



Level



Pressure



Flow



Temperature



Liquid  
Analysis



Registration



Systems  
Components



Services



Solutions

# Chemical Pulping

## Overviews of processes



Level



Pressure



Flow



Temperature



Liquid  
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Registration



Systems  
Components

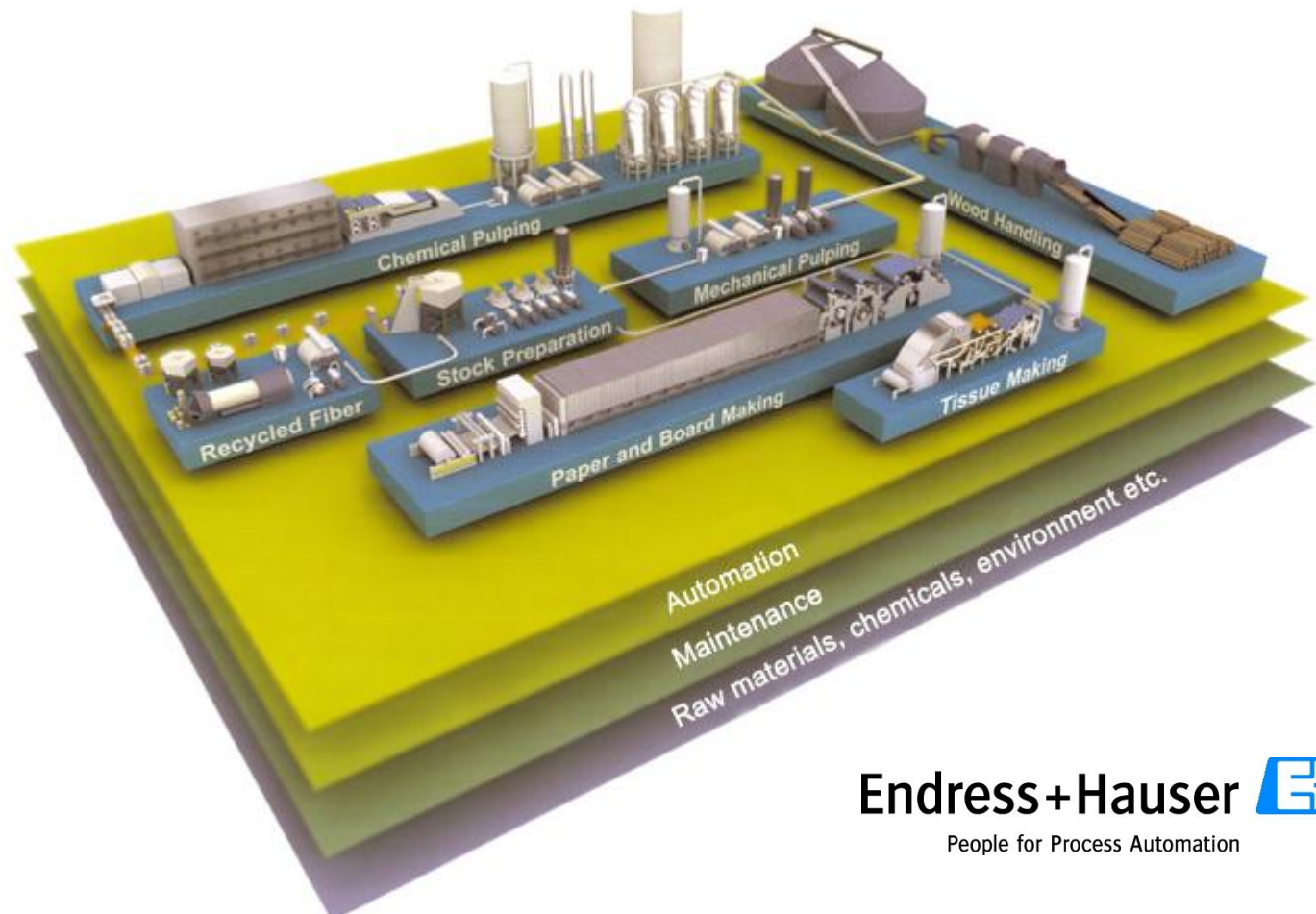


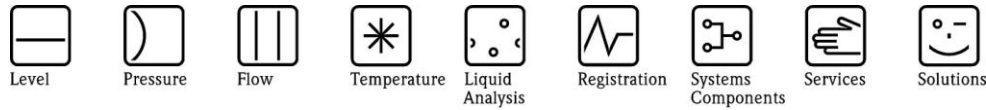
Services



Solutions

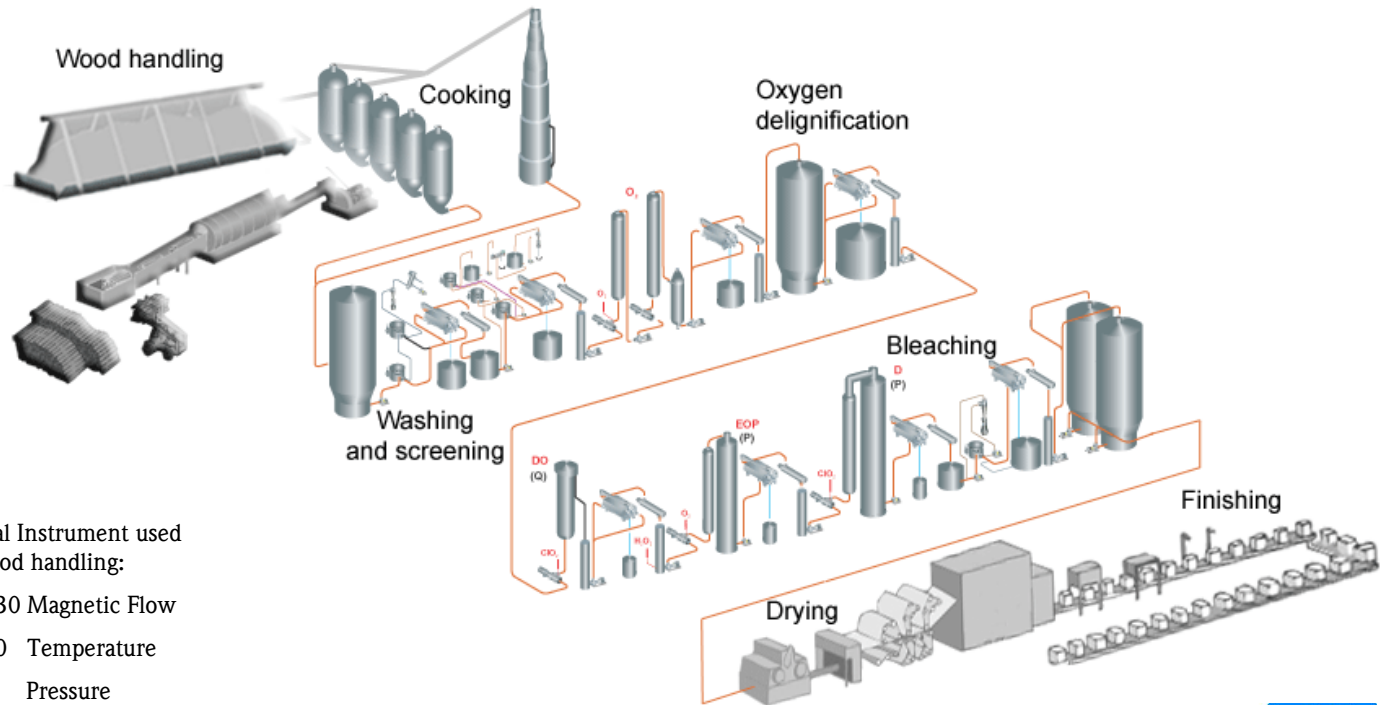
# Chemical Pulping (Kraft Mill)





# Chemical Pulping (Kraft Mill)

## Wood Handling

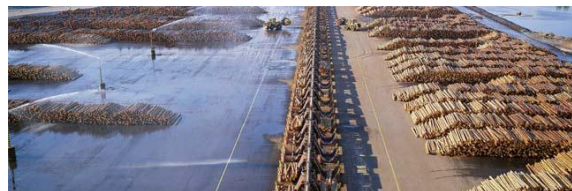
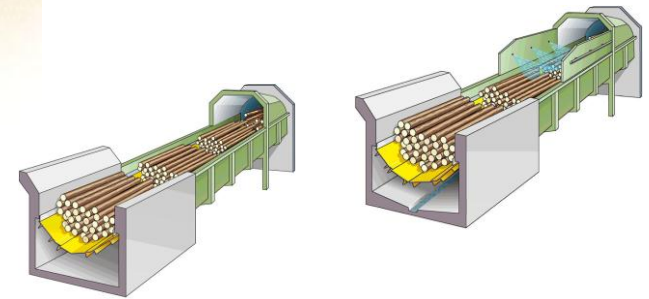
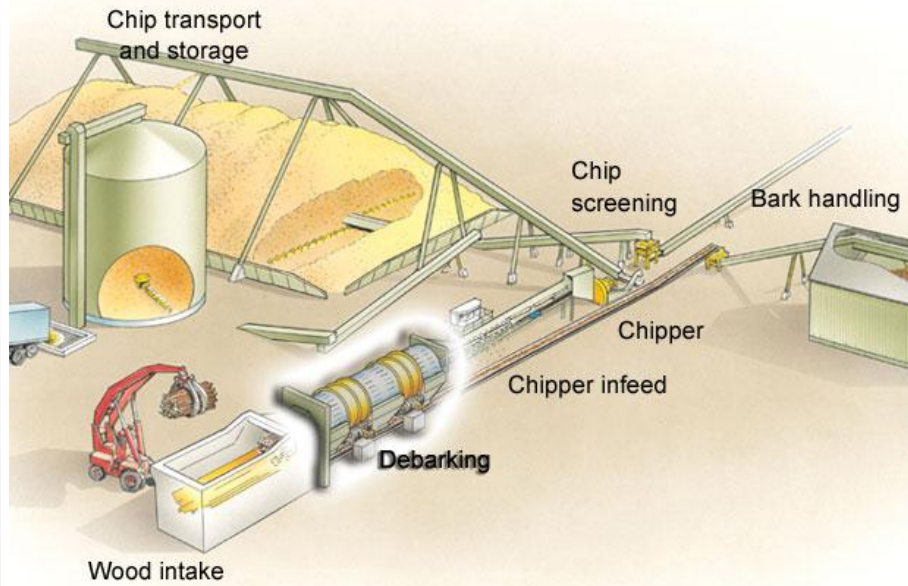


Typical Instrument used in Wood handling:

- 20-30 Magnetic Flow
- 5-10 Temperature
- 10 Pressure
- 4-6 Gamma
- 2-3 pH
- 5-10 Level



# Wood intake and storage



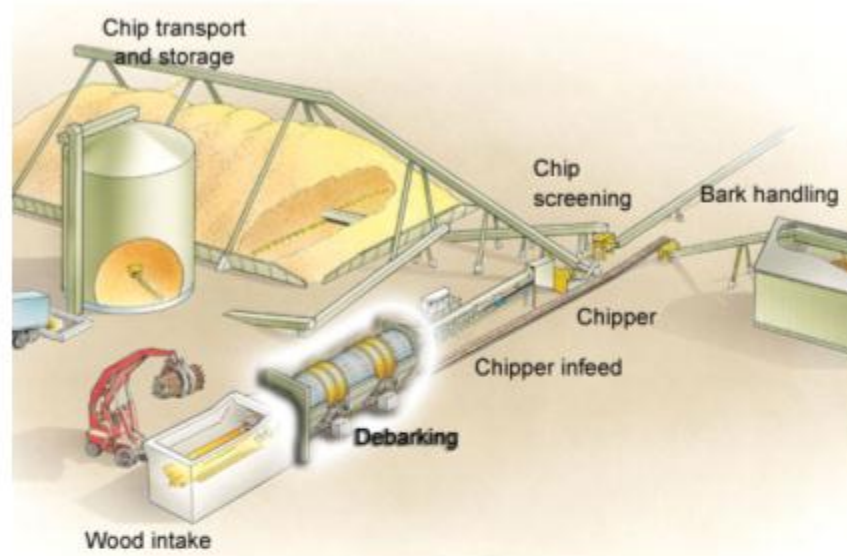


# De-icing



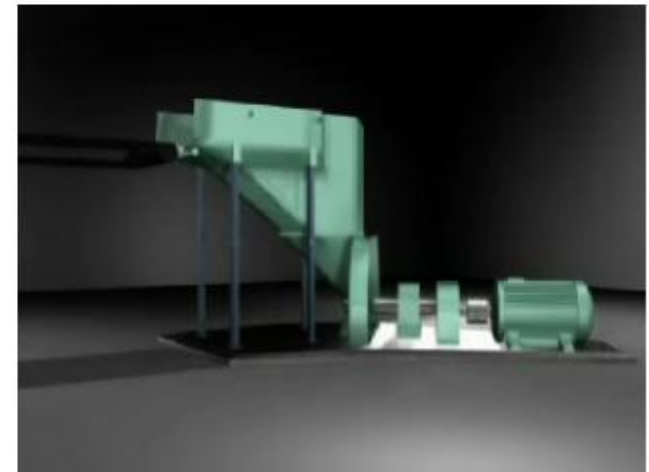
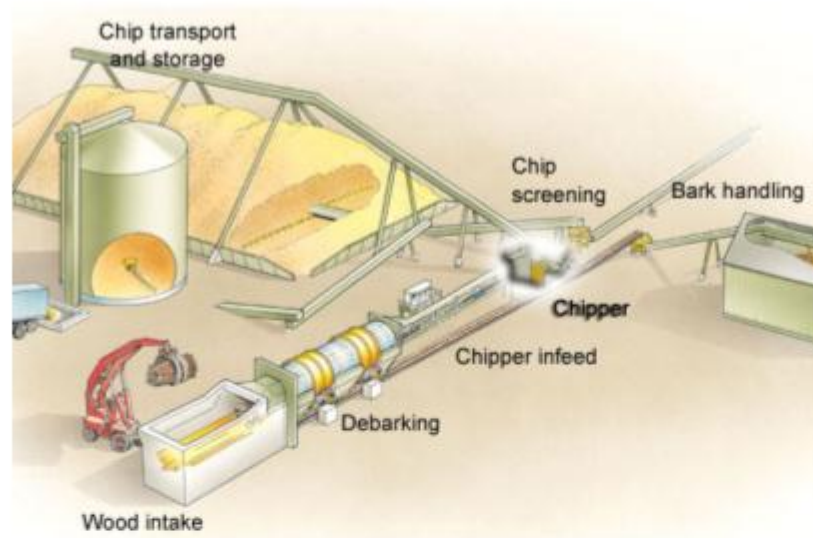


# Debarking



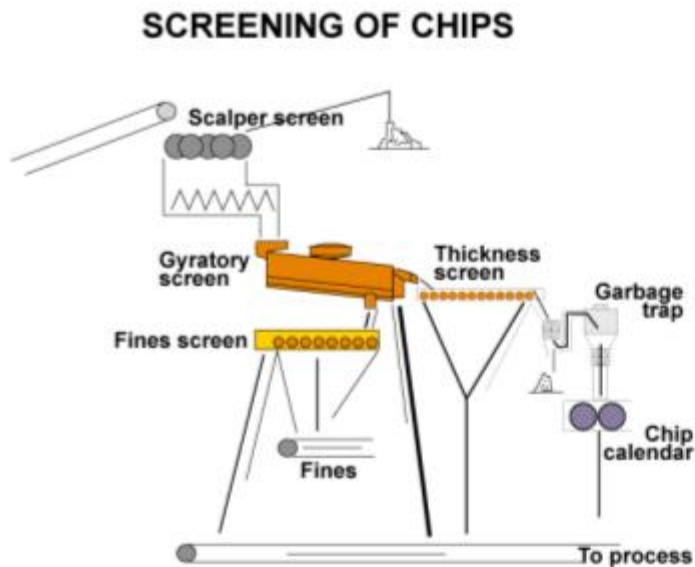


# Chipping





# Chip screening and storing







# Level: Chip screens

SCA Östrand Pulp Mill Sweden

Wood handling



## Ultrasonic Measurement

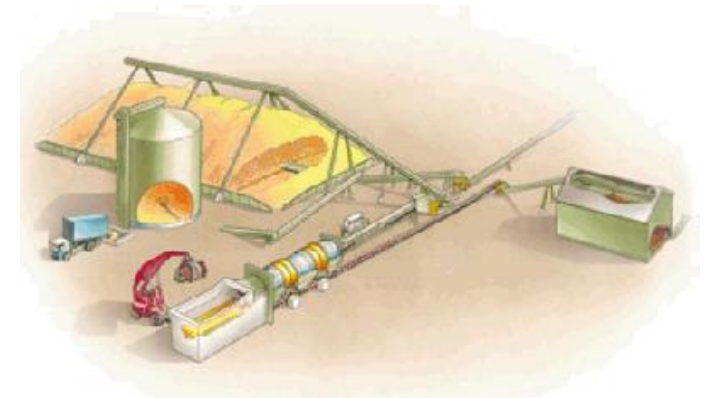
**Type:** Prosonic M FMU 40  
**Media:** Wood Chips  
**Temp:** Ambient  
**Pressure:** Atmospheric

### Other info:

On short distances it is always an advantage to use smaller models of ultrasonic with a millimetre resolution, small dead band and fast response time.

SCA Östrand wanted to control the chip screens in a more stable way.

Tests was arranged, and the result out of these tests was so good, that all their measurements today are done with the FMU40.



# Level: Pre-steam Chip Chute

Iggesund Paperboard AB Sweden

Wood handling



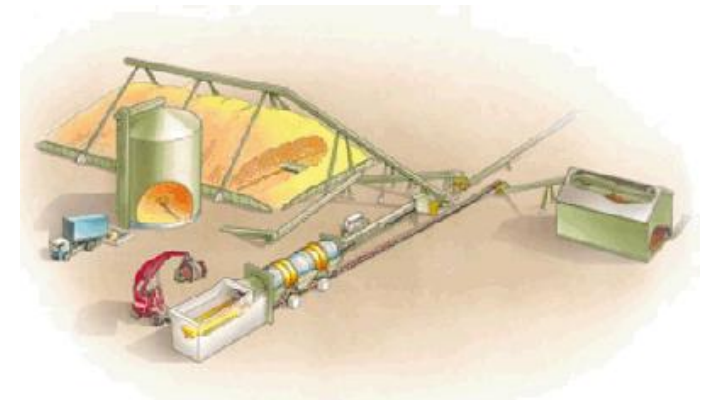
## Ultrasonic Measurement

**Type:** Prosonic FDU86  
**Media:** Wood Chips  
**Temp:** +10...80 C  
**Pressure:** Atmospheric

### Other info:

The chips are normally pre steamed, but it is possible that they are more or less dry. Radar equipment are very often losing the signal in applications such as this one.

Iggesund was looking for a complement to radiometric measurement that was used as a high alarm in the chip chute. FDU86 measures since December 2002 the whole chutes range of 10 meter and this makes it possible to have a more stable flow of the wood chips.





# Level: Pre steaming bin

SCA Östrand Sweden

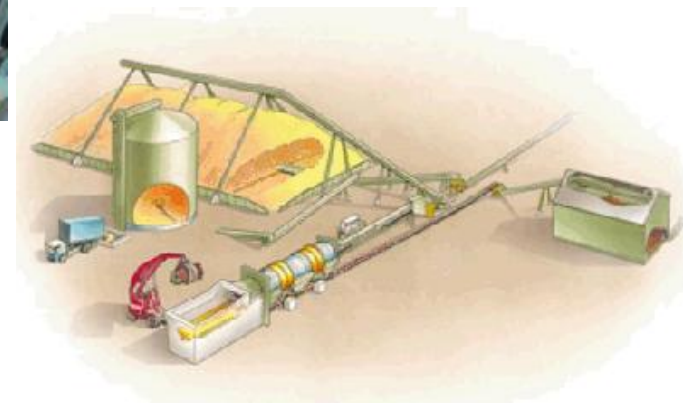
Wood handling



## Ultrasonic level measurement

Type: FDU86  
Media: Wood Chips  
Temp: +110c  
Pressure:

Increased range compared to gamma measurement.



# Level: Stock pile

Abitibi Consolidated Newsprint , PQ Canada

Wood handling



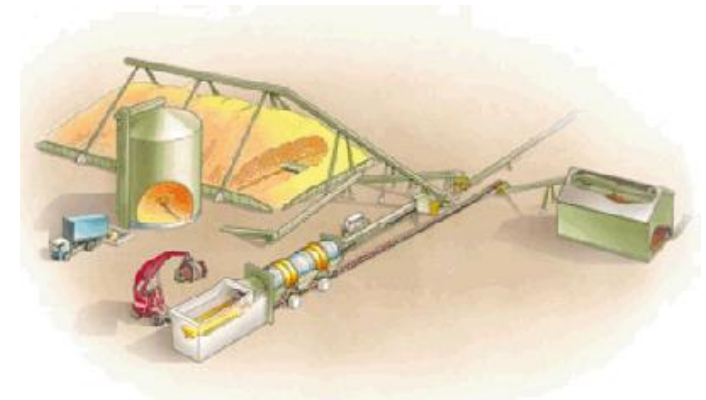
## Ultrasonic Measurement

**Type:** Prosonic FDU86  
**Media:** Wood Chips  
**Temp:** Ambient  
**Pressure:** Atmospheric

### Other info:

Ultrasonic measurements gives a secure measurement when the Wood chips are dry. Avoid to use a radar in these applications since the low DC factor gives a high uncertainty.

Our strongest ultrasonic device FDU86 with 11KHz pulses measures all the way down to the ground. By using the strong signals generated we are always getting a good signal back, even when the piles looks like in the above picture.



# Level: Pre steaming bin

Billerud Karlsborg

Wood Handling

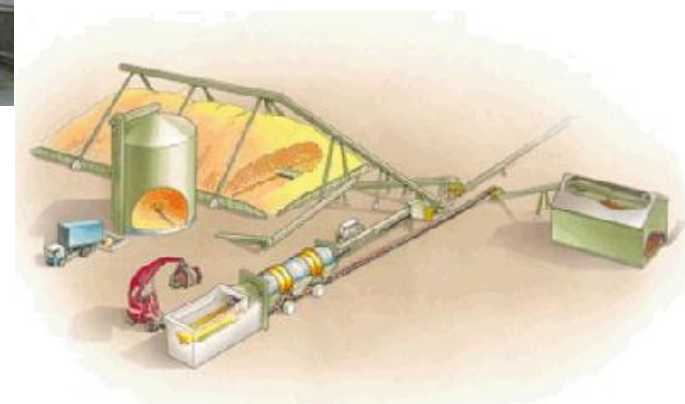


Easy mounting from top with contact free measurement to minimize maintenance.



## Ultrasonic level measurement

Type: FDU86  
Media: Woodchips  
Temp:  
Pressure:





# Level: Bark storage silos

Stora Enso Fors

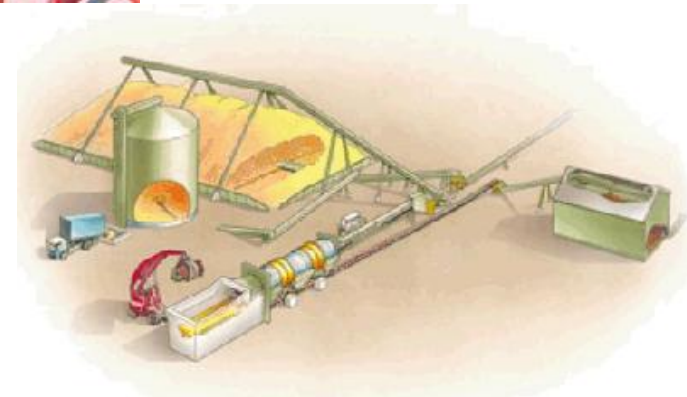
Wood Handling

## Ultrasonic level measurement

Type:	FDU84
Media:	Bark
Temp:	Ambient



Level measurement at the energy plant were the mill use the waste bark for the furnace. The environment inside the silo are generally dusty due to continuous filling but the signal processing of the Prosonic copes with this and keep track of the real level.



# Level: Lateral movement in Chip silo

Lasarre, PQ Canada

Wood handling



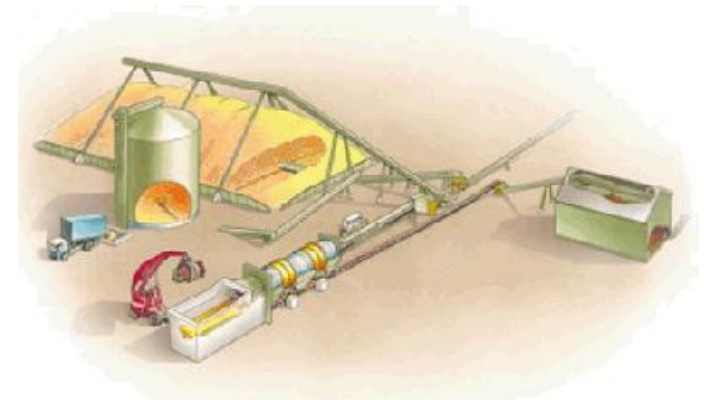
## Ultrasonic Measurement

**Type:** Prosonic FDU86  
**Media:** Wood Chips  
**Temp:** Ambient  
**Pressure:** Atmospheric

### Other info:

The chips are dry, with very low DC.  
Radar based equipment are very often failing in these applications.

The FDU86 ultrasonic device gives a solid and correct signal in this application, despite the heavy dust occurring inside of the silo.





# Level in Chip silo

Wood handling



## Radiometric Measurement

The level of a chip silo with a capacity of 150 m<sup>3</sup> is monitored by a radiometric measuring point. Pneumatic filling causes swirling of an intensity prohibiting the use of conventional level measurement methods like ultrasonic transmitters. Weighing is also excluded because of the varying moisture content of the chips. Radiometric measurement offers a reliable solution.

**Type: Gamma**

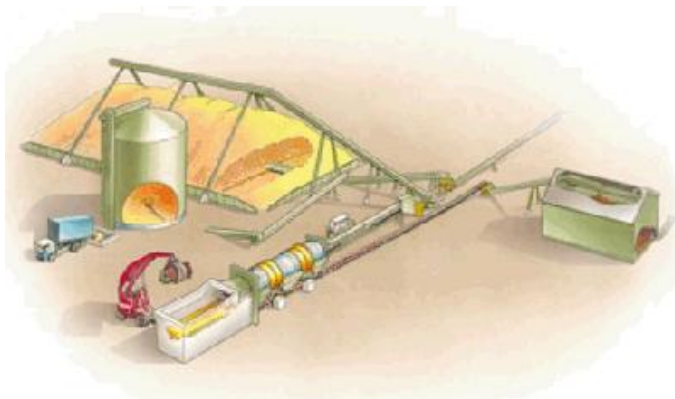
**Media: Wood Chips**

**Temp: Ambient**

**Pressure: Atmospheric**

## Advantages of radiometric measurement:

- Measurement not effected by swirling of the medium
- Measurement not effected of the varying moisture content of the chips





# Level: Wood chips cyclone

Billerud Karlsborg

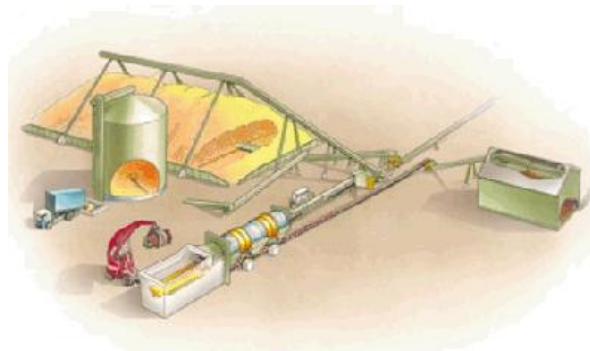
Wood Handling



## Radiometric level measurement

Type: DG17  
Media: wood chips  
Temp:  
Pressure:

Safe and reliable level control  
with source and detector mounted from  
outside of vessel





Level



Pressure



Flow



Temperature



Liquid  
Analysis



Registration



Systems  
Components



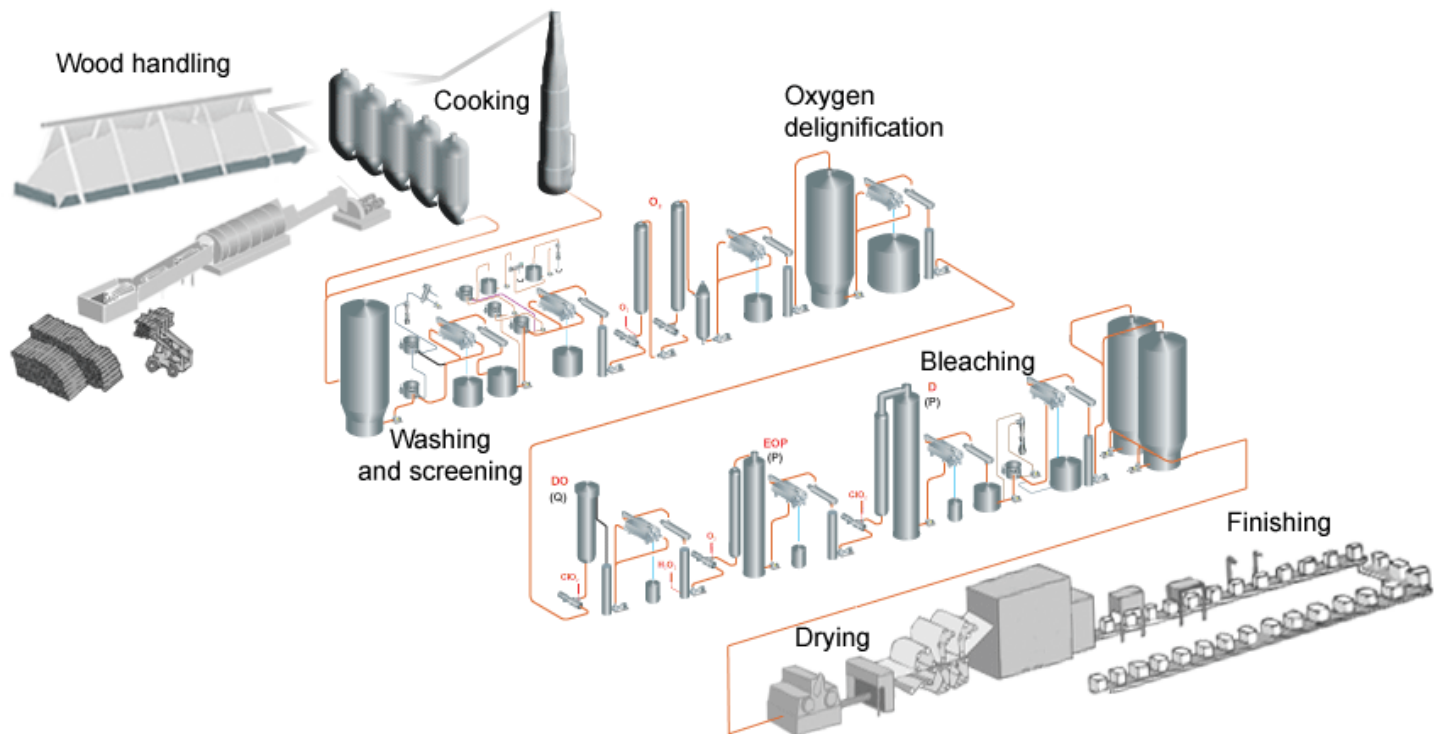
Services



Solutions

# Chemical Pulping (Kraft Mill)

## Cooking

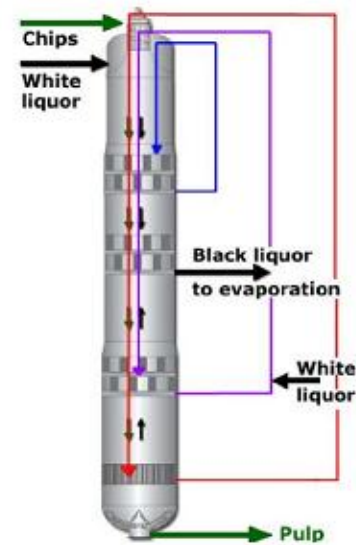
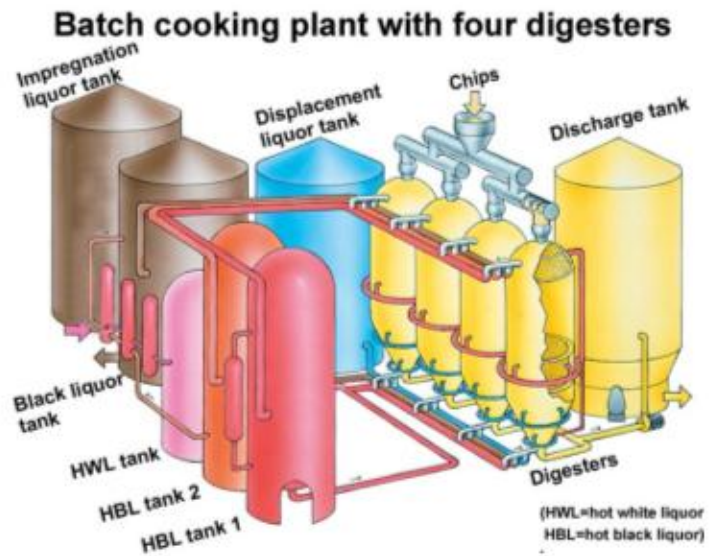
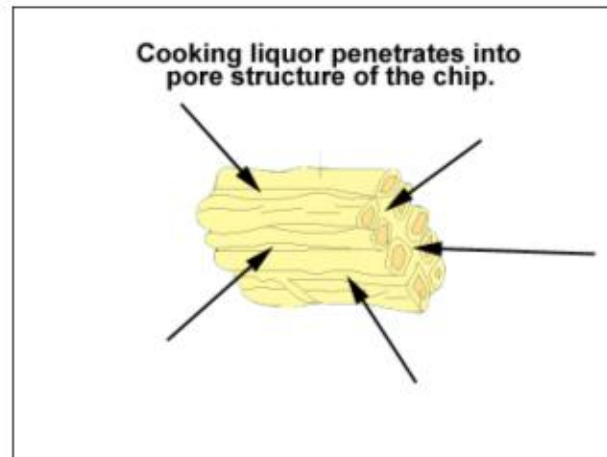
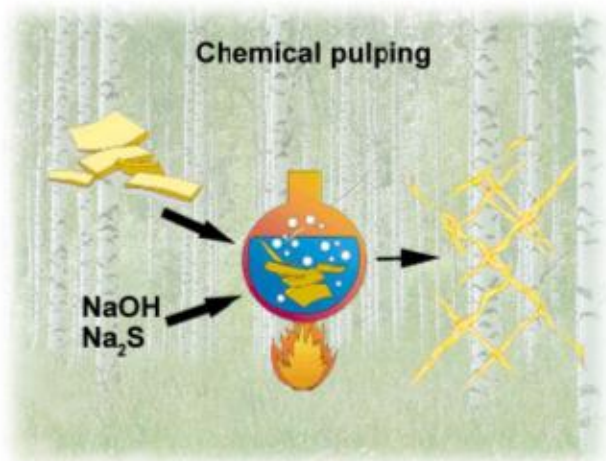


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# Sulfate pulping processes



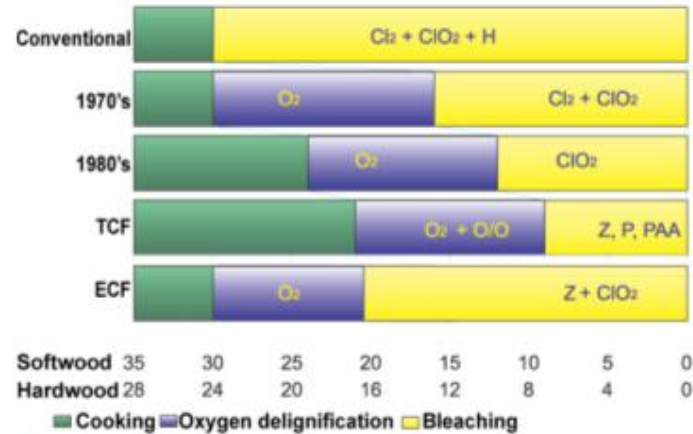
## Operating principle of continuous digester

- Chips flow downwards in a digester (green arrows) and liquor either downwards or upwards depending the zone (black arrows).
- Liquor is extracted at the screen zones, heated using indirect steam, added some alkali (if necessary) and pumped back to digester along the center tube. Part of the liquor is extracted to evaporation.
- Pulp comes out at the bottom of the digester. Consistency is about 10%. Pulp is being fibrated at this stage.

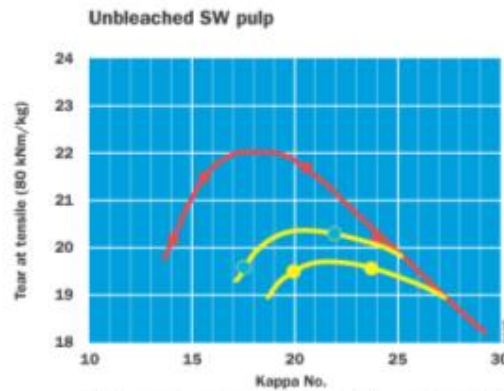
# Kappa number



## Changes in delignification

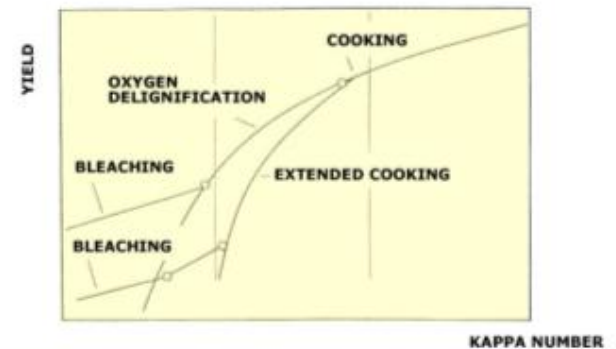


## An example of kappa number influence on tear strength



- Different colors mean differences between cooking methods

## Yield using different lignin removal methods



- There can be large process-specific differences in yields, for example between different cooking methods

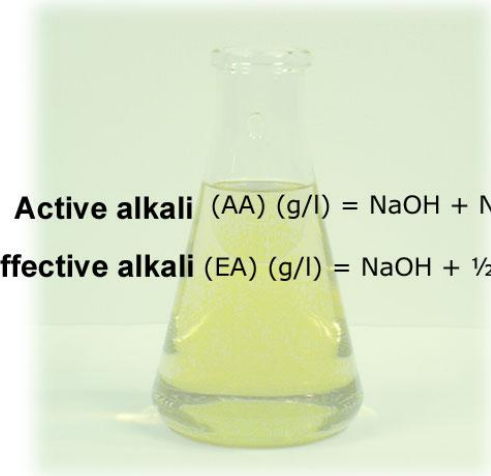
# Cooking chemicals – White liquor

## Typical white liquor analysis



Chemical	Quantity [g/kg dry matter]
Sodium (Na)	78,0
K	14,1
S <sub>tot</sub>	22,4
Cl <sub>tot</sub>	1,7
S <sup>2-</sup>	18,0
NaOH	88,2
Na <sub>2</sub> S	41,8
Na <sub>2</sub> CO <sub>3</sub>	40,3
Na <sub>2</sub> SO <sub>3</sub>	0,1
Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub>	8,99
Na <sub>2</sub> SO <sub>4</sub>	0,5

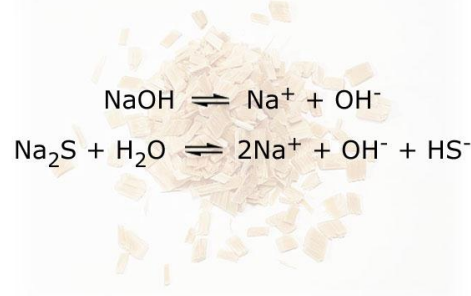
Total alkali, g NaOH/l 161,6  
 Active alkali, g NaOH/l 131,2  
 Effective alkali, g NaOH/l 109,8



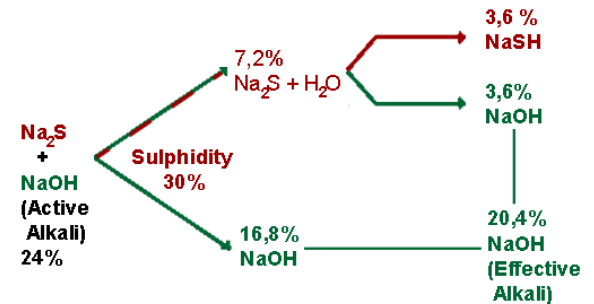
**Active alkali (AA) (g/l) = NaOH + Na<sub>2</sub>S**

**Effective alkali (EA) (g/l) = NaOH + 1/2 Na<sub>2</sub>S**

## Sodium hydroxide and sulfide reactions in cooking liquor



## An example of active and effective alkali dependence



# Cooking chemicals – Black liquor

## Birch black liquor composition (an example, can vary a lot)

Organic compounds (original in paranthesis) Include bonded Na and S	Per cent of dry solids (%)
	<b>Total 78%</b>
Lignin	37,5
Saccharine acids (hemicelluloses)	22,6
Aliphatic acids (lignin, carbohydrates)	14,4
Fat and resinous acids (extractives)	0,5
Polysaccharides (cellulose and hemicelluloses)	3,0
<hr/>	
Inorganic compounds	Total 22%
NaOH	2,4
NaHS	3,6
Na <sub>2</sub> CO <sub>3</sub> ja K <sub>2</sub> CO <sub>3</sub>	9,2
Na <sub>2</sub> SO <sub>4</sub>	4,8
Na <sub>2</sub> S <sub>2</sub> O ja Na <sub>2</sub> S	0,5
NaCl	0,5
Others (Si, Ca, Mn, Mg, jne.)	0,2

## Typical black liquor analysis



Agent	Content (g/kg dry solid)
Na	19.3
K	3.34
S <sub>tot</sub>	5.50
Cl <sub>tot</sub>	0.41
S <sup>2-</sup>	1.93
NaOH	1.1
CO <sub>3</sub> <sup>2-</sup>	6.2
Na <sub>2</sub> SO <sub>3</sub>	0.1
Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub>	2.13
Na <sub>2</sub> SO <sub>4</sub>	1.23
C	31.9
H	3.33
N	0.08

Calorimetric heat value, HHV 12.74  
(MJ/kg dry solids)

## An example of alkali strength calculation

A liter of white liquor contains for instance 90 g NaOH and 40 g Na<sub>2</sub>S.

In 90 grams of NaOH there is 51,7 grams sodium (Na) and in 40 grams of Na<sub>2</sub>S there is 23,5 grams of Na. Thus Na content is totally 75,2 grams.

The same quantity of sodium is in 130,9 grams of NaOH or in 101,4 grams of Na<sub>2</sub>O. Therefore, liquor concentration (as active alkali) is 130,9 g/l as NaOH and 101,4 g/l as Na<sub>2</sub>O.

Cooking chemicals calculation either as NaOH or Na<sub>2</sub>O is based on their sodium concentrations.

**Easies way to calculate is based on atomic weights.  
Atomic weights (about):**

- NaOH: 40 g/mol
- Na<sub>2</sub>S: 78 g/mol
- Na<sub>2</sub>O: 62 g/mol

(mol = 6,023\*10<sup>23</sup> units)

(Singe Na<sub>2</sub>S and Na<sub>2</sub>O molecule contains twice the sodium amount than NaOH => must be taken into account in calculations)

Calculation as Na<sub>2</sub>O is an older method but still in use.

# Recovered chemicals – Green liquor

## Typical analysis of green liquor



Substance	Quantity [g/kg dry matter]
Sodium (Na)	90,8
K	14,5
S <sub>tot</sub>	24,1
Cl <sub>tot</sub>	1,9
S <sup>2-</sup>	19,1
NaOH	18,8
Na <sub>2</sub> S	42,7
Na <sub>2</sub> CO <sub>3</sub>	134,9
Na <sub>2</sub> SO <sub>3</sub>	1,41
Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub>	7,08
Na <sub>2</sub> SO <sub>4</sub>	8,7

Total alkali, g NaOH/l	165,2
Active alkali, g NaOH/l	62,7
Effective alkali, g NaOH/l	40,7

$$\text{Sulfidity (S) (\%)} = \frac{\text{Na}_2\text{S}}{(\text{NaOH} + \text{Na}_2\text{S})} * 100$$

(Calculation as corresponding quantities of NaOH or Na<sub>2</sub>O. For instance, as NaOH: first will be calculated the quantity of Na<sub>2</sub>S as NaOH and then placed to formula.)

$$\text{Reduction efficiency (\%)} = \frac{\text{Na}_2\text{S}}{(\text{Na}_2\text{S} + \text{Na}_2\text{SO}_4)} * 100\%$$

(Calculation as corresponding quantities of NaOH or Na<sub>2</sub>O. For instance, as NaOH: first will be calculated the quantity of Na<sub>2</sub>S and Na<sub>2</sub>SO<sub>4</sub> as NaOH and then placed to formula.)

$$\text{Causticizing efficiency (\%)} = \frac{\text{NaOH}}{(\text{NaOH} + \text{Na}_2\text{CO}_3)} * 100\%$$

(Calculation as corresponding quantities of NaOH or Na<sub>2</sub>O. For instance, as NaOH: first will be calculated the quantity of Na<sub>2</sub>CO<sub>3</sub> as NaOH and then placed to formula.)



# Level: Digester Limit Detection

Celulosa Arauco Constitucion Chile

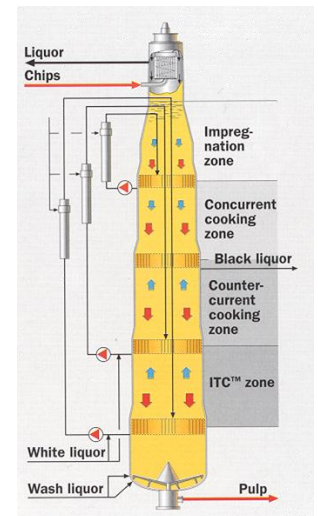
Cooking



## Radiometric Measurement

Type: DG17Z,FTG470Z,QG100  
source CO60  
Media: Wood Chips  
Temp: +140-160C  
Pressure:

Other info: Radioactive Switches independent from product, and process temperature and pressure



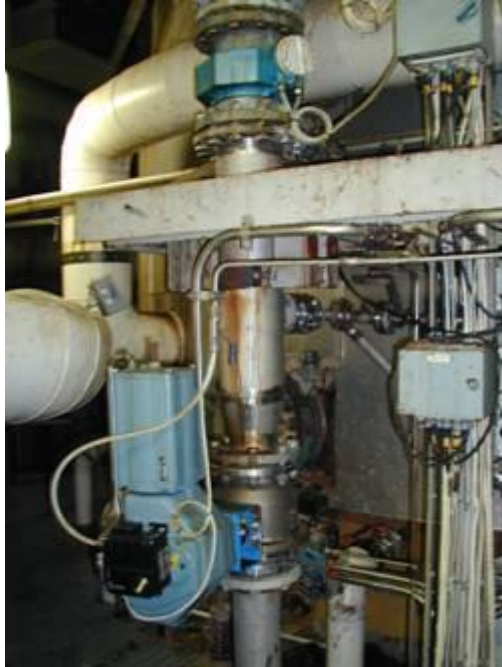




# Flow: Blowline after continuous digester

M-Real Husum Sweden

Cooking



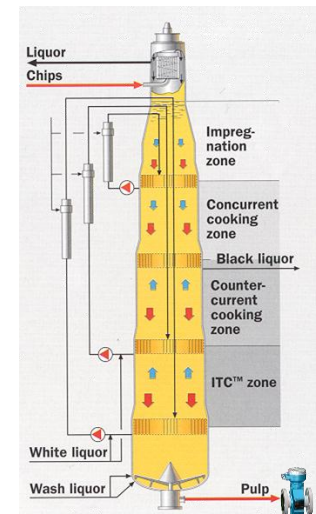
## Inductive Flow measurement

Type: Promag  
Media: Pulp 10 % consistency  
Temp: +95C  
Pressure: <1bar

**Other info:** Vacuum resistant reinforced PFA takes away the needs of exchanging magmeters due to collapsed or temperature damaged liner

During parallel testing under 2003, the traditional Teflon lined meters have to be changed 3 times. The PFA lined meter is totally unaffected at inspection.

**PFA resists vacuum at 0 bar abs / +180C**





# Flow: Black Liquor Extraction

Billerud Gruvöns Mill Sweden

Cooking



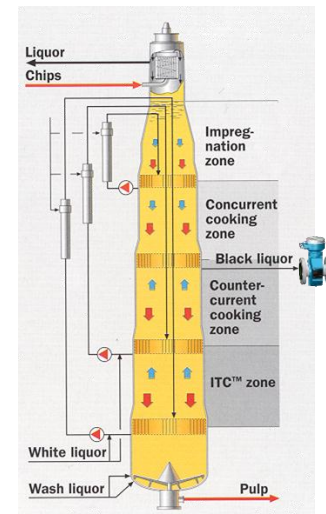
## Inductive Flow measurement

Type: Promag  
Media: Black Liquor  
Temp: 130-150 C  
Pressure: 6 bar

**Other info:** Vacuum resistant reinforced PFA takes away the needs of exchanging magmeters due to collapsed or temperature damaged liner

Gruvöns Mill was facing serious problems with the Teflon lined meters. After changing to reinforced PFA liner the problems where gone.

**PFA resists vacuum at  
0 bar abs / +180C**





# Flow: Pulp from Digester

VCP Jacarei, Brazil

Cooking



This application was a challenge to solve with a Promag 53. The Pulp consistency is approx. 7 % which normally demands Us to use a Promag 35S. The flow is also very turbulent.

**The measurement is working very well which also indicate that the problem to indicate the limits for the correct instrument to use is not easy to define.**

## Inductive Flow measurement

Type: Promag 53  
Media: Pulp  
Temp: 40 C  
Pressure: 6 bar

Other info:





# Level: High level switch in batch digesters

Billerud Karlsborg Sweden

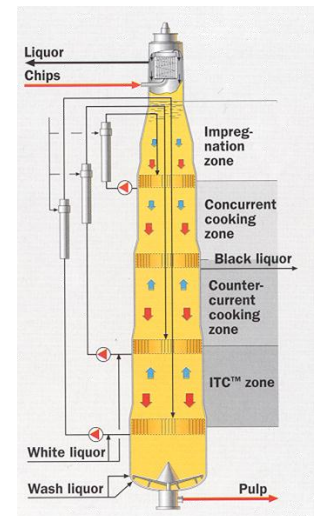
Cooking



## Radiometric level measurement

Type: DG17  
Media: Pulp  
Temp:  
Pressure:

Safe and reliable level control  
with source and detector mounted  
outside vessel.





# Level: Blowtank from Digester

M-Real Husum Sweden

Cooking



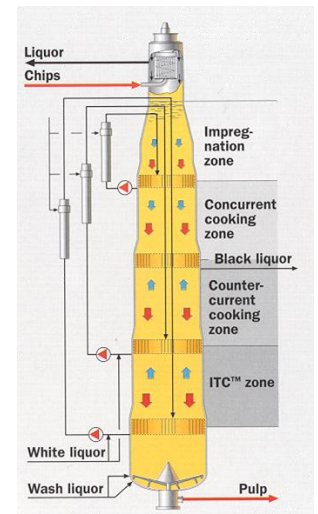
## Level Measurement

Type: Cerabar M PMC45 Media: Pulp  
 Temp: +100C  
 Pressure: Atmospheric

### Other info:

PMC45 with flush mounted  
 DN 80 flange and ceramic membrane.

Level measurement in the Blowtank after a Batch Digester.  
 The traditional metal membrane was very often damaged.  
 After changing to Ceramic membrane the problem was solved.





Level



Pressure



Flow



Temperature



Liquid Analysis



Registration



Systems Components



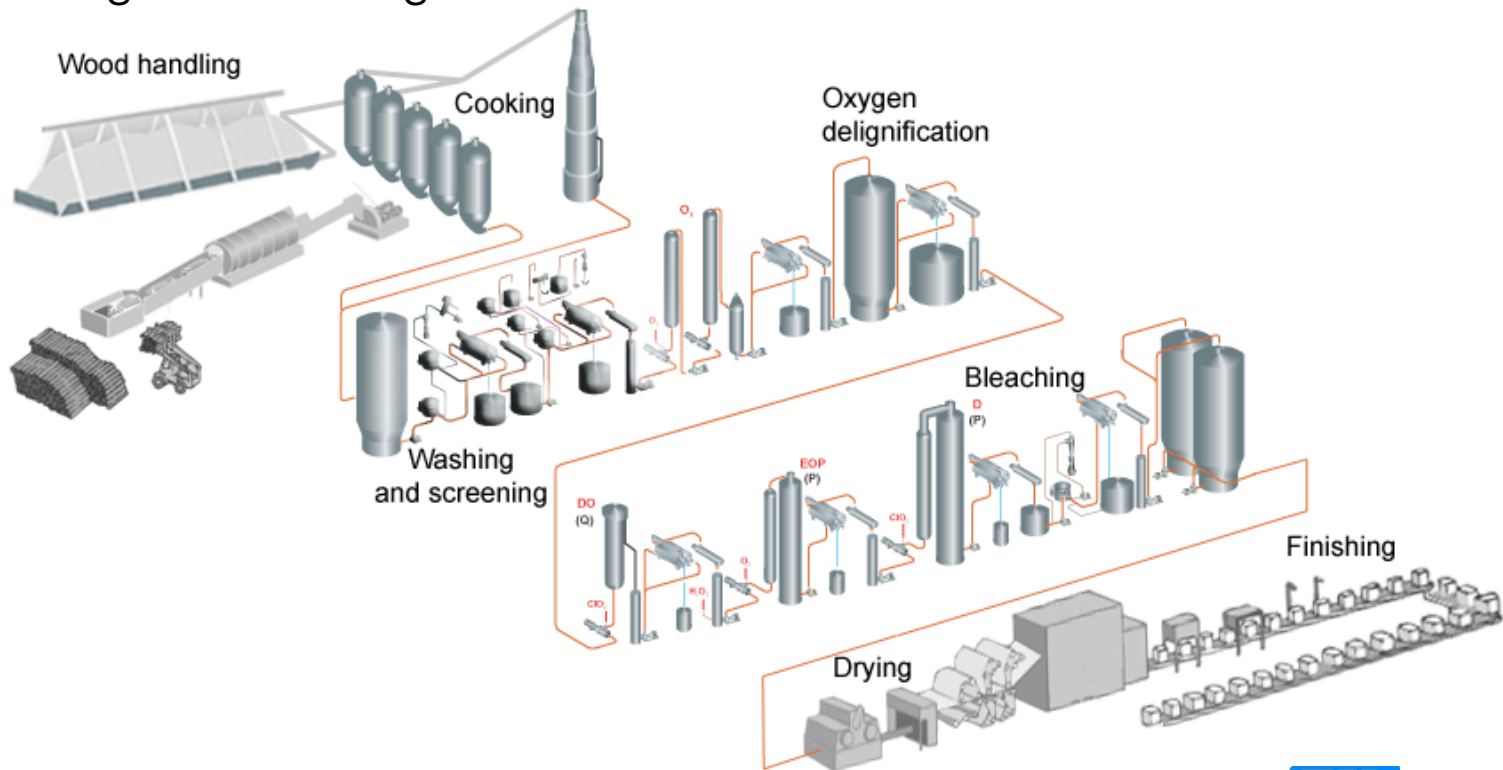
Services



Solutions

# Chemical Pulping (Kraft Mill)

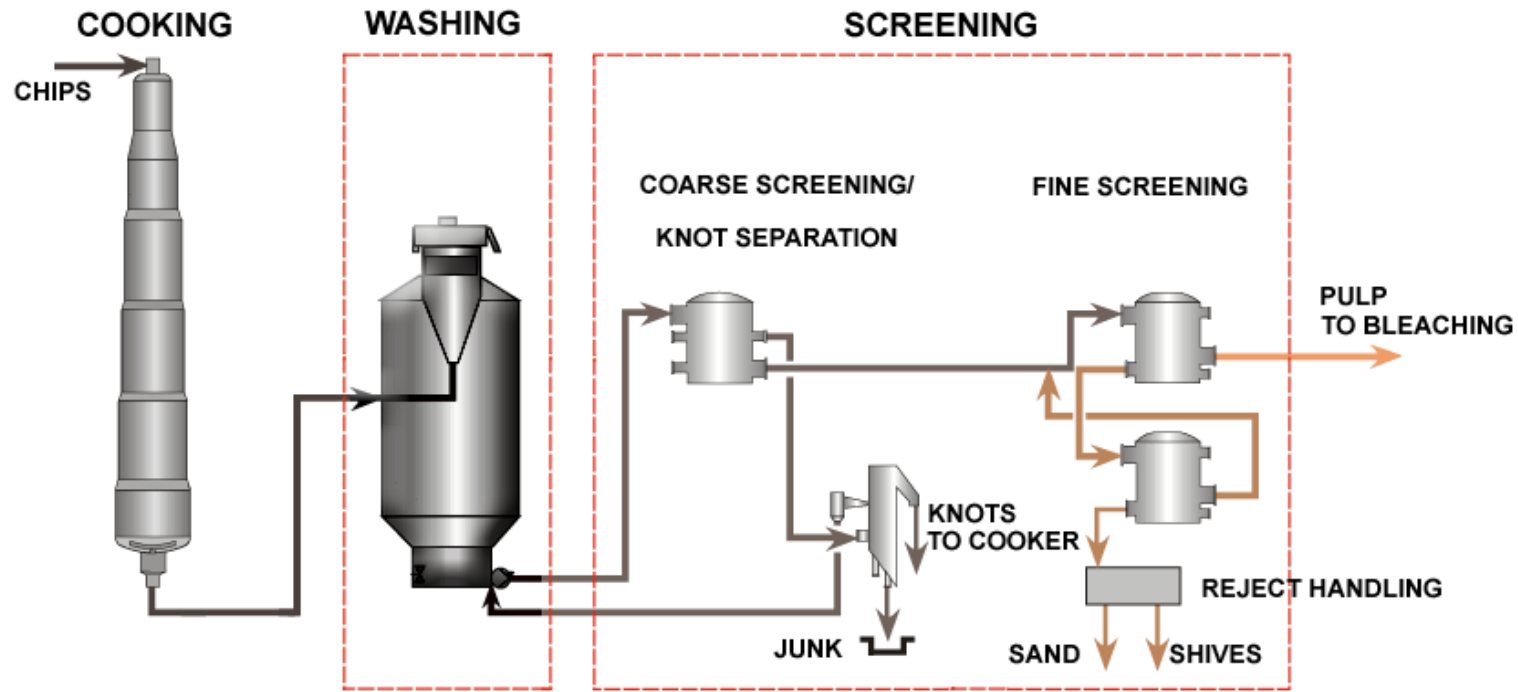
## Washing and Screening



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# Washing

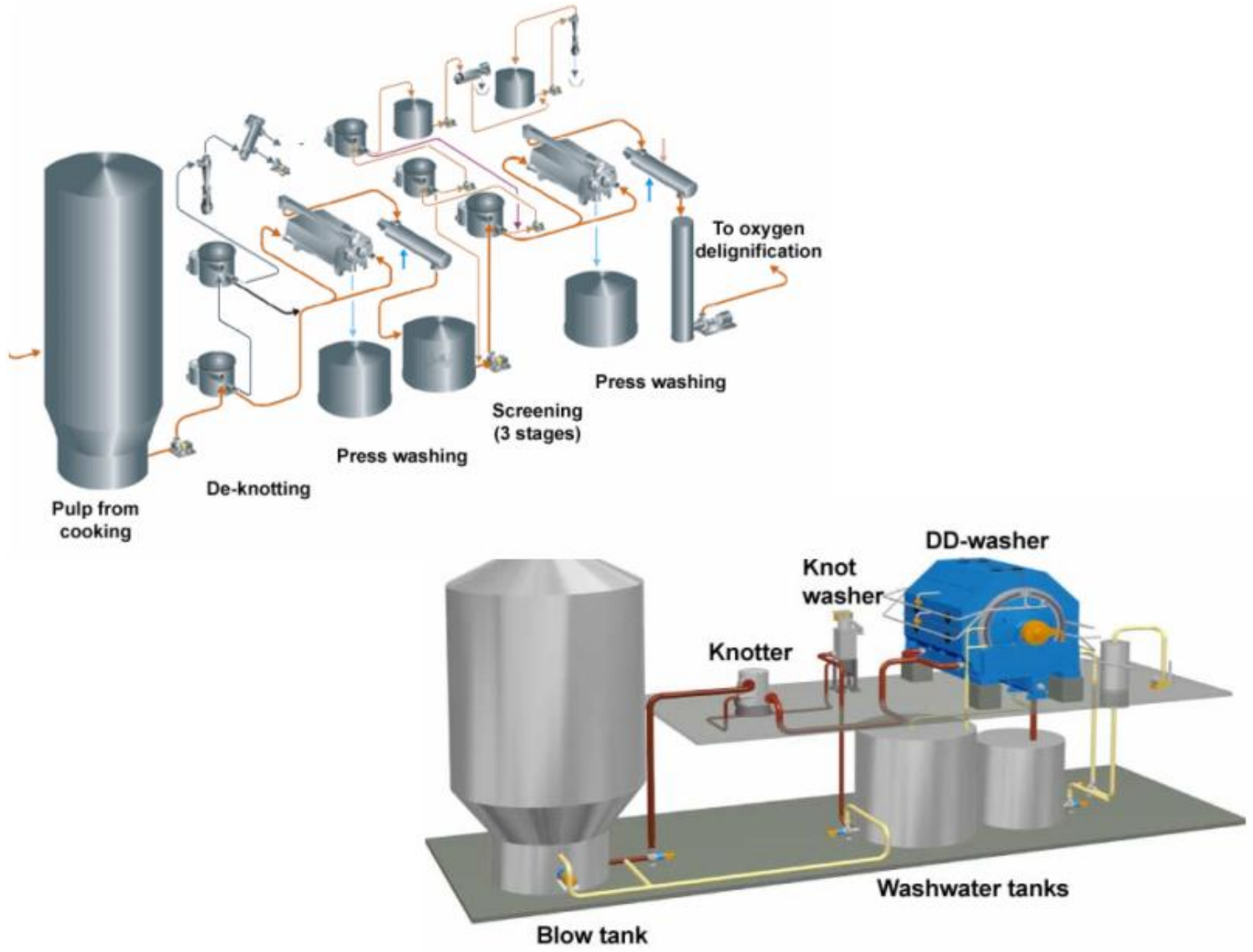


# Washing



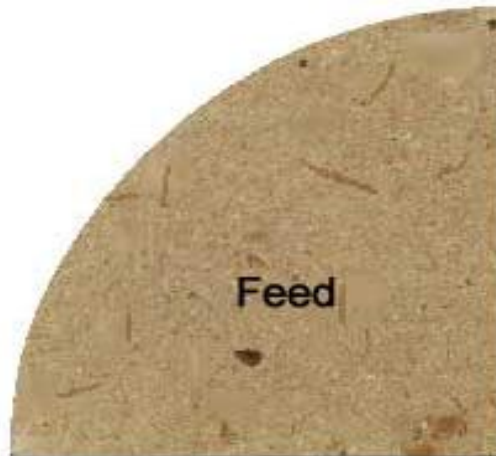


# Washing

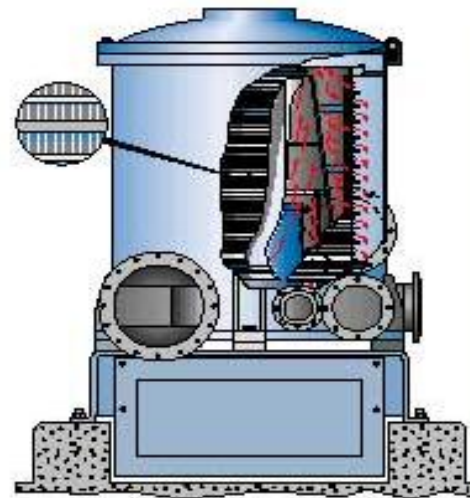




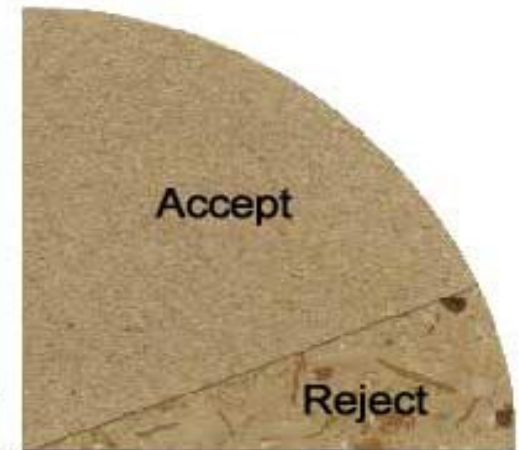
# Screening



Pulp before screening

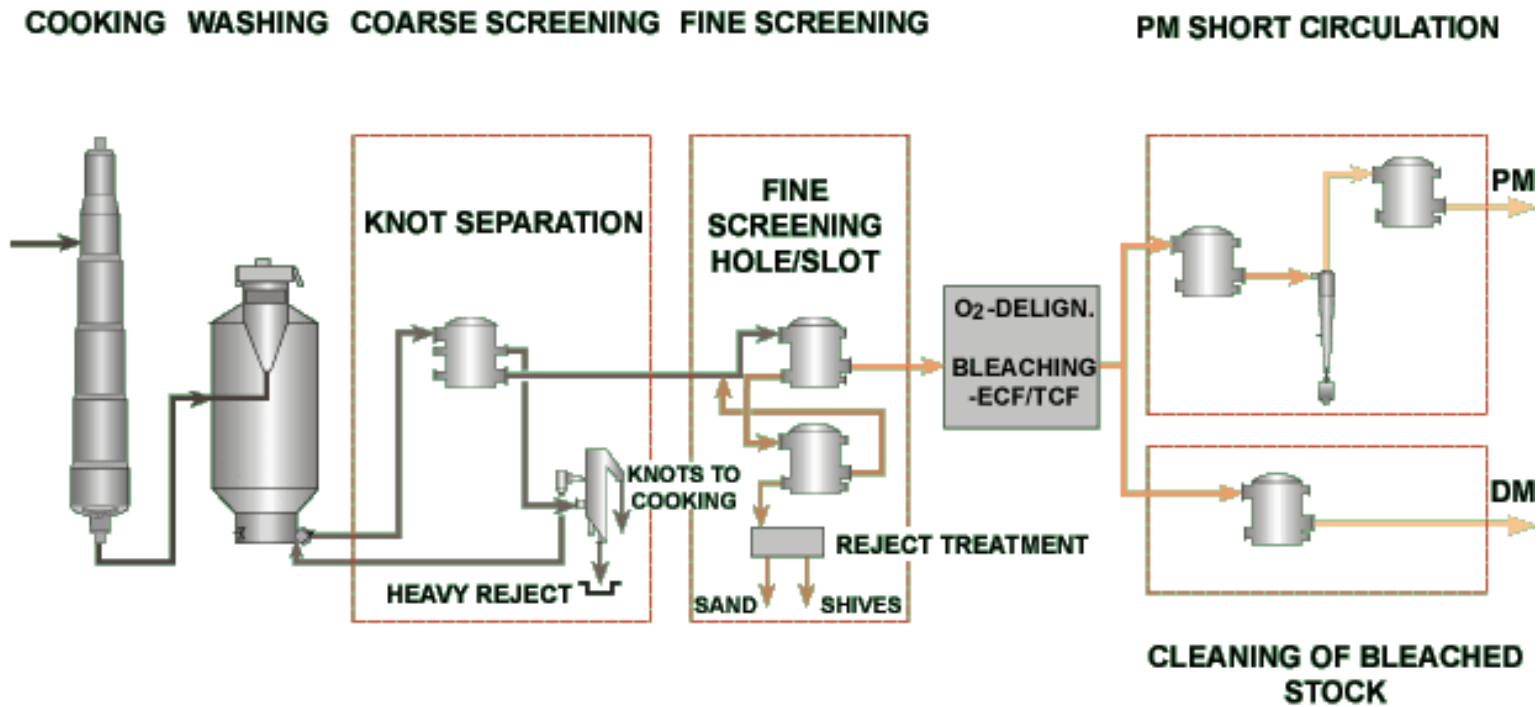


The screen divides the pulp into two fractions:  
-accept (clean fraction)  
-reject (unclean fraction)



Pulp after screening

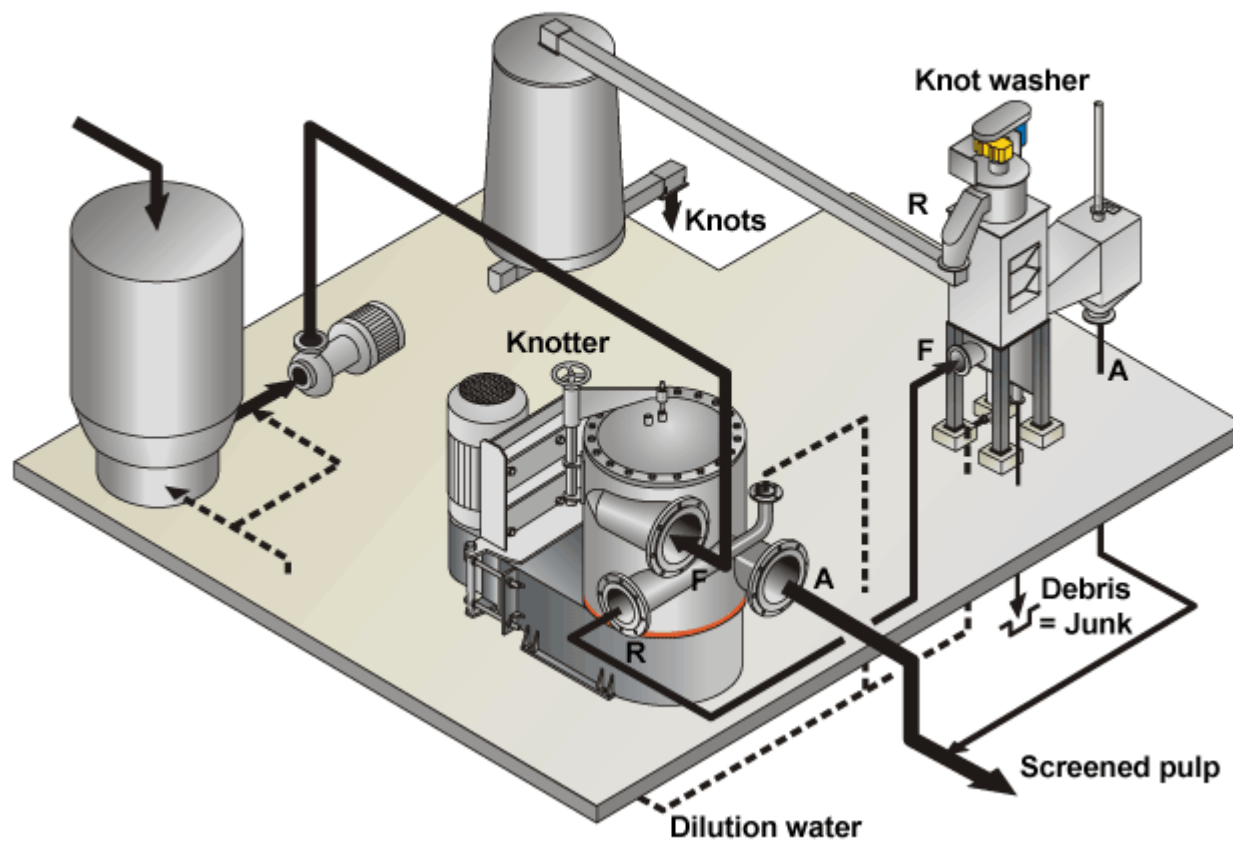
# Screening





# Screening

## Knot separation system





# Pressure: Pressure in Wash press

M-Real Husum Sweden

Washing and Screening



## Pressure Measurement

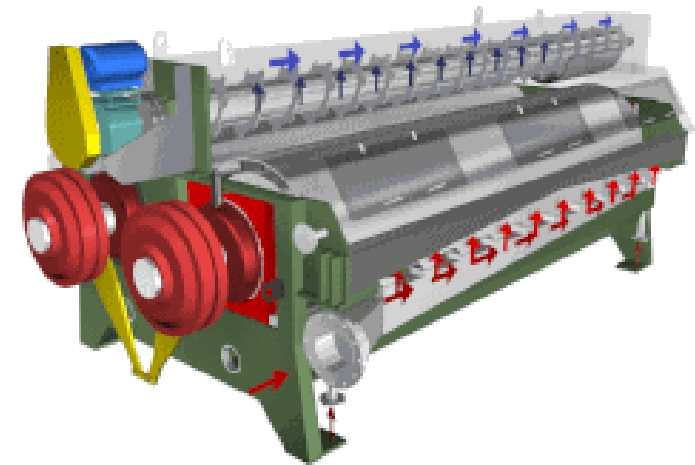
**Type:** Cerabar M PMC45  
**Media:** Pulp  
**Temp:** +40C  
**Pressure:** <1bar

## Other info:

PMC45 with flush mounted  
DN 80 flange and ceramic membrane.

Pressure measurement on the inlet of the Wash press to avoid blockage in the wash press. The metal membranes often collapsed due to the pressure from the incoming pulp.

After changing to ceramic membrane the problem was solved



# Pressure: Pressure at MC pump

M-Real Husum Sweden

Washing and Screening



## Level Measurement

Type: Cerabar M PMC45

Media: Pulp

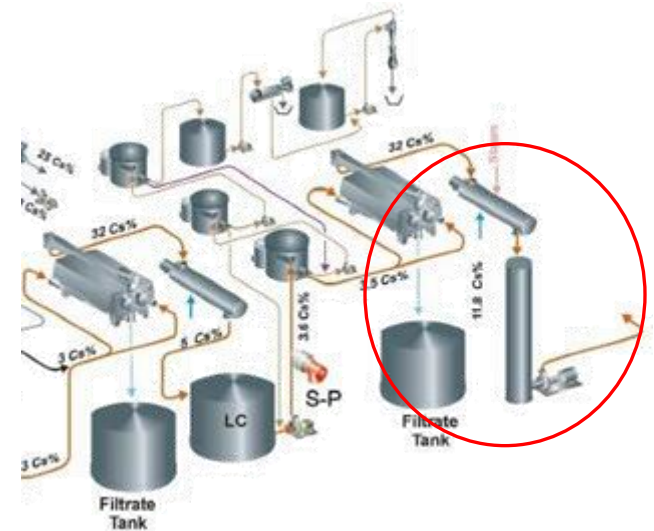
Temp:

Pressure:

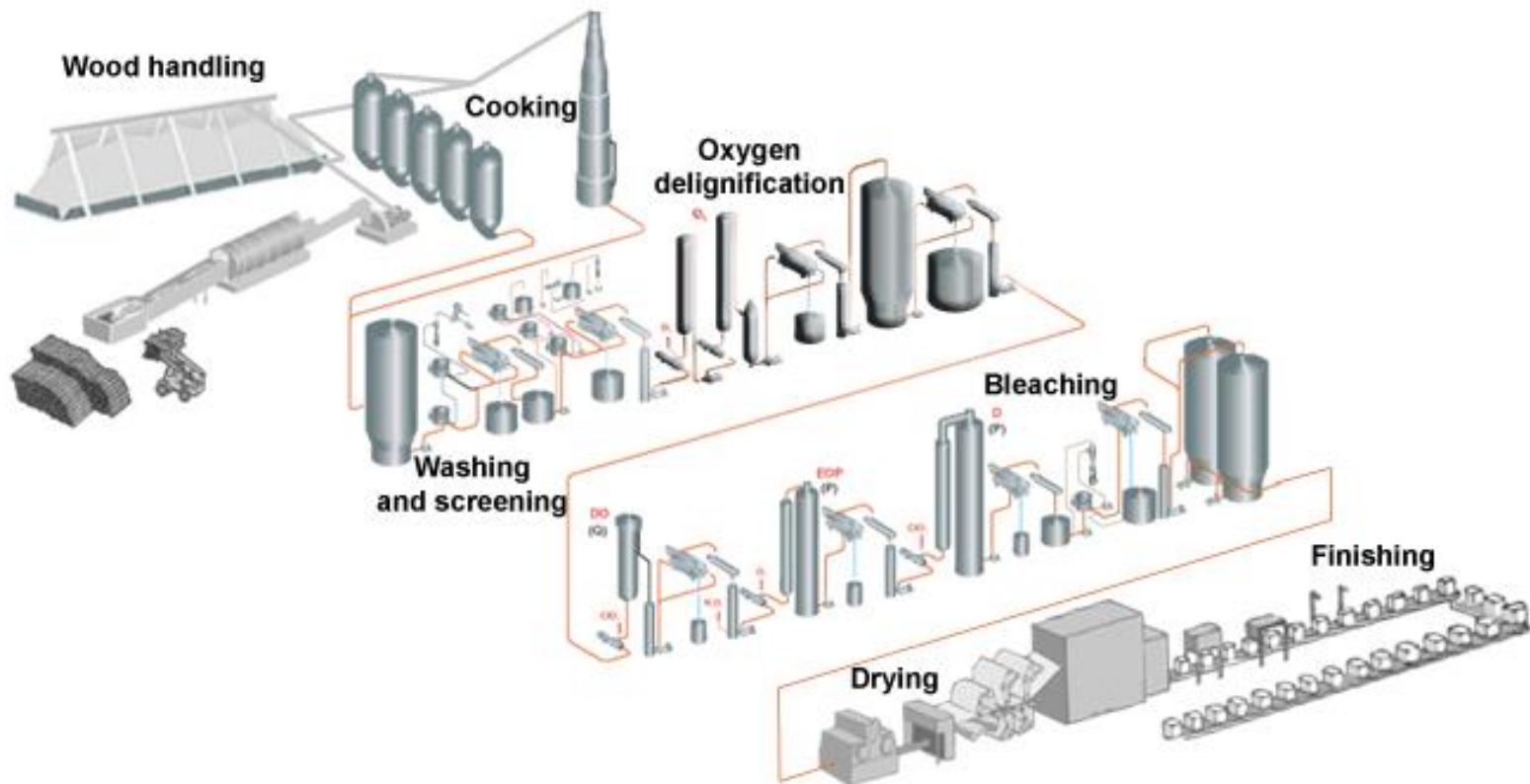
Other info:

Measurement of vacuum to avoid blockage of the MC pump. Customer had a lot of problem with the metal membrane due too metal fatigue.

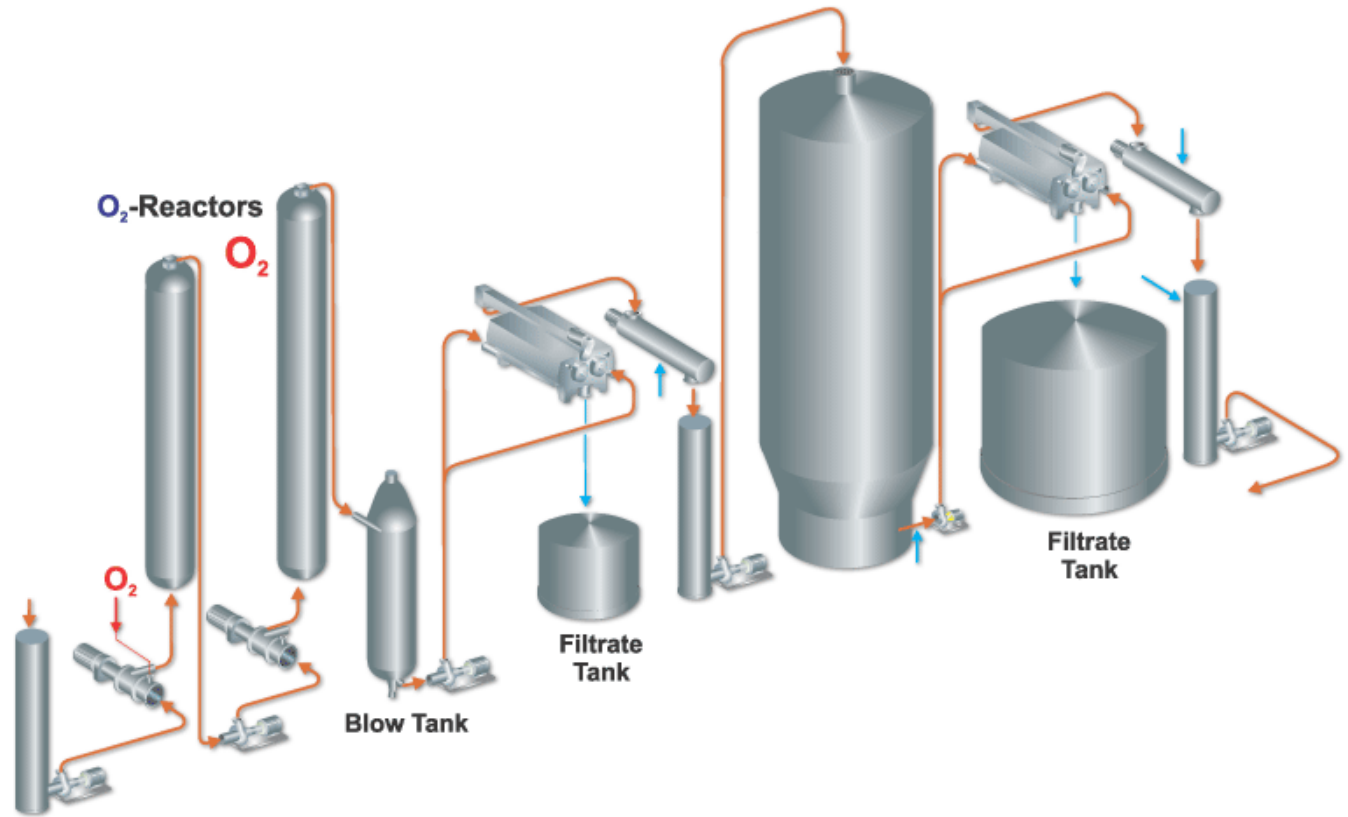
Ceramic membrane are unaffected by vacuum.



# Bleaching: Oxygen Delignification

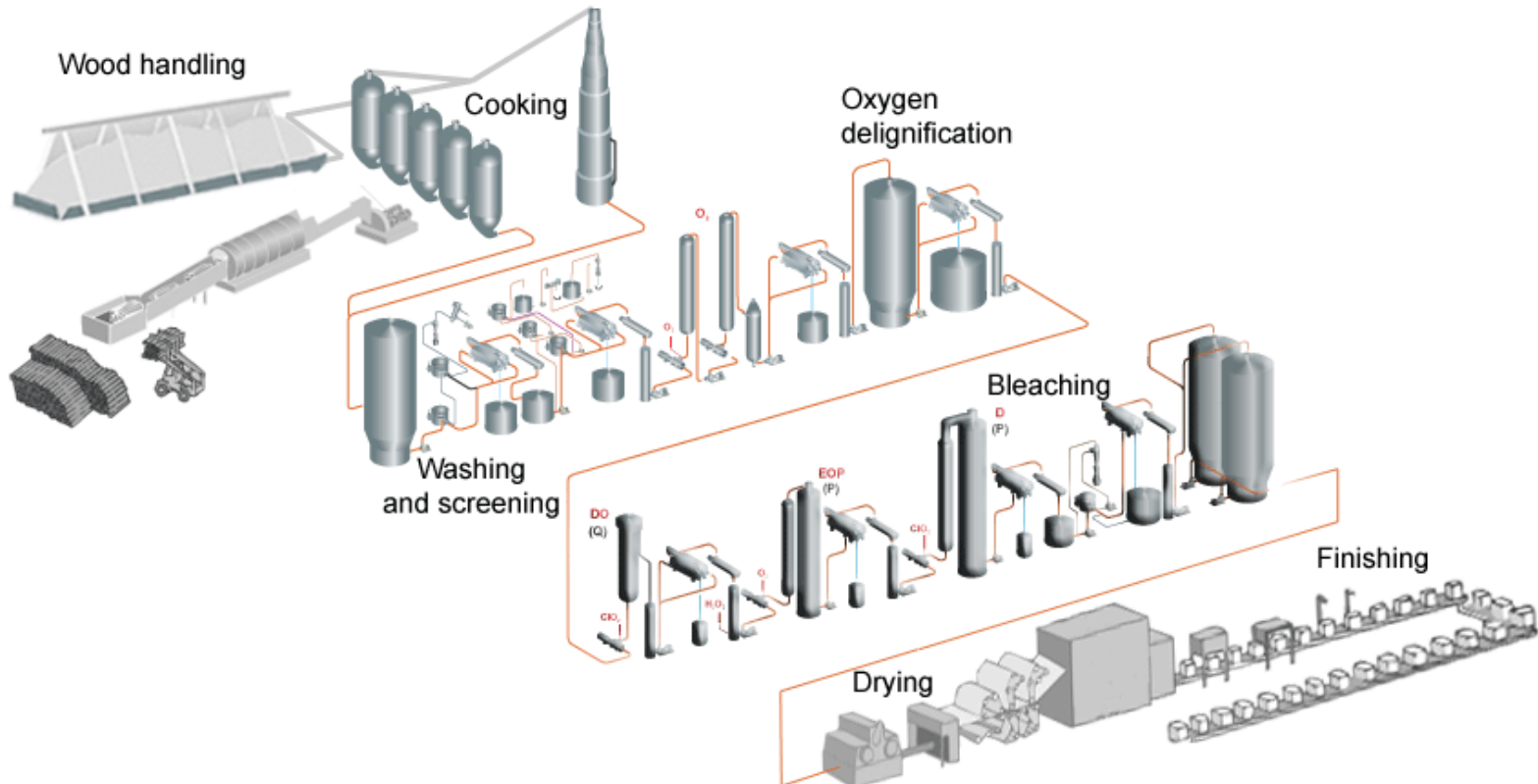


# Oxygen Delignification





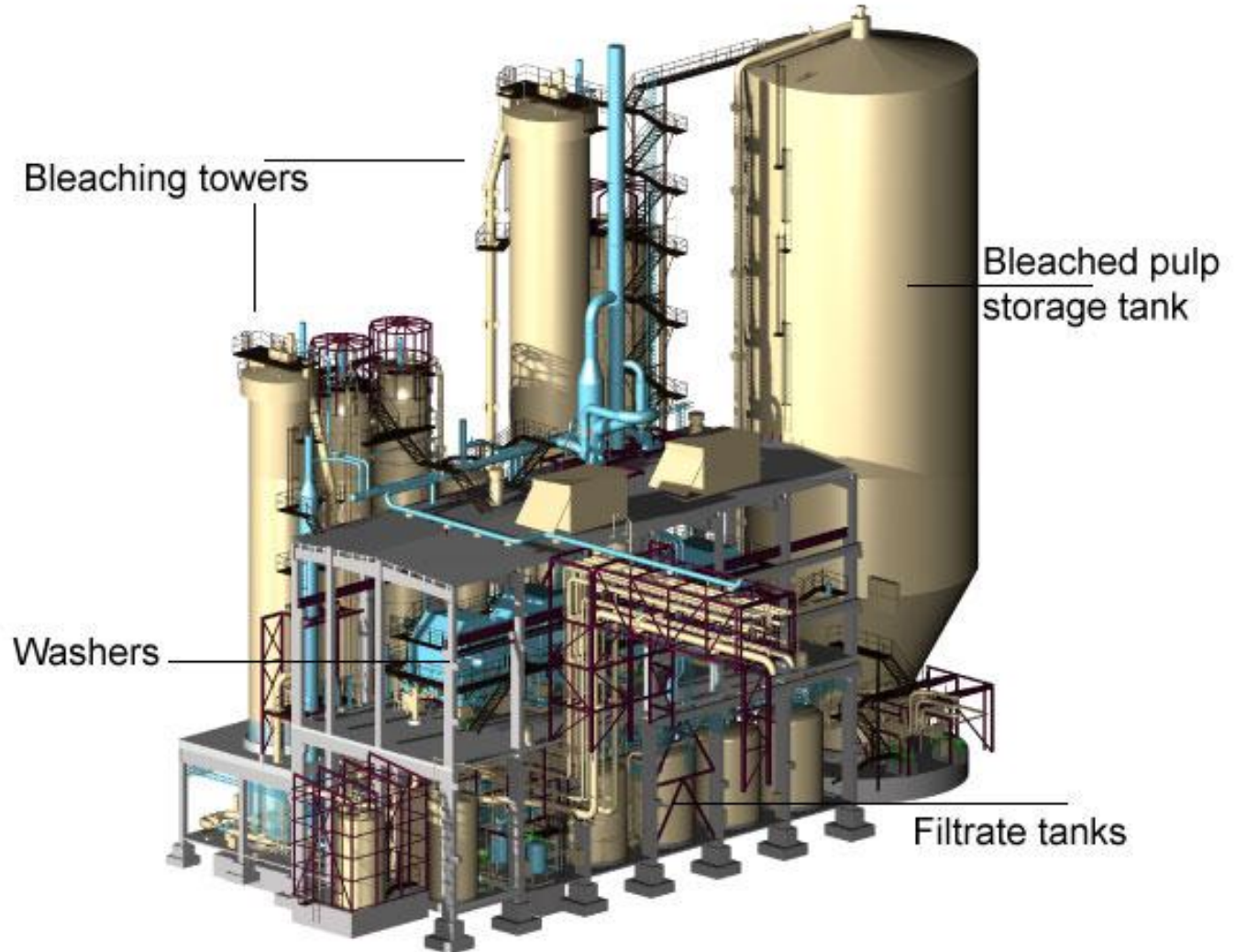
# Bleaching



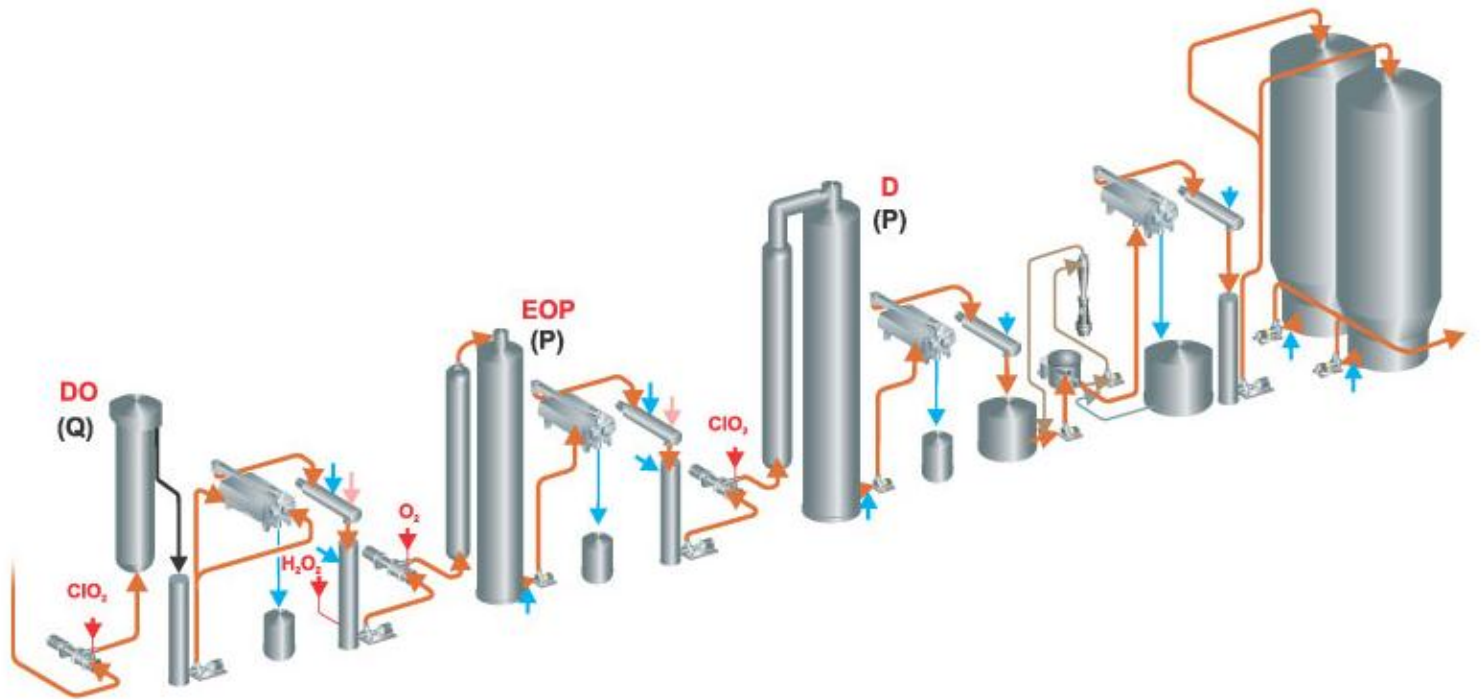
# Bleaching



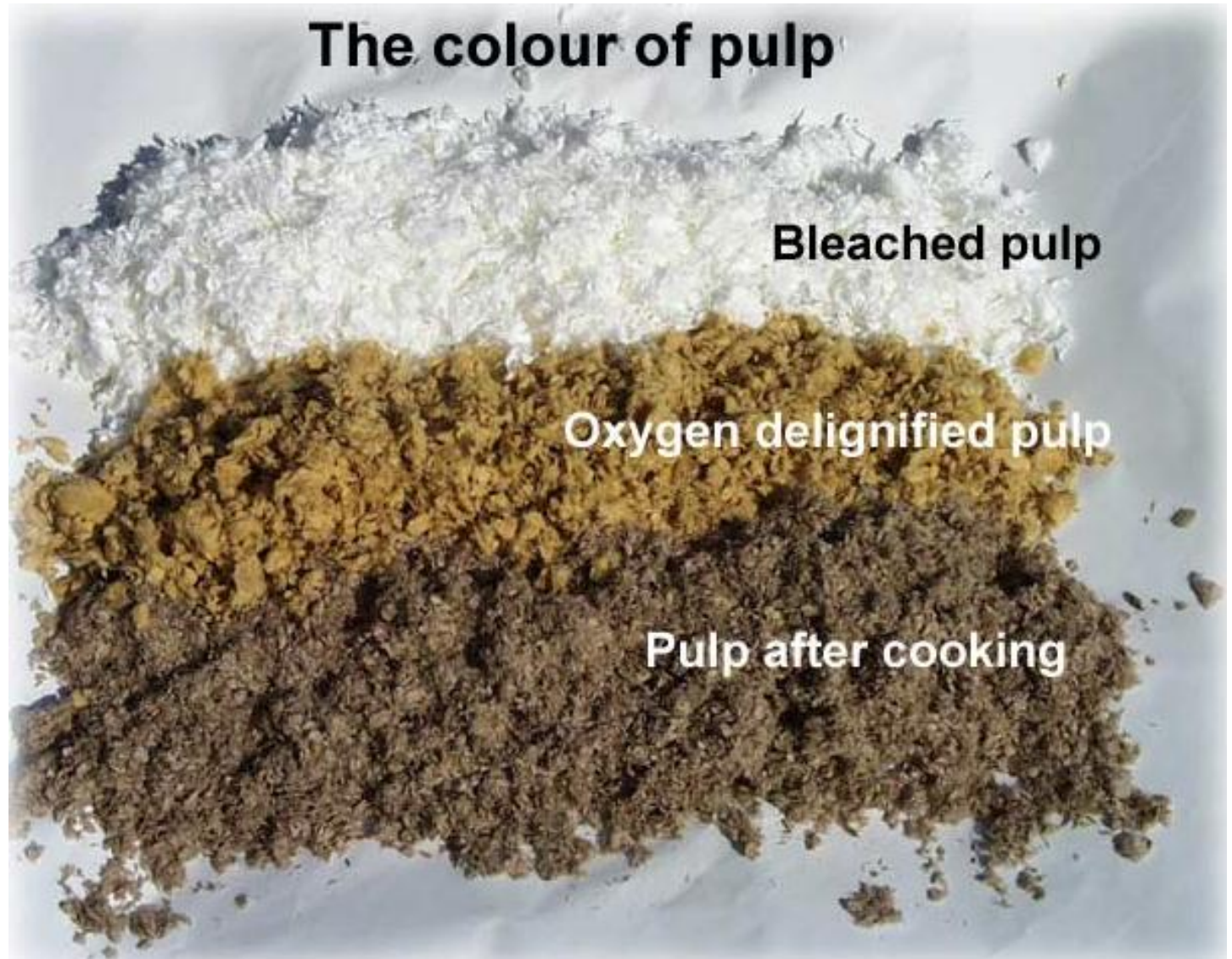
## Example of a bleach plant



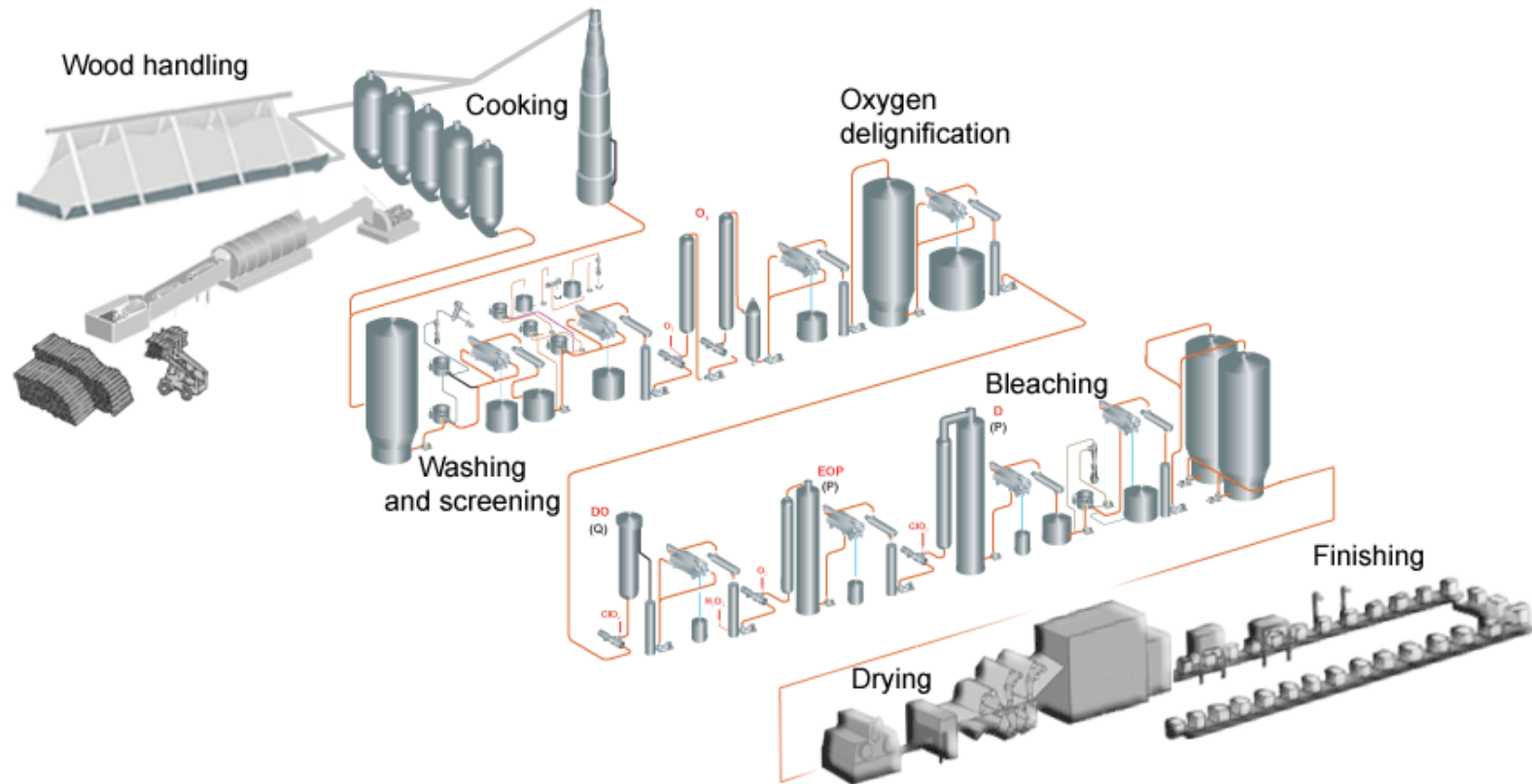
# Bleaching



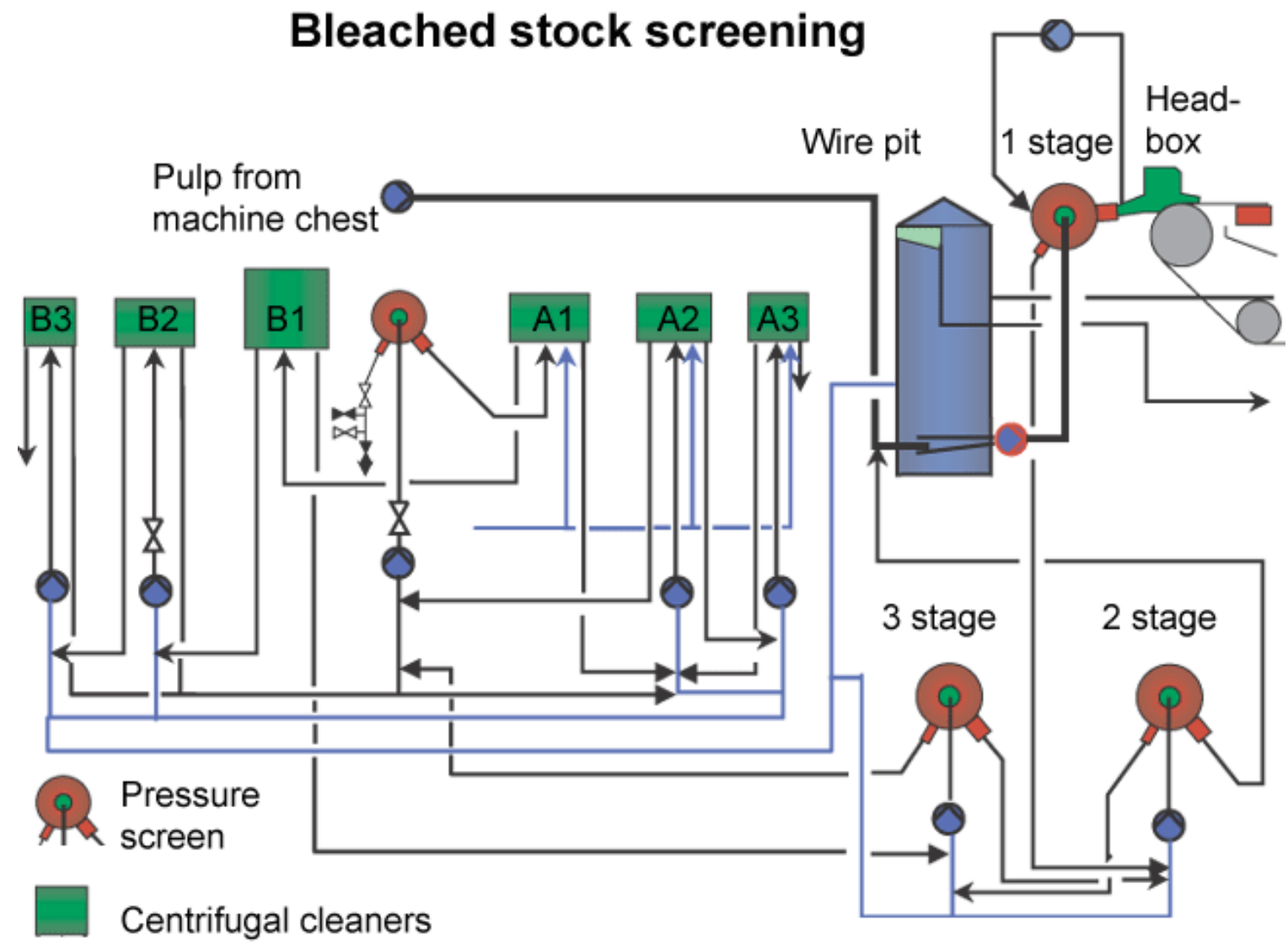
# Bleaching



# Drying and Finishing



# Drying and Finishing: Bleached Stock Screening

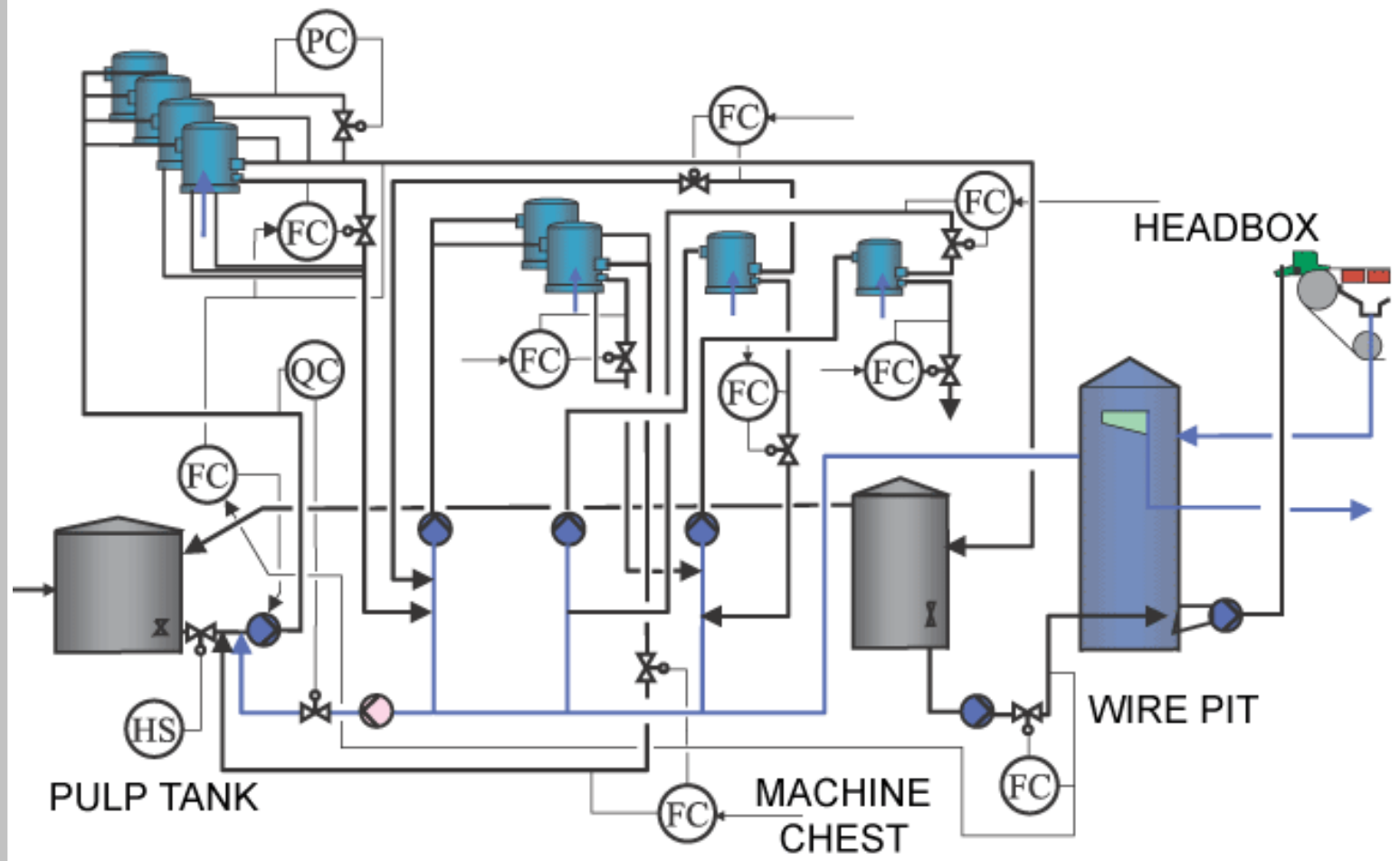


# Drying and Finishing: Bleached Stock Screening



## 4-stage pressure screening plant

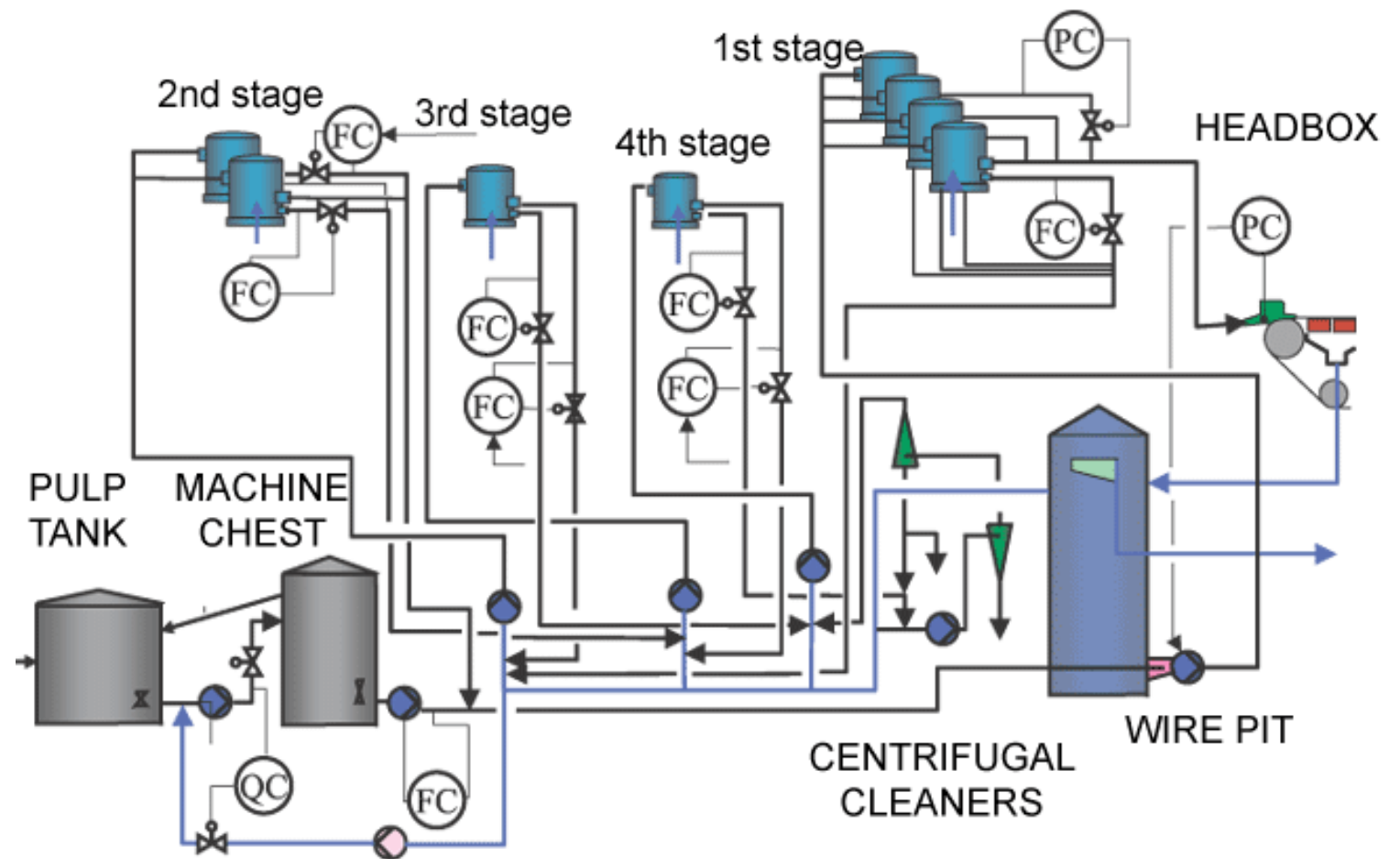
between two pulp tanks





# Drying and Finishing: Bleached Stock Screening

**4-stage pressure screening plant**  
before headbox, fine reject centrifugal cleaning and  
hydraulic low consistency headbox



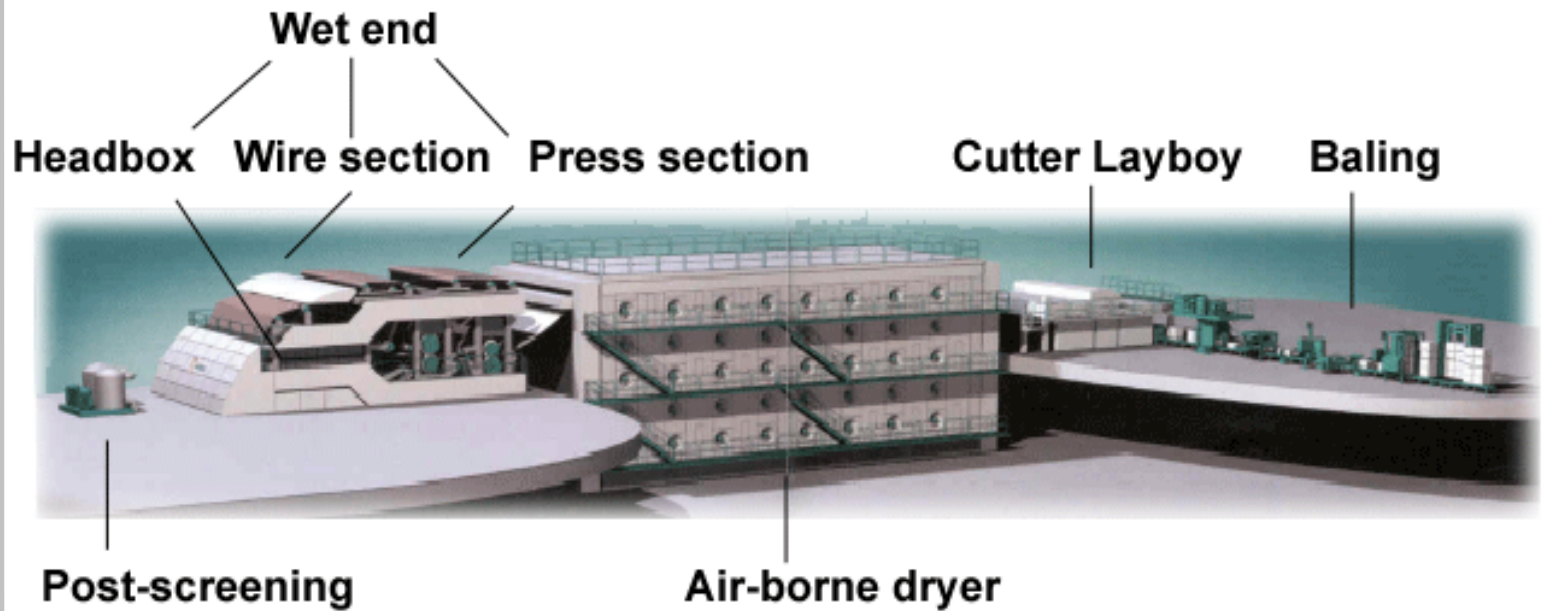


# Drying and Finishing

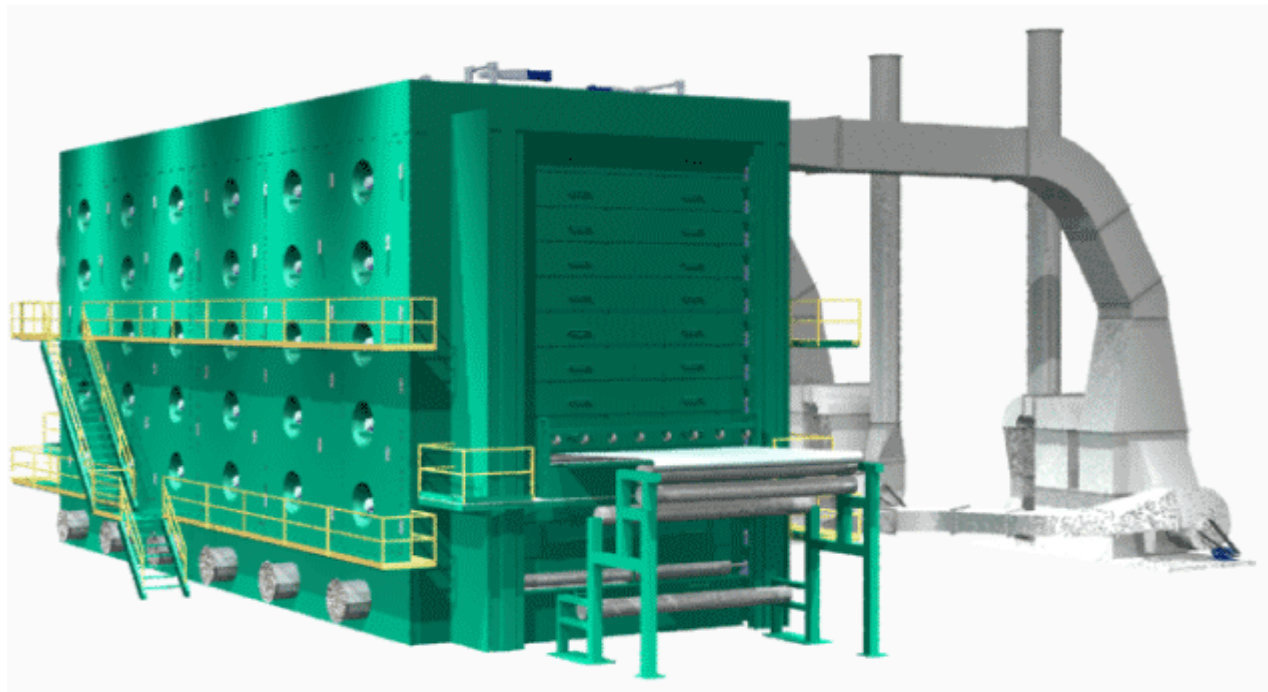
## Drying and finishing

Drying

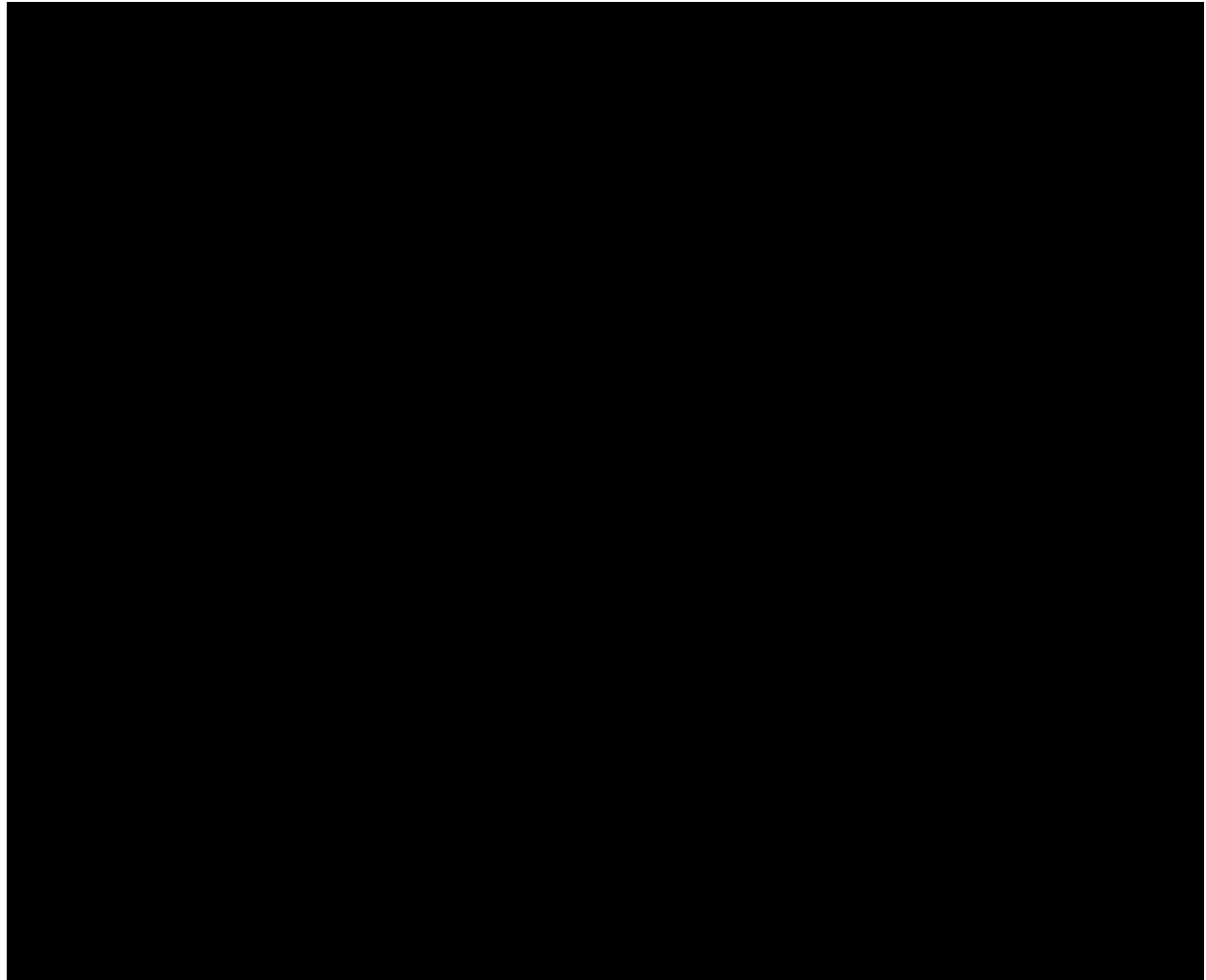
Finishing



# Drying and Finishing



# Drying and Finishing



# Drying and Finishing: Cutting



# Drying and Finishing

