 170 – 176 deg. C, Pressure 660 – 925 kPa	Time 6 – 12 h, temp 125 – 160 deg, C, Pressure 620 – 755 kPa
4. Chemical recovery	Most of the process is devoted to the recovery of cooking chemicals, with recovery of heat through organic matter dissolved in liquor from wood; Chemical losses from the system is replenished with salt cake and Na_2SO_4	SO_3 Relief gas recovered; magnesium liquor recovered and reused after wood digestion and pulp washing
5. Material of construction	Digesters, pipelines, pumps, and tanks can be made of mild steel or, preferably of stainless steel	Acid and magnifite process requires digester lining of acid-proof brick; fittings of chrome-nickel steel, lead and bronze

Pulp and Paper – Pulping Methods

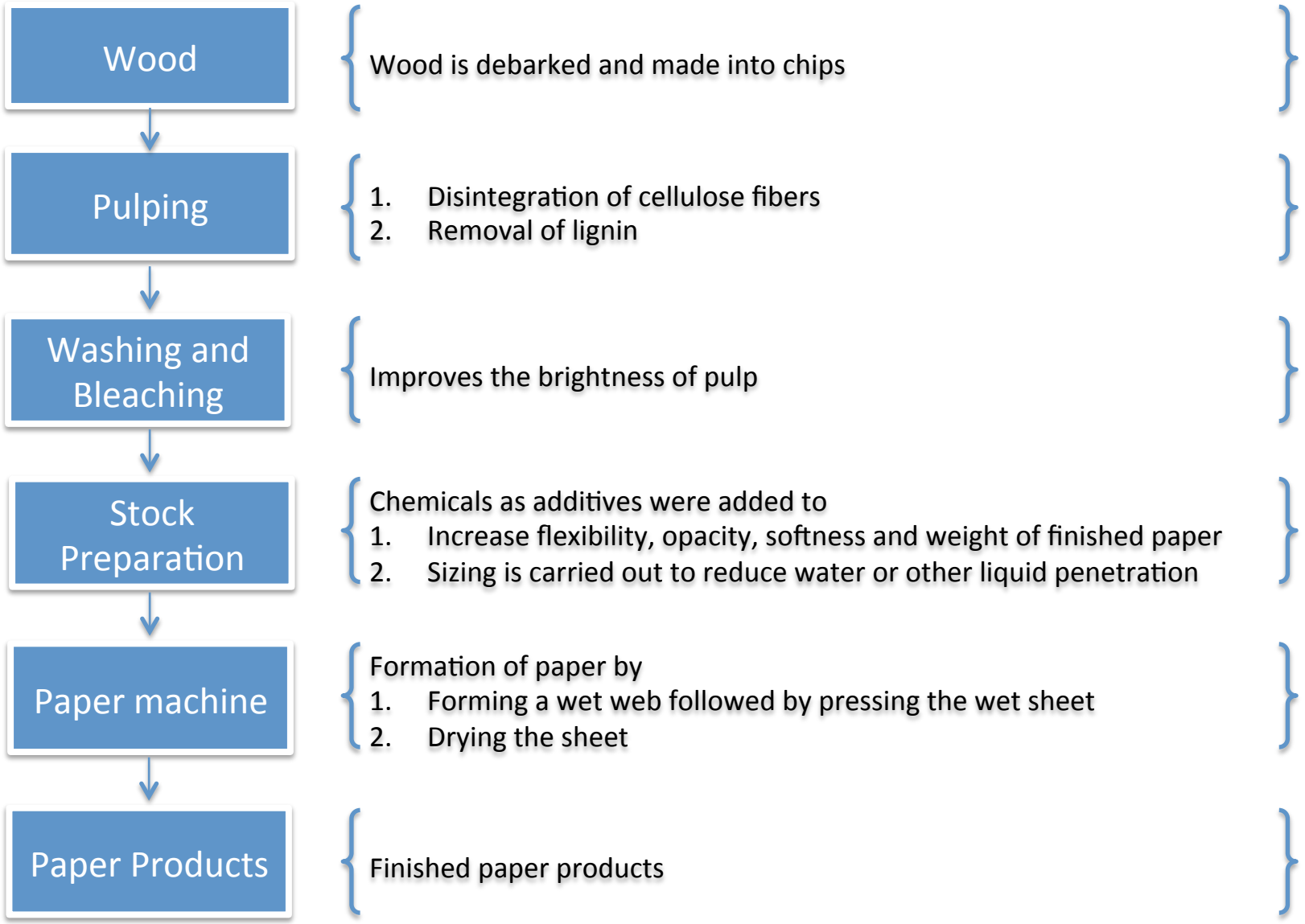
Characteristics	Sulfate, or Kraft pulp(Alkaline)	Sulfite Pulp (Acid)
6. Pulp characteristics	Brown color; difficult to bleach; strong fibers; resistant to mechanical refining	Dull white color; easily bleached; fibers weaker than Kraft
7. Typical paper products	Strong brown bag and wrapping, multiwall bags, gumming paper, strong white writing and printing paper, corrugated boards and cartons	White grades: book paper, bread wrap, fruit tissue, sanitary tissue

Pulp and Paper – Manufacture

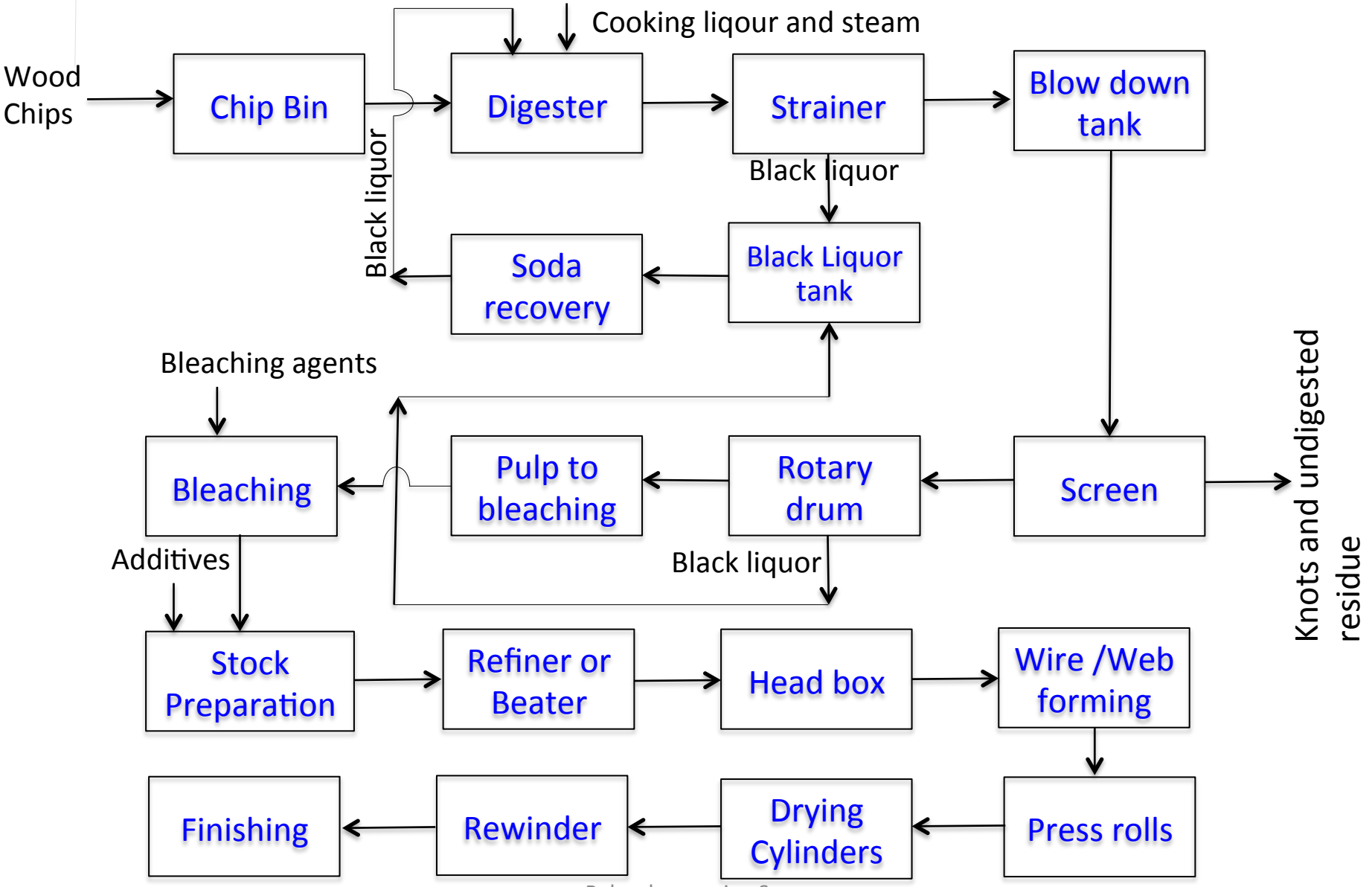
General process



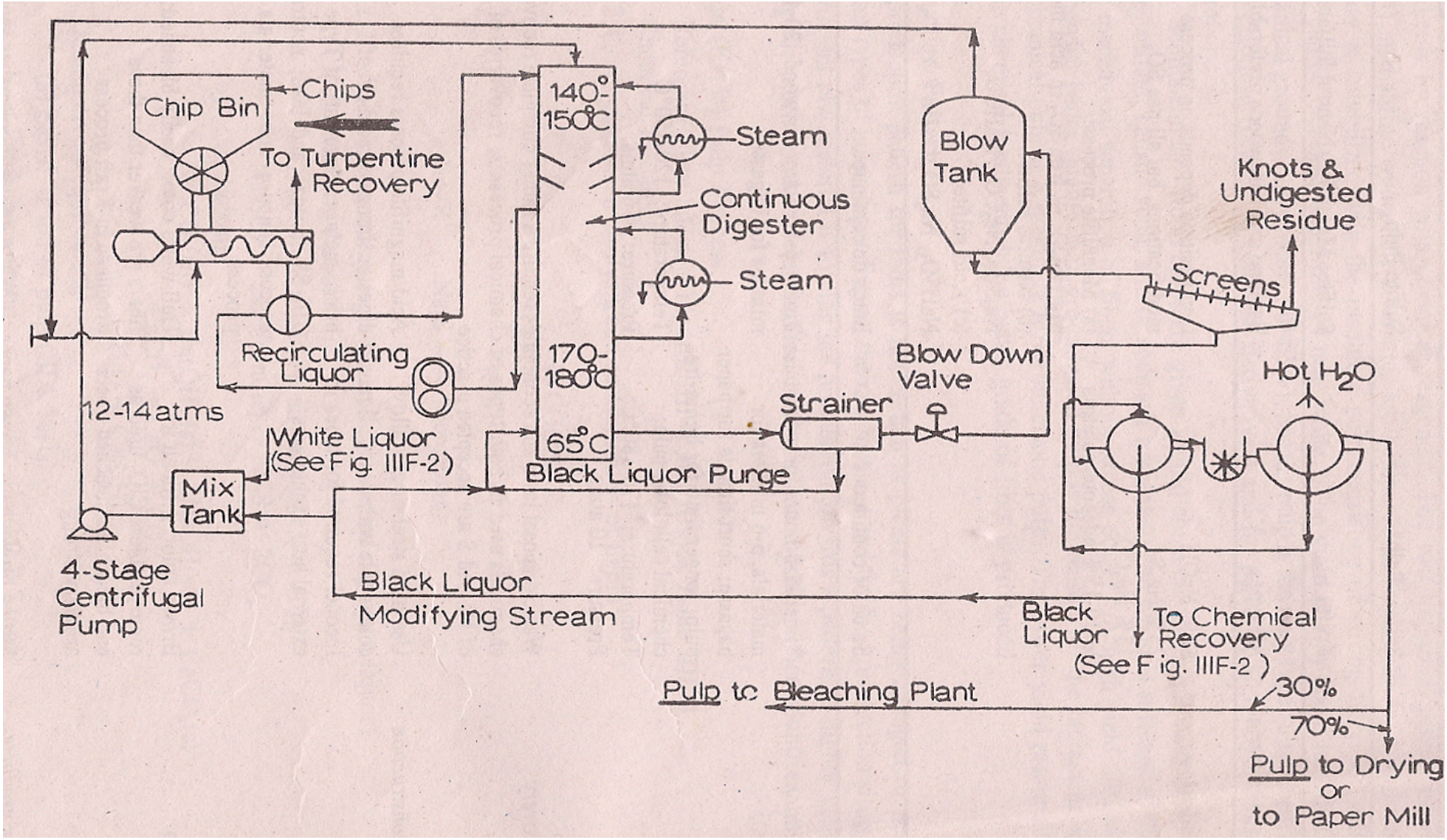
Pulp and Paper – General aspects process steps



Pulp manufacture – Block diagram for Kraft process



Pulp manufacture – Process diagram for Kraft process



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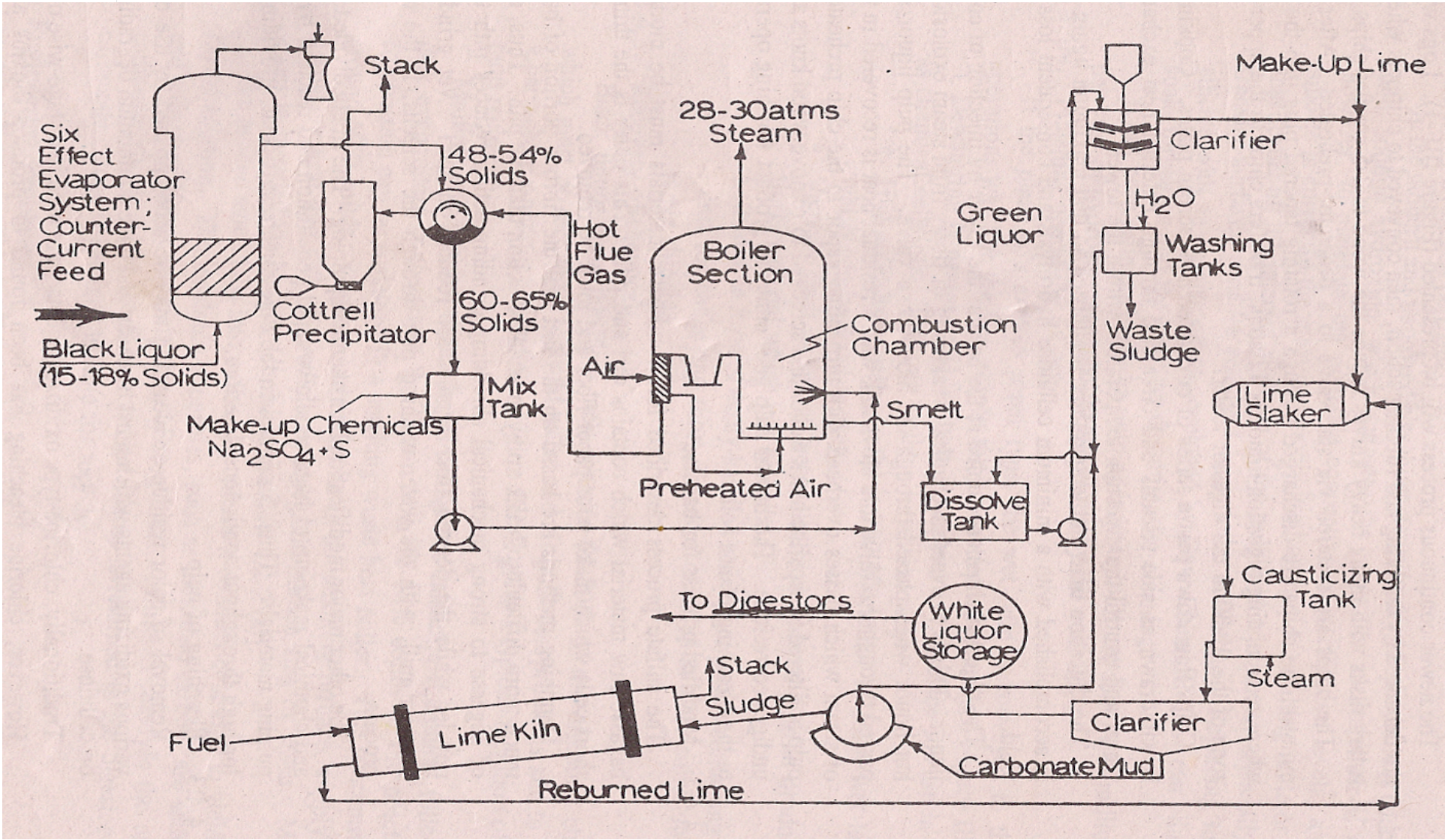
Pulp manufacture – Process description

Process	Equipment	Unit Operation	Unit Process	Objective	Operating Conditions
Continuous	Chip bin	Storage	--------	Receive and store the chips from the chipper	--------
Continuous	Digester		Hydrolysis	Solubilizing the lignin components by adding white liquor	65 – 180 deg. C 12 atm presssure
Continuous	Strainer	Solid-Liquid Separation	--------	Removal of black liquor and solubilized lignin	--------
Continuous	Blow down tank	Storage and Transportation	--------	Cool and transport the digested pulp to further processes. Separate the turpentine as the top product and reuse it to preheat the chips entering into the chip bin.	--------
Continuous	Screen	Size separation	--------	To remove the wood knots and other undigested residue	--------
Continuous	Washing	Solid-Liquid Separation	--------	Recover the black liquor by washing the digested wood cellulose. Prepare the cellulose for bleaching	--------

Pulp manufacture-Soda recovery for the Kraft process



Pulp manufacture – Process description of soda recovery

Process	Equipment	Unit Operation	Unit Process	Objective	Operating Conditions
Continuous	Multiple Effect Evaporator	Solid-Liquid separation	--------	To concentrate the black liquor	5 – 6 stages
Continuous	Smelting furnace	--------	Oxidation	Burn the organic carbon to produce an inorganic Molten slag. CO_2 is liberated. To facilitate the process alkali is supplied via Na_2SO_4 $2NaR\ (Lignin) + Air \rightarrow Na_2CO_3 + CO_2$ $Na_2SO_4 + 2C \text{ from } R \rightarrow Na_2S + 2CO_2$	--------
Continuous	Dissolve tank	Physical Separation	--------	Bring contact between slag and water to yield Green liquor	--------
Continuous	Clarifier	Solid-Liquid Separation	--------	To separate insoluble impurities such as unburned carbon and also to obtained a clear liquor by adding lime	--------
Continuous	Washing tank	Solid-Liquid Separation	--------	To separate and cool the clarifier sludge	--------
Continuous	Rotary drum Filter	Solid-Liquid separation	--------	Thickening sludge obtained from the clarifier	--------
Continuous	Lime kiln	Drying	--------	Remove the moisture and recovers the lime to reuse as causticizing agent.	--------
Continuous	Lime Slacker	Mixing		Mixing quick lime with water to prepare white liquor	

Pulp manufacture – Process description of soda recovery

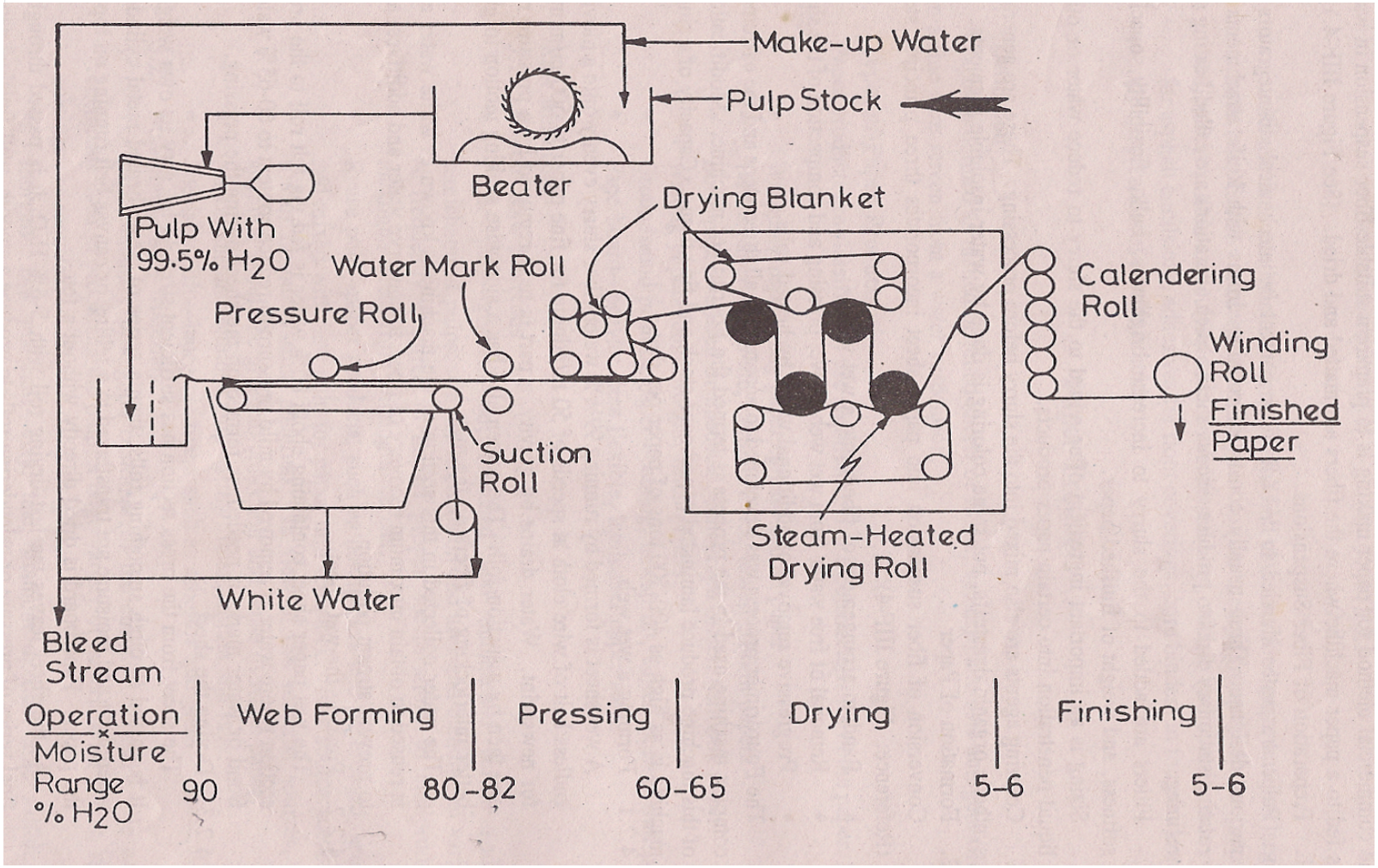
Process	Equipment	Unit Operation	Unit Process	Objective	Operating Conditions
Continuous	Causticizing Tank	--------	Causticizing	To prepare white liquor for digestion Na_2CO_3 (aq) + $Ca(OH)_2$ (s) → 2NaOH (aq) + $CaCO_3$ (s) $CaCO_3$ → CaO + CO_2 CaO + Water → $Ca(OH)_2$	--------
Continuous	Clarifier	Solid – Liquid Separation	-------	Separate white liquor and solid impurities	--------
Continuous	Storage tank	Storage	-------	Store the white liquor	-------

Paper Machine

Primary process involved in the paper sheet formation:

- Random arrangement of fibers into a wet web
- Removal of free water from wet web by wet pressing
- Progressive removal of additional water by heated rolls

Paper Machine



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Pulp manufacture – Process description of soda recovery

Process	Equipment	Unit Operation	Unit Process	Objective	Operating Conditions
Continuous	Beater	Mechanical Separation	-------	Disintegrate the fibers	-------
Continuous	Press rolls	Solid-Liquid Separation	-------	Random arrangement of fibers into a web form. Removal of free water (White water) from wet web by pressing and compaction	80% of water removal
Continuous	Suction rolls	Solid-Liquid Separation	-------	Water removal	60–65% of water removal
Continuous	Drying Blanket	Solid-Liquid separation	-------	Removal of residual moisture	5–6% of remaining water removal
Continuous	Calenderia rolls	Physical Rolling	-------	Rolling of sheet of paper	-------
Continuous	Winding rolls	Physical Rolling	-------	Rolling finished paper	-------

Paper Products

Paper

- Writing-printing papers
- News print papers
- Coated printing papers
- Packaging papers
- Tissue papers
- Corrugated boards

References

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3. Finar IL, Organic Chemistry Vol. 1 6th Edition Pearson Education 2009 pp.116-117