
Pulp & Paper

The **Kraft process** (also known as **Kraft pulping** or **sulfate process**) is used in production of paper pulp and involves the use of sodium hydroxide and sodium sulfide to extract the lignin from wood chips in large pressure vessels called digesters. Some digesters operate in a batch manner and some in a continuous process such as the Kamyr digester. Digesters producing 1,000 tonnes of pulp per day and more are common. One of the key advantages of a kraft mill is that it is almost closed-cycle with respect to inorganic chemicals, apart from those used in the bleaching process. The process name is derived from German *kraft*, meaning *strength/power.*

Kraft pulp makes paper that is stronger than that made from any of the other pulping processes. The sulfite process degrades cellulose more than the kraft process and degraded cellulose makes weaker fibers. Kraft pulping removes most of the lignin present originally in the wood while the mechanical pulping processes leave most of the lignin in the fibers. The hydrophobic nature of lignin interferes with the formation of the hydrogen bonds between cellulose (and hemicellulose) in the fibers needed for the strength of paper.

Kraft pulp is darker than other forms of wood pulp, but it can be bleached to make very white pulp. Fully bleached kraft pulp is used to make high quality paper where strength, whiteness and resistance to yellowing are important.

The kraft process can use a wider range of fiber sources than most other pulping processes. All types of wood, including very resinous types like southern pine and non-wood species like bamboo can be used in the kraft process.

Pulping process

Wood chips and **white liquor**, a mixture of sodium hydroxide and sodium sulfide, produced in the recovery process, are added to the top of the digester. In a continuous digester the materials are fed at a rate which allows the pulping reaction to be complete by the time the material exit the reactor. Typically this takes several hours and is done at high temperatures (130 to 180 °C (265 to 355 °F). These conditions break down lignin and some hemicellulose and the fragments become soluble in the strongly basic liquid. The solid pulp (about 50% by weight based on the dry wood chips) is collected and washed. At this point the pulp is quite brown and is known as "brown stock". The combined liquids, known as black liquor (so called because of its color), contain lignin fragments, carbohydrates from the breakdown of hemicellulose, sodium carbonate, sodium sulfate and other inorganic salts.

Recovery process

The black liquor is concentrated in multiple-effect evaporator to about 60% solids and burned in the recovery boiler to recover the inorganic chemicals for reuse in the pulping process. The combustion is carried out such that sodium sulfate is reduced to sodium sulfide by the organic carbon in the mixture:

1. $Na_2SO_4 + 2\ C \longrightarrow Na_2S + 2\ CO_2$

The molten salts ("smelt") from the recovery boiler are dissolved in water to give a solution of sodium carbonate and sodium sulfide, known as "green liquor". This liquid is mixed with calcium hydroxide to regenerate the white liquor used in the pulping process (Na_2S is shown since it is part of the green liquor, but does not participate in the reaction):

2. $Na_2S + 2\ Na_2CO_3 + Ca(OH)_2 \longrightarrow Na_2S + 2\ NaOH + CaCO_3$

Calcium carbonate precipitates from the white liquor and is recovered and heated in a kiln where it is converted to calcium oxide.

3. $CaCO_3 \longrightarrow CaO + CO_2$

Calcium oxide is reacted with water to regenerate the calcium hydroxide used in Reaction 2:

4. $CaO + H_2O \longrightarrow Ca(OH)_2$

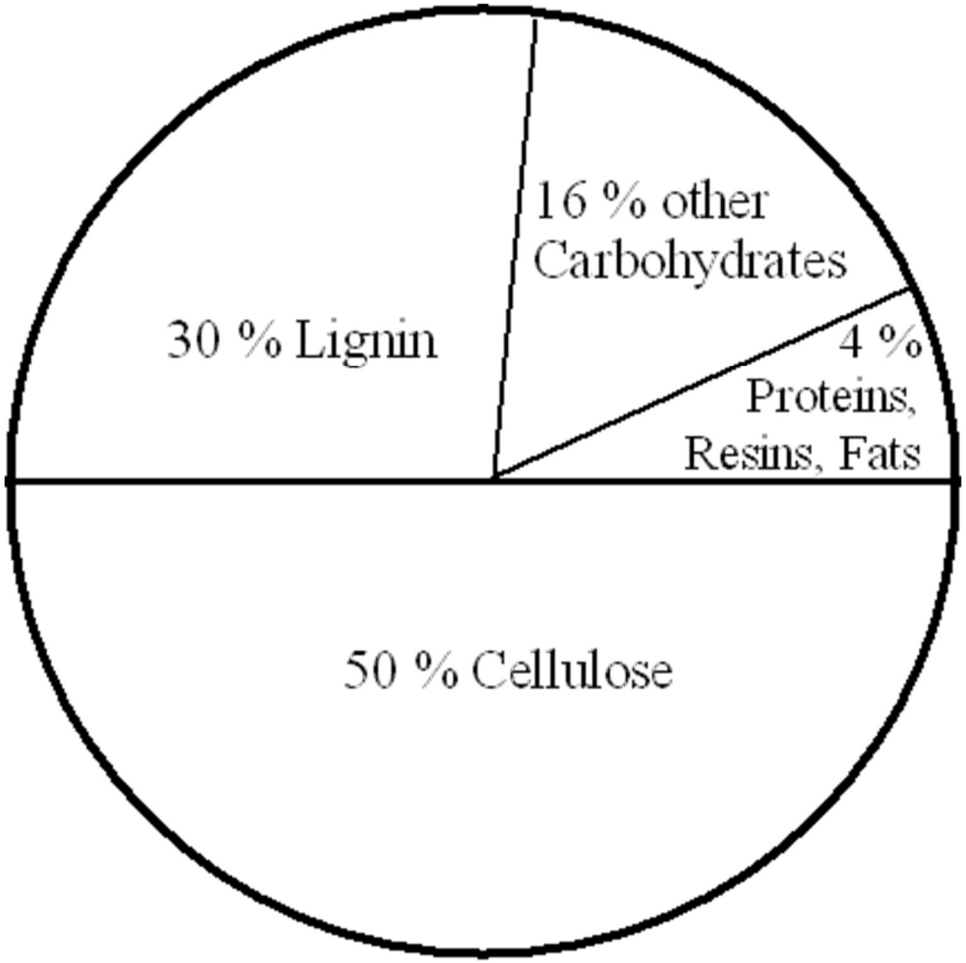
The combination of reactions 1 through 4 form a closed cycle with respect to sodium, sulfur and calcium.

The recovery boiler also generates high pressure which is led to turbogenerators, reducing the steam pressure for the mill use and generating electricity. A modern kraft pulp mill is more than self-sufficient in its electrical generation and normally will provide a net flow of energy to the local electrical grid. Additionally: bark and wood residues are often burned in a separate power boiler to generate steam.

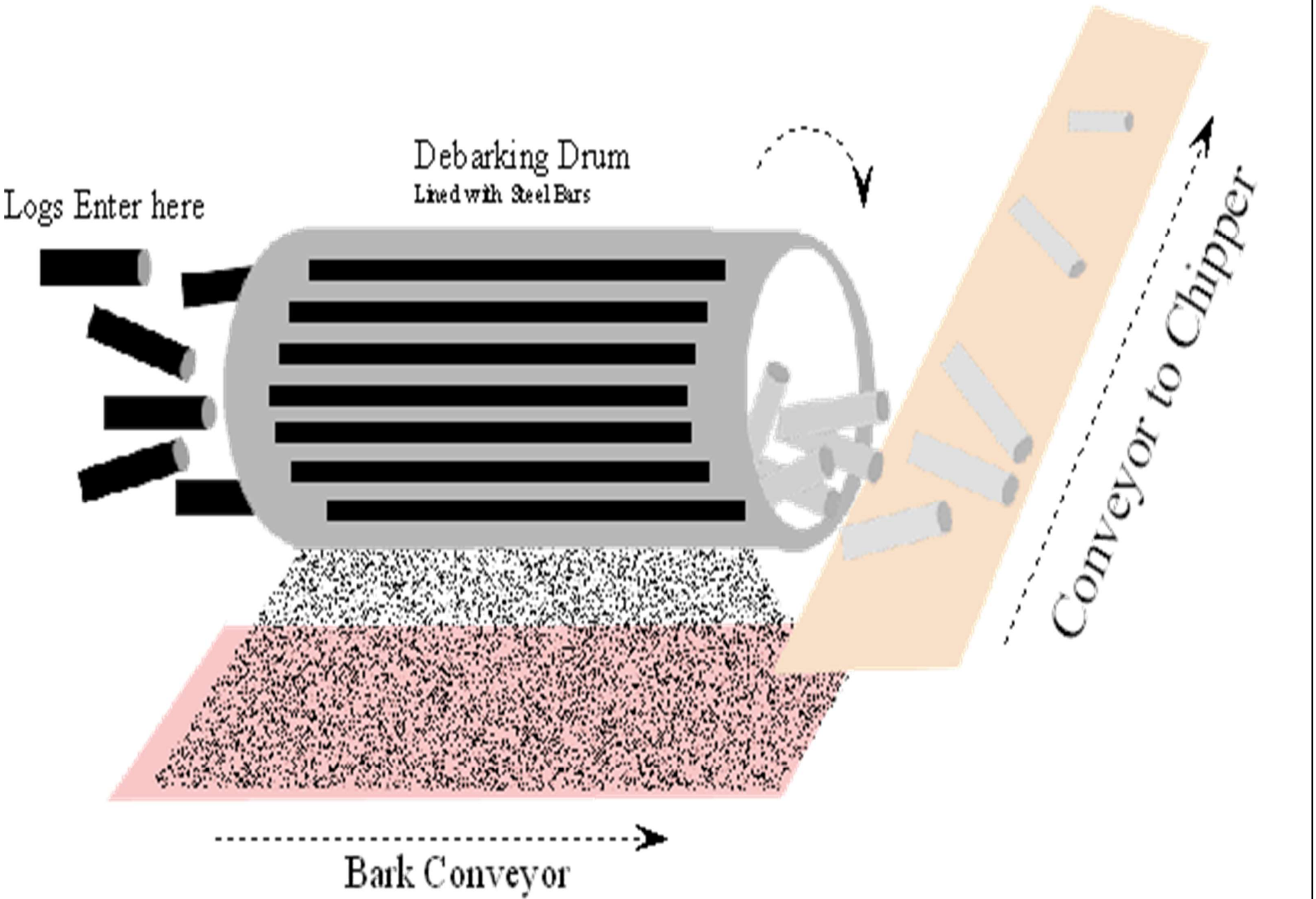
Bleaching

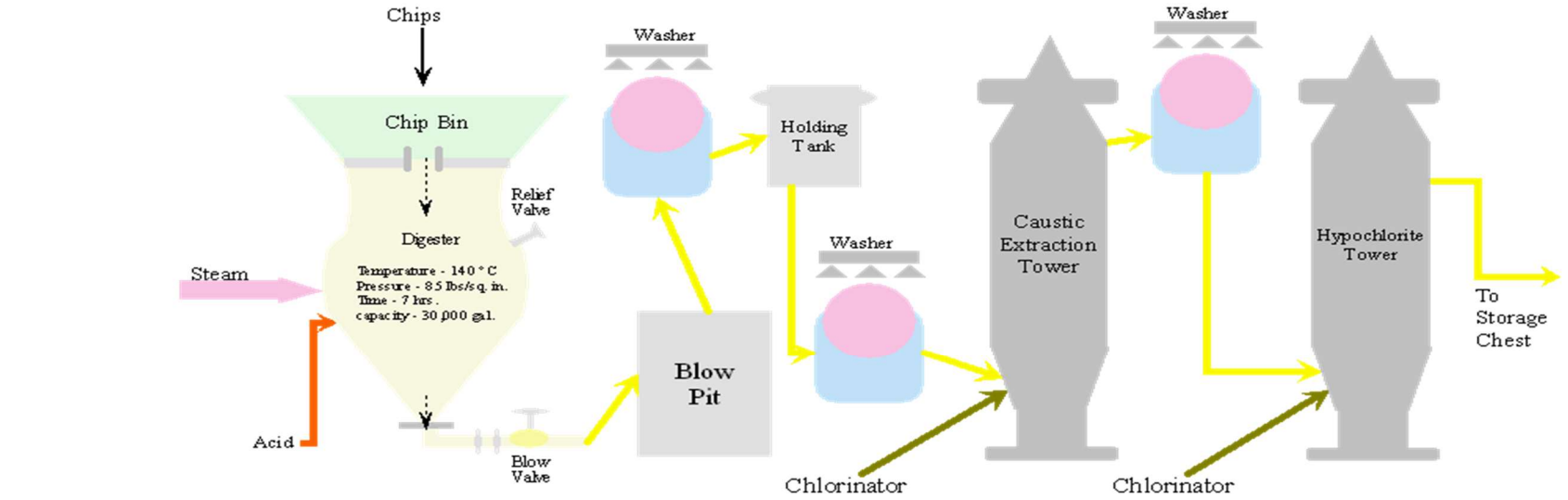
In a modern mill, brown pulp, (cellulose fibers containing residual lignin), following the cooking process is first washed to remove some of the dissolved organic material and then further delignified by an oxygen/alkali reaction and subsequently bleached with a combination of acidic (chlorine dioxide) and alkaline (sodium hydroxide) stages, reinforced with oxygen and/or hydrogen peroxide.

In the case of a plant designed to produce pulp to make brown sack paper or linerboard for boxes and packaging, the pulp does not always need to be bleached to a high brightness. In these cases, a higher yield of fiber from wood can be achieved.

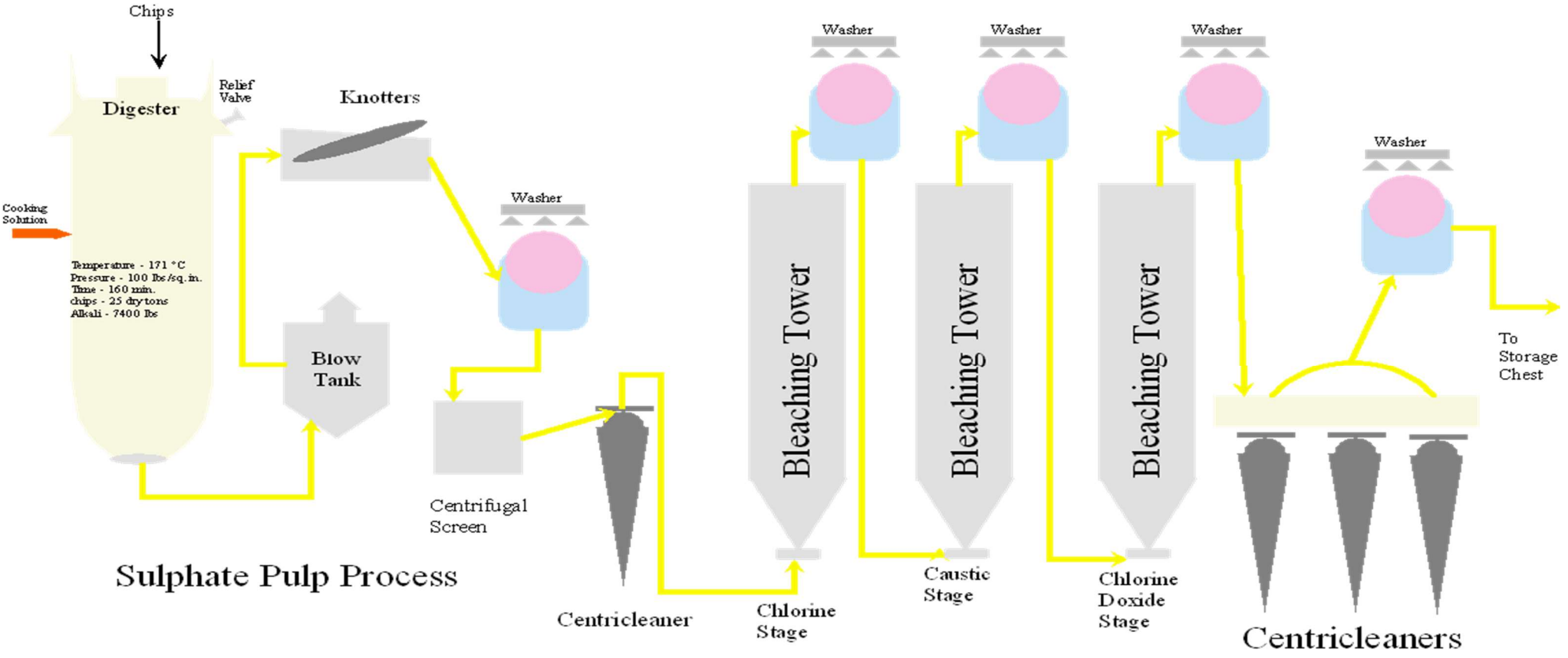


Wood Composition

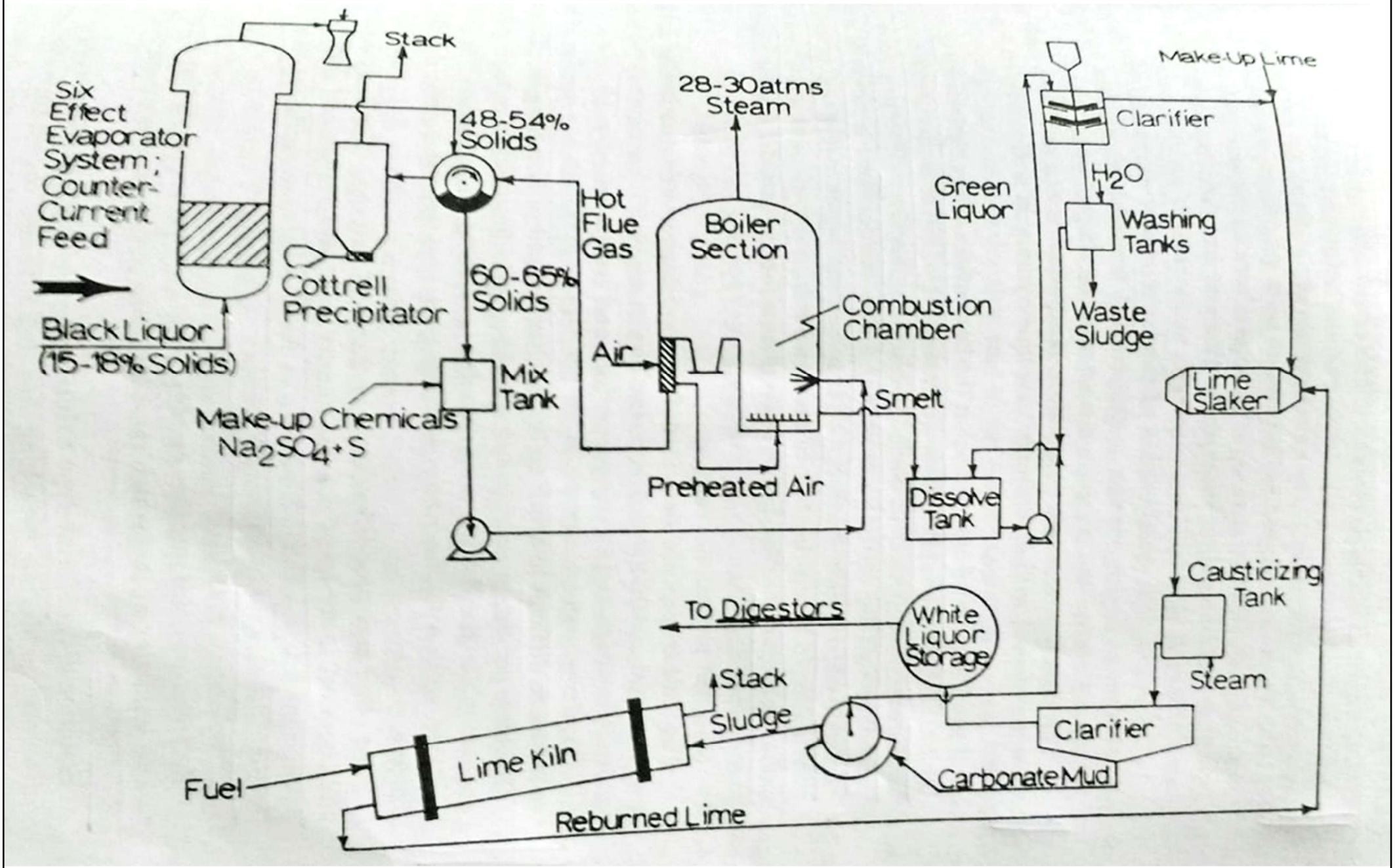

Debarking Drum
Lined with Steel Bars
Logs Enter here
Conveyor to Chipper
Bark Conveyor



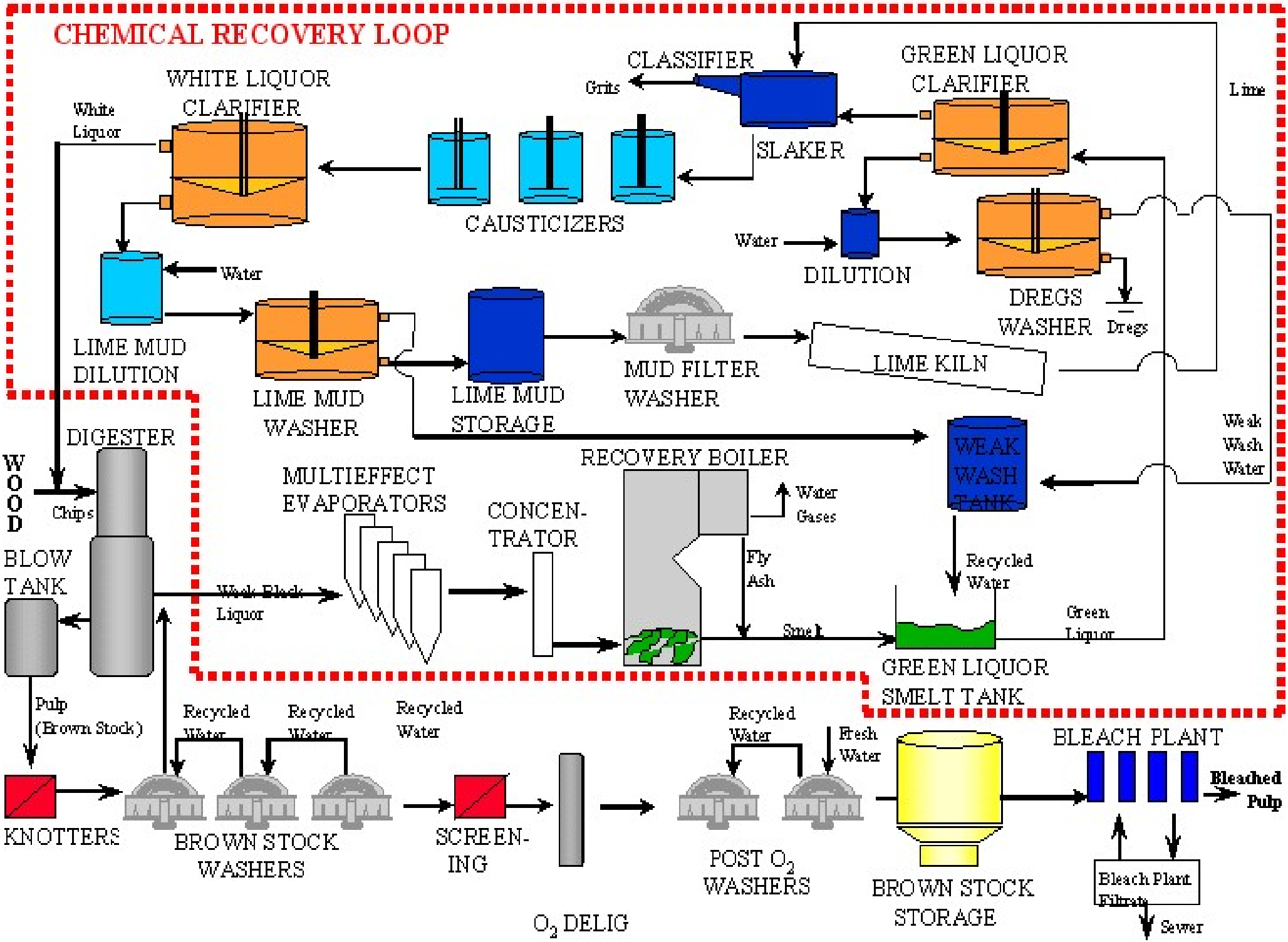
Sulphite Pulp Process

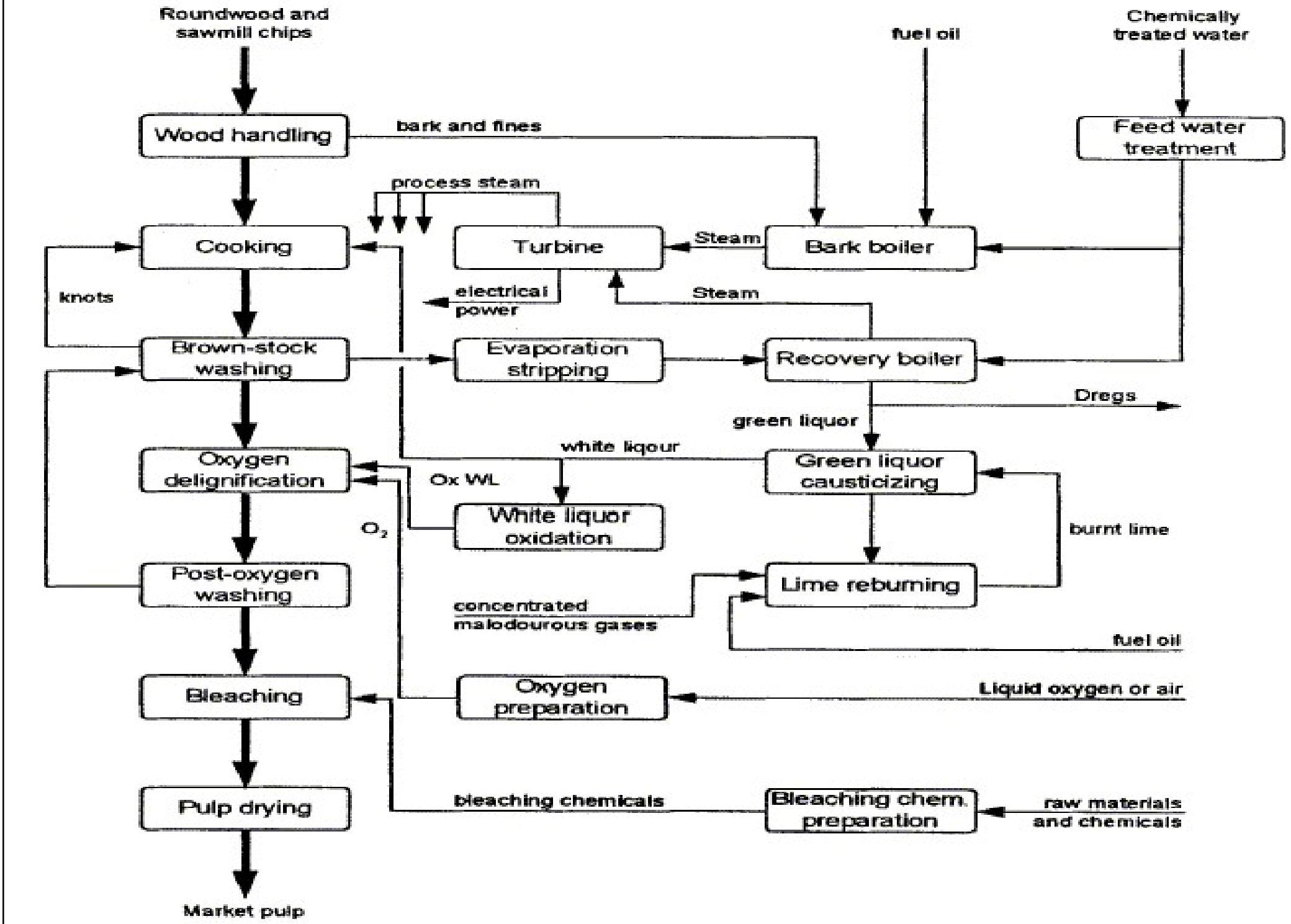


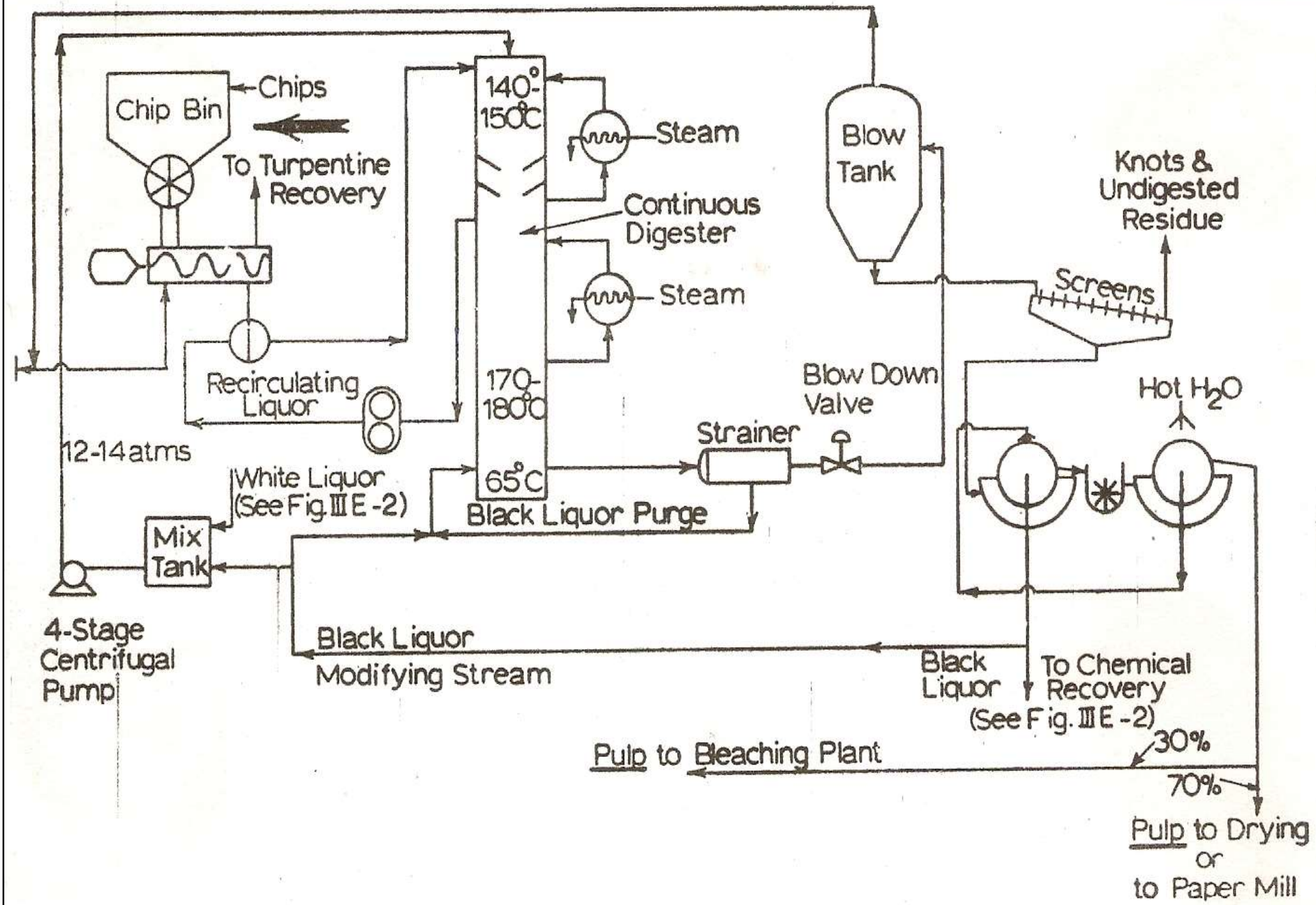
Sulphate Pulp Process



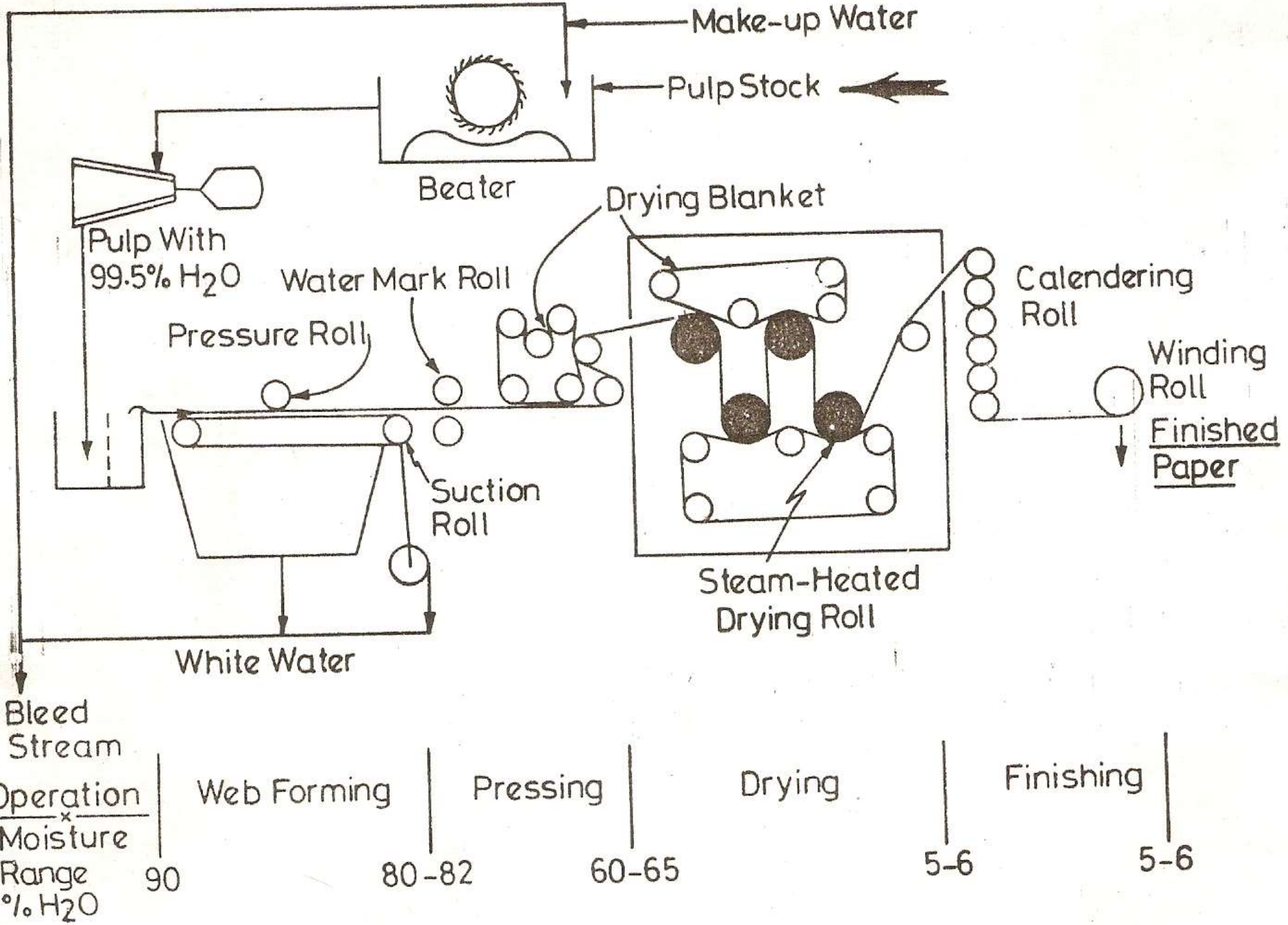
Chemical recovery from sulphate pulp – black liqour


CHEMICAL RECOVERY LOOP
CLASSIFIER
Grits
GREEN LIQUOR CLARIFIER
Lime
WHITE LIQUOR CLARIFIER
White Liquor
SLAKER
CAUSTICIZERS
Water
DILUTION
DREGS WASHER
Dregs
Water
LIME MUD DILUTION
LIME MUD WASHER
LIME MUD STORAGE
MUD FILTER WASHER
LIME KILN
DIGESTER
WOOD
Chips
BLOW TANK
MULTIEFFECT EVAPORATORS
CONCEN-TRATOR
RECOVERY BOILER
Water
Gases
Fly Ash
Smelt
WEAK WASH TANK
Weak Wash Water
Recycled Water
Green Liquor
GREEN LIQUOR SMELT TANK
Weak Black Liquor
Pulp (Brown Stock)
Recycled Water
Recycled Water
Recycled Water
KNOTTERS
BROWN STOCK WASHERS
SCREEN-ING
O2 DELIG
Recycled Water
Fresh Water
POST O2 WASHERS
BROWN STOCK STORAGE
BLEACH PLANT
Bleached Pulp
Bleach Plant Filtrate
Sewer

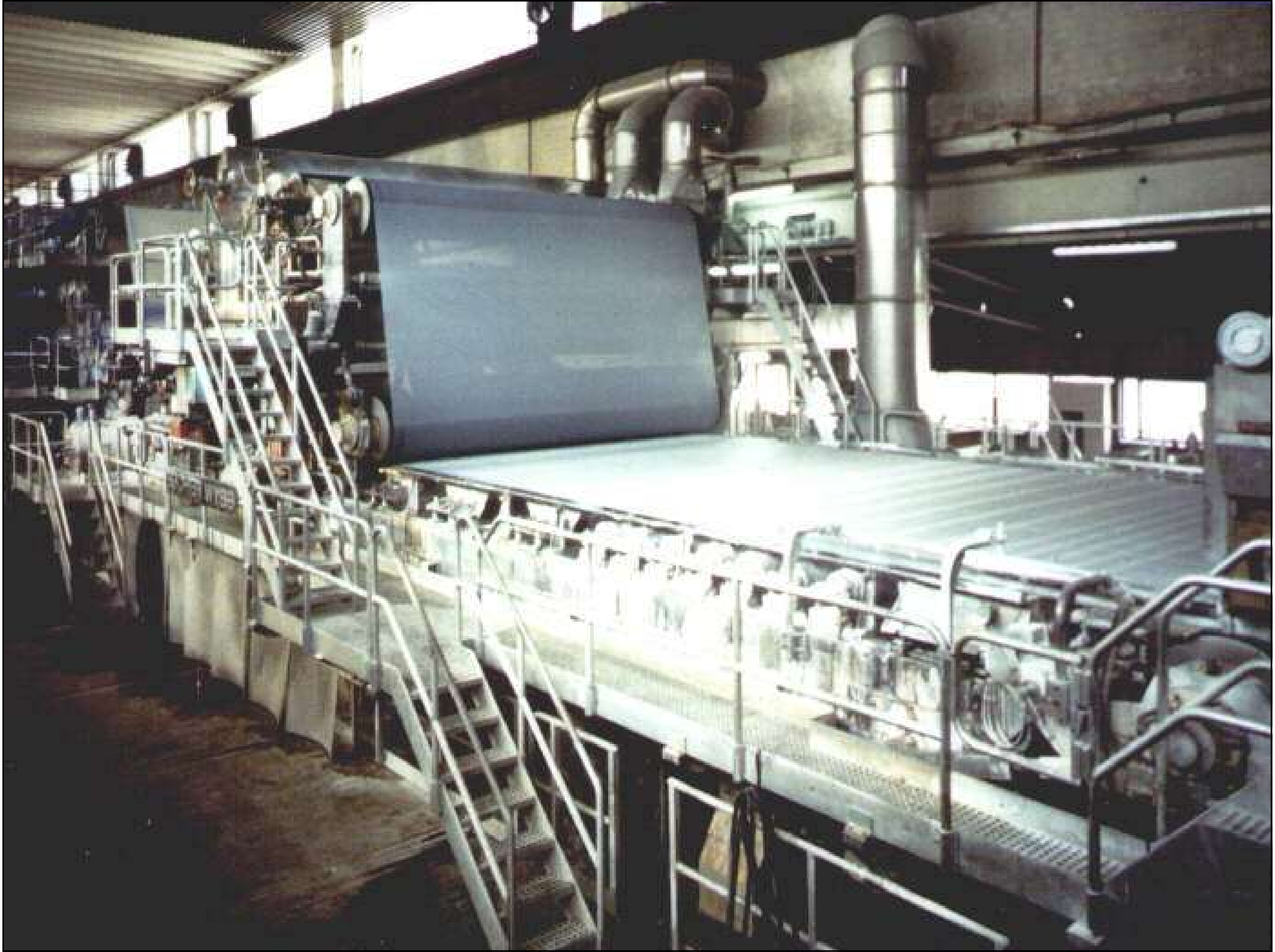

Roundwood and sawmill chips
fuel oil
Chemically treated water
Wood handling
bark and fines
Feed water treatment
process steam
Cooking
Turbine
Steam
Bark boiler
knots
electrical power
Steam
Brown-stock washing
Evaporation stripping
Recovery boiler
Dregs
green liquor
white liqour
Oxygen delignification
Ox WL
Green liquor causticizing
White liquor oxidation
O_2
burnt lime
Post-oxygen washing
Lime reburning
concentrated malodourous gases
fuel oil
Bleaching
Oxygen preparation
Liquid oxygen or air
Pulp drying
bleaching chemicals
Bleaching chem. preparation
raw materials and chemicals
Market pulp



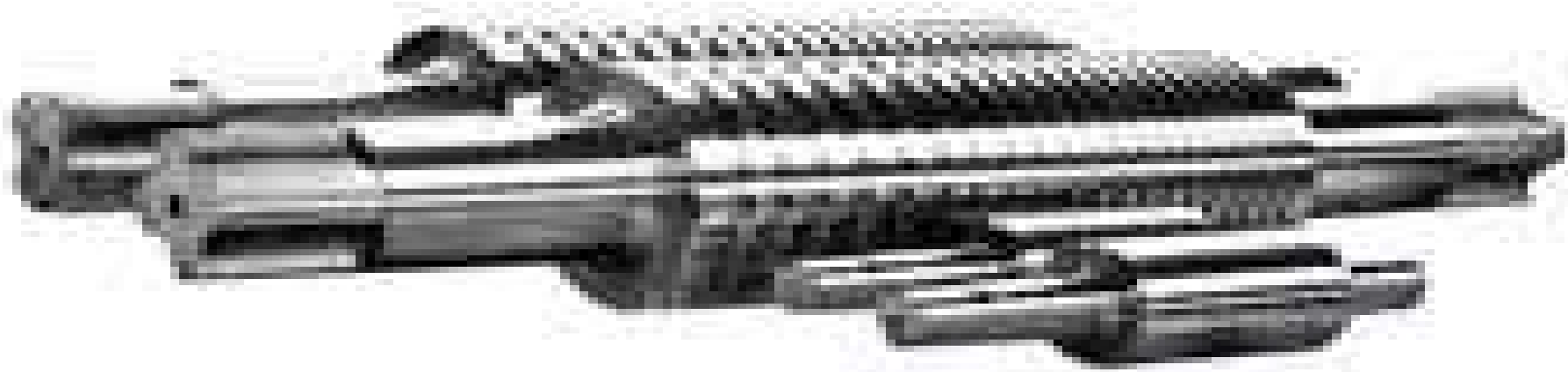
Preparation of wood pulp by sulfate process.

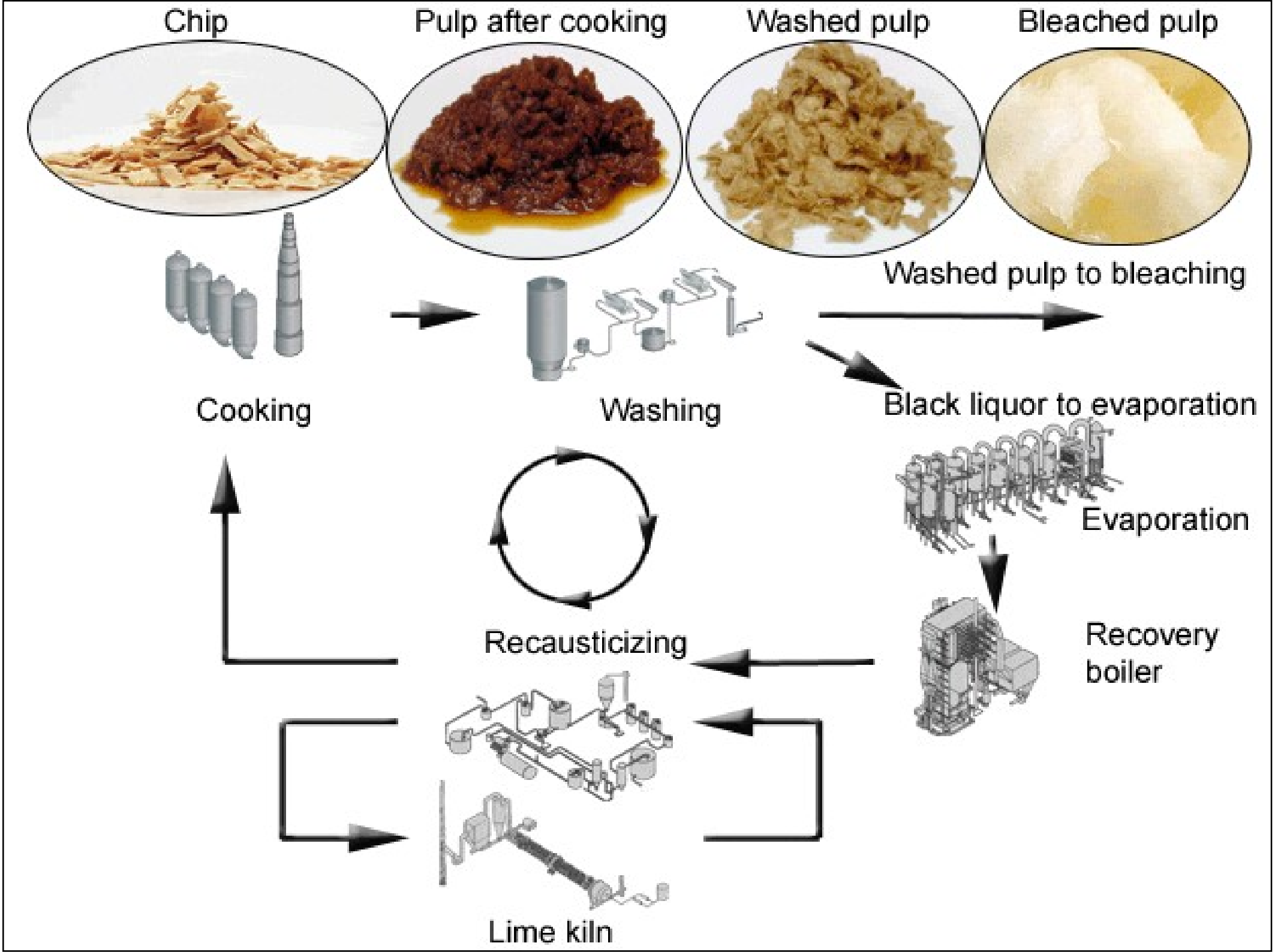


Schematic drawing of a paper making process.



Drying Cylinder




Chip
Pulp after cooking
Washed pulp
Bleached pulp
Washed pulp to bleaching
Cooking
Washing
Black liquor to evaporation
Evaporation
Recausticizing
Recovery boiler
Lime kiln