Kraft Spent Liquor Recovery

- Add PFD from Lewis Radash

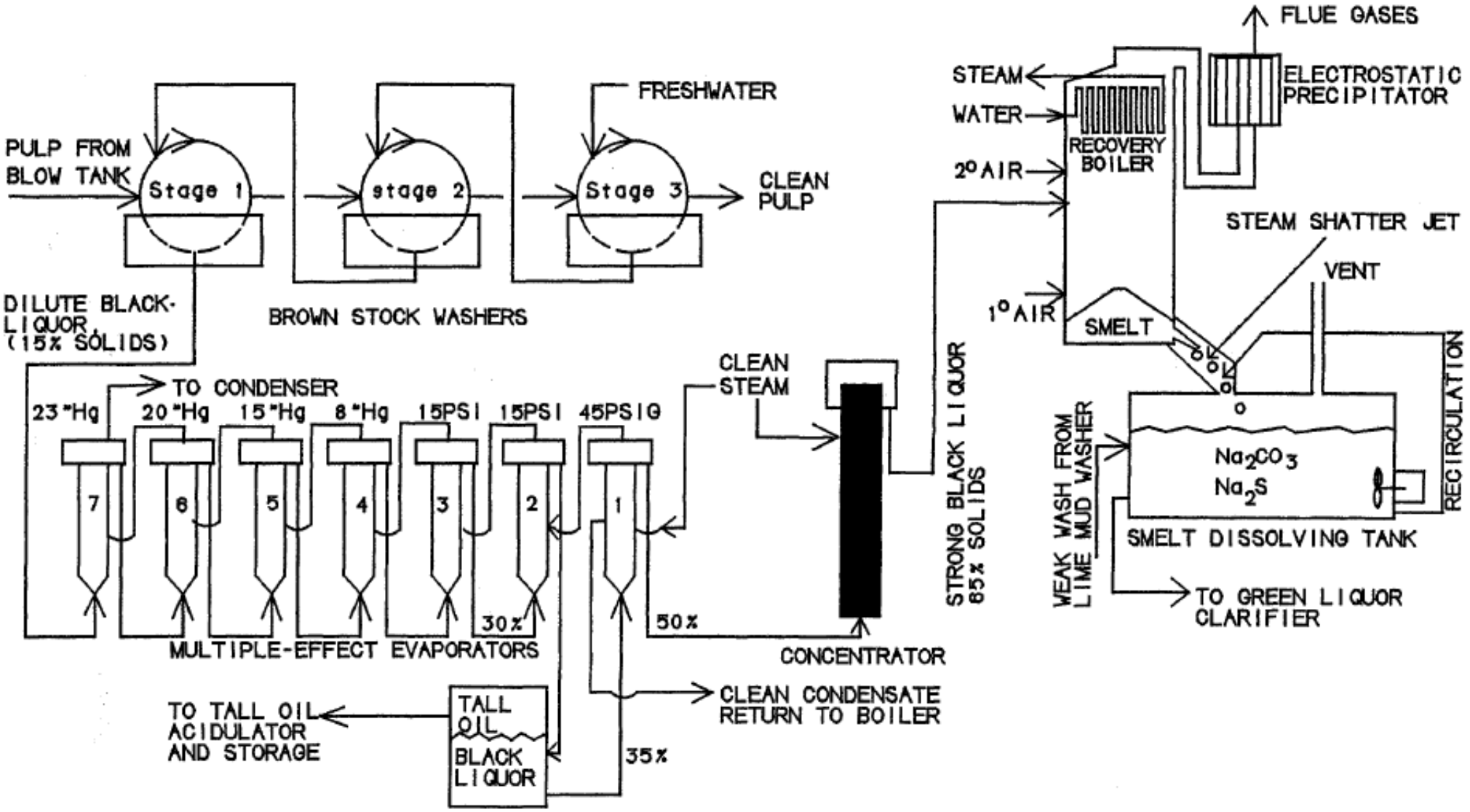


Fig. 4-1. The liquor recovery cycle in a kraft mill before causticizing. (Not to scale and liquor storage points are not shown.)

Reactions in Recovery Boiler

- Most expensive, $100M
- Overall reactions:

Oxidation zone:

$CO + \frac{1}{2}O_2 \rightarrow CO_2$

$H_2 + \frac{1}{2}O_2 \rightarrow H_2O$

$Na_2S + 2O_2 \rightarrow Na_2SO_4$

$H_2S + 1\frac{1}{2}O_2 \rightarrow SO_2 + H_2O$

Drying zone:

$Organics \rightarrow C + CO + H_2$

$2NaOH + CO_2 \rightarrow Na_2CO_3 + H_2O$

conversion of sodium salts:

$2NaOH + CO_2 \rightarrow Na_2CO_3 + H_2O$

reduction of make-up chemical:

$Na_2SO_4 + 4C \rightleftarrows Na_2S + 4CO$

Reduction zone:

$Organics \rightarrow C + CO + H_2$

$2C + O_2 \rightarrow 2CO$

$Na_2SO_4 + 4C \rightarrow Na_2S + 4CO$

$C + H_2O \rightarrow CO + H_2$

Causticizing of Kraft liquor

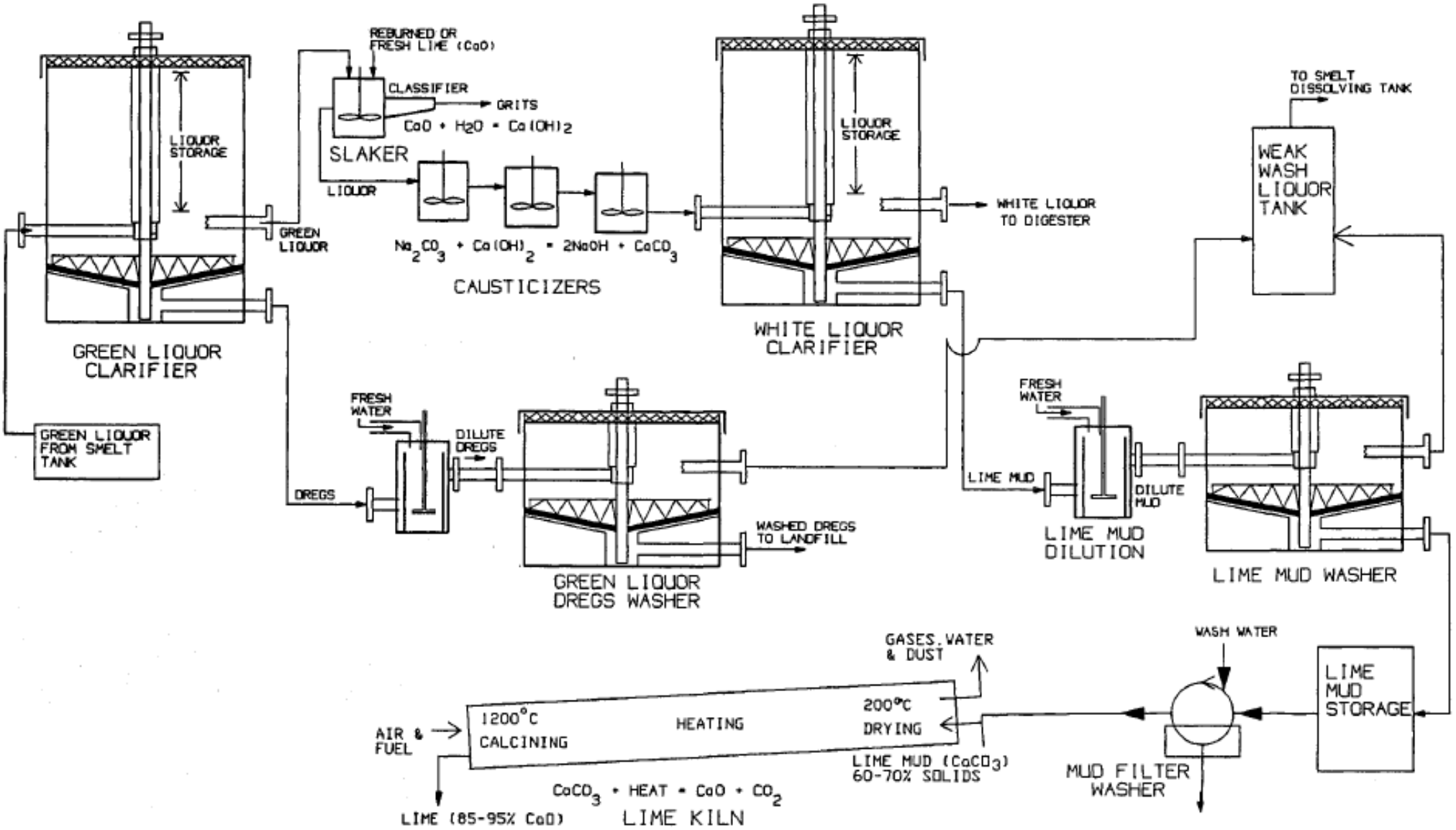


Fig. 4-12. A summary of the causticizing process of a kraft mill.

Sulphite liquor recovery

Pulp Bleaching

Approximate brightness level

Unbleached kraft	20%
Unbleached sulfite	35%
Newsprint	60%
Groundwood	65%
White tablet paper	75%
High grade bond	85%
Dissolving pulp	90%

Scale from 0% (absolute black) to 100% (relative to a MgO standard, which has an absolute brightness of about 96%) by the reflectance of blue light (457 nm) from the paper.

Bleaching of Mechanical Pulp

- Bleaching of mechanical pulp is referred as **brightening**. Because it involves masking of lignin rather than removal.
- Reducing agent: Dithionite and oxidizing agent: Hydrogen per oxide are the example of bleaching agents.

Measurement of lignin content

- Vital tool to monitor cook, lignin content before and between the various stages of bleaching.
- **Kappa Number:** The kappa number is the number of milliliters of 0.1 $KMn0_4$ consumed by one gram of pulp in 0.5 *N sulftiric acid after a ten* minute reaction time at 25°C (77°F) under conditions such that one-half of the permanganate remains unreacted.

Permanganate number or K number

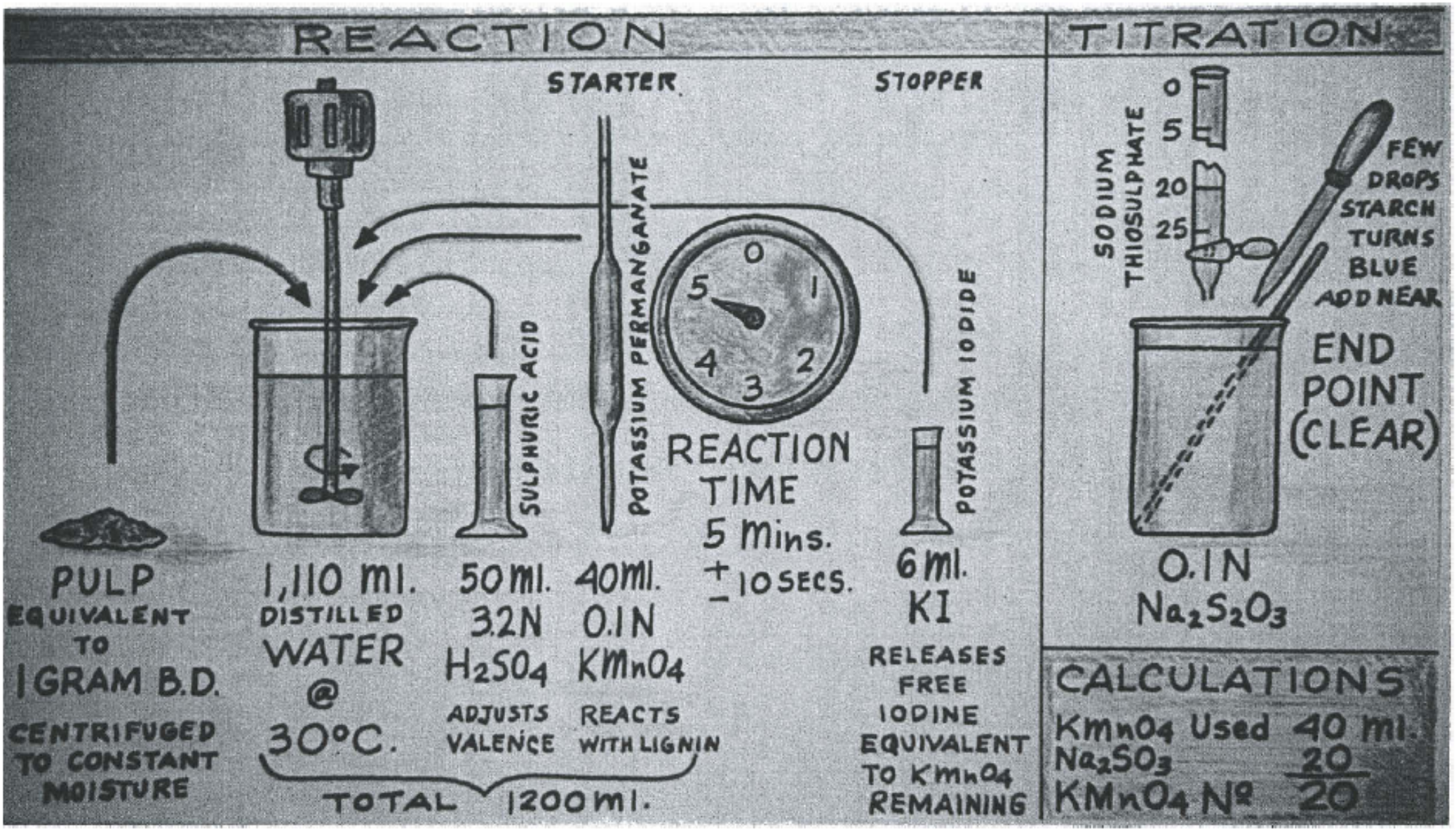
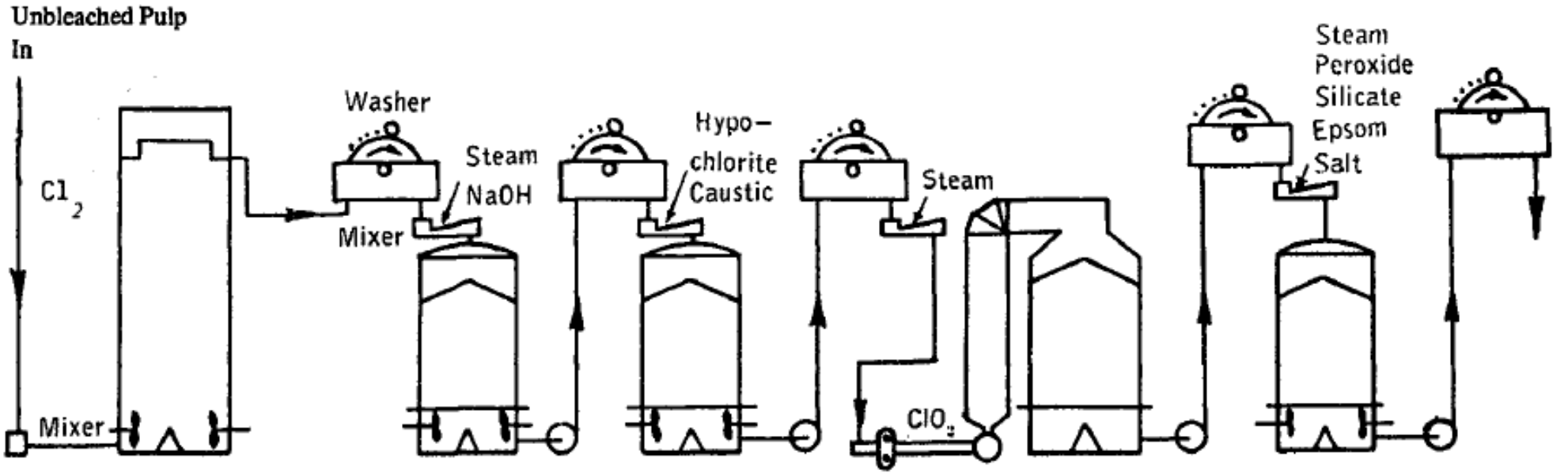


Fig. 5-2. Lignin content with permanganate (40 ml K No.). From J. Ainsworth, *Papermaking*, ©1957 Thilmany Paper Co., with permission.

- ***Roe number:*** is a measure of lignin content by the number of grams of gaseous Cl_2 consumed by 100 grams dry pulp at 25 °C in 15 minutes.
- ***Chlorine number, C, hypo number:*** The chlorine number is a test method similar to that of Roe, except the ClO_2 is generated *in situ* by acidification of sodium hypochlorite.

Bleaching of chemical pulp



	Chlorination Stage	Caustic Extraction Stage	Hypo-chlorite Stage	Thick Stock Pump	Mixer	Chlorine Dioxide Stage	Peroxide Stage	To Storage
Time, hr:	1 hr	1-2 hr	2-4 hr			5 hr	4 hr	
Temp., °F:	ambient	160°	90°			160°	160°	
Cons.:	3.0%	12%	12%			12%	12%	
pH:	1.5	10.5	9.0			3.0	10.5	
Bright., %:	20-25%	30-35%	65-75			85-90%	90-92%	

Fig. 5-4. CEHDP sequence used to bleach pulp to 90-92% brightness. Reprinted from *Making Pulp and Paper*, ©1967 Crown Zellerbach Corp., with permission.

Next classes

* Stock preparation and additives for paper making
* Paper manufacture