High Yield Pulp Bleaching

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INTRODUCTION

Demand is increasing throughout the world for fibre products such as lumber and plywood; composition board; papers and packaging materials; synthetic fibres and film. The source of fibre is from the land in the form of trees, bamboo, cane, grasses and other plants. Man, over the centuries, carelessly and with little thought to the future has exploited and destroyed a large part of the world forest and agricultural lands.

Man is only now beginning to understand that the world's bounty has a limit which is close at hand. He is learning that he must protect the natural environment and restore to his capability what he has destroyed. This will be expensive and will require individual, communal, national and world effort and cooperation economically and politically.

Fortunately the land wisely used and restored will provide food and fibre in increasing quantity. Scientific research, engineering and technology are leading the way to improve the quantity and quality of food and fibre production from the land. Also there are advances toward more efficient utilization of the product.

It is on this theme that more efficient utilisation of fiberous materials will be discussed. The writer's background and experience has been North American and the processes described are particular to that area. However, fiberous plants consist principally of celluloes fibre and lignin with lesser amount of sugars, resins, etc. The treatments for utilization have general similarity.

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TREE AND PLANT UTILIZATION

The larger softwood or conifer trees (pine, fir, spruce, hemlock, cedar redwood) and suitable hardwood trees (oak, walnut, beach, birch) proceed to mills which cut lumber or produce plywood. There is a residue of slabs, edgings, shavings and sawdust and bark. The larger plants now remove the bark first by mechanical or hydraulic means and the residue is chipped and sold to the pulp and paper mills. The large fir and pine trees of the North American Pacific Coast are cut into lumber with 1/4" (6 cm) saws which produce a coarse sawdust which is utilized for pulping. Some pulp mills of over 1000 tons per day production operate only with residue chips, sawdust and shavings, which in time past were used for fuel or wastefully destroyed by burning.

In warmer climates, bagasse from sugar cane is also being utilized for pulp production instead of fuel. Straw, grasses and canes are being employed for fibre con-

tent rather than less economic uses.

No generalization can be made for any country or region of the world concerning utilization of its trees or plants for the production of wood products or cellulose fibre. The economy as a whole or political action will dictate the utilization.

HIGH YIELD FIBRE PRODUCTION AND BLEACHING

This is a subject which cannot be clearly defined since it encompasses a broad spectrum of raw materials and the desired type, quality and economic gain in the end product. Various raw materials processes and end products, will be discussed.

Groundwood Pulps

This product approaches total conversion of the raw material to the final product. Pieces of wood, chips and sawdust from trees are mechanically defibred with stone grinders or disc refiners. Groundwood is principally used with a smaller portion of chemical fibre for newsprint production. It adds bulk, printability and absorption qualities to a wide range of other products such as paper toweling, napkins, sanitary tissues, quality printing papers, etc.

Groundwood from some wood species will have a GE brightness of 58 to 60 suitable for printing papers and bright newsprint. Other wood containing tannins and other colour bodies is bleached to attain the brightness desired.

Some wood species can be brightened with hypochlorite alone but brightness stability is preferably attained with reducing agents, sodium or zinc hydrosulfite, (dithionite) $Na_2S_2O_4$ and/or hydrogen peroxide. Each can be used separately or sequentially.

Hydrosulphite Bleaching

Hydrosulfite entered its major commencial use in the USA and Canadian Pacific Coast newsprint mills, 1925, because the Western hemlock (Tsuga heterophylla) produced low brightness groundwood. Purchased or mill produced zinc hydrosulfite from zinc dust and SO_2, is used to increase the brightness level from 53-54 to 59-60-GE. Hydrosulphite is now used widely for brightening newsprint and also special printing papers.

The essential conditions for bleaching groundwood with hydro sulfite solutions are:

1. Air, entrained in the pulp by pumping, agitation or mixing must be avoided since it will oxidize and neutralize hydrosulfite solutions.
2. Groundwoood should preferably be freshly ground.
3. Heavy metal ions in the pulp, particularly ferric ions destroy the bleaching efficiency. Corrosion proof equipment should be used. Sodium tripolyphosphate and organic agents sequester heavy metal ions.
4. Consistency from 5 to 18% has little effect on final brightness. At high consistency, less steam is required for heating and the reaction is more rapid.
5. Temperature has a direct effect in improving brightness up to 75°C, all other conditions remaining equal. Each 15°C temperature rise will improve brightness 1 point. Temperature employed is 60 to 75°C.
6. Time. Hydrosulfite reaction is rapid at 60 to 75°C requiring only 0.5 to 1.0 hour retention.
7. pH range mildly acidic, 5 to 6 for ZnS_2O_4, 5.5 to 6.5 for $Na_2S_2O_4$.
8. Hydrosulfite from 0.5 to 1.0% will increase brightness 4 to 8 points on groundwood pulp. The economical limit is about 1% ZnS_2O_4 for 8 point rise The chemical and steam heating cost is about US $6 to 8 per ton.

Peroxide Bleaching

Peroxide bleaching solutions are employed in the production of papers which require moderate strength, brightness and colour stability, with good opacity, bulk, absorbency and printability. These include, book, magazine, catalog, mimeograph, tablet papers and tissues. Precautions for bleaching require corrosion proof equipment and absence of heavy metal ions, particularly ferric ions, which decompose peroxide solutions. Magnesium sulfate and organic sequestering agents added to the pulp minimize peroxide loss and pulp darkening. Bleaching conditions are:

1. Consistency. Rising consistency directly improves brightening. Newer plants employing 25 to 30% consistency gain about 2 brightness points over older operations at 10% consistency, other conditions being equal.
2. Temperature is normally 45 to 60°C. Higher temperature decreases bleaching time and increases colour slightly.
3. Time normal 2 hours, depending on pulp consistency and temperature.
4. pH range 10 to 11.
5. Peroxide dosage. Many hardwoods and conifers are suitable for making bleached groundwood. Pulps should not be low brightness since it may not be economical to bleach with peroxide. Pulps 53-54 GE can be treated to ggain 7 to 8 points with a 0.5% (100% basis H_2O_2) hydrogen peroxide buffered solution. Whiter groundwoods 60 to 62 GE, can be easily bleached to 75 GE. Peroxide bleaching is unique in that brightness reversion is slight.
6. Peroxide bleaching solutions are prepared from weekly acidic 35 or 50% H_2O_2 solution or from highly alkaline Na_2O_2 granules. Tither type

of peroxide can be used. H_2O_2 must be made alkaline and Na_2O_2 must be acidified. In addition, sodium silicate buffering and magnesium sulfate are part of the bleaching solution. A typical solution which will raise ground brightness 8 to 12 GE points is shown:

Percent on weight of Pulp

	H_2O_2 Solution	Na_2O_2 Solution	H_2O_2 + Na_2O_2
$MaSO_4$	0.05%	0.05%	0.05%
Na_2SiO_3 42°Be	5.0	5.0	5.0
H_2O_2 (50% solution)	1.7	—	0.84
NaOH (100%)	1.0	—	—
Na_2O_2 (96%)	—	2.0	1.0
H_2SO_4 (66°Be)	—	1.4	—

The usual bleaching equipment is washer or screw press to provide 12 to 30% consistency pulp, a chemical and steam mixer and a retention tower providing 1 to 4 hours retention. The bleaching action of peroxide solutions is always terminated with SO_2 which deactivates the residual peroxide. **Fig. No. 1** illustrates one method.

Two Stage Bleaching Peroxide, Hydrosulphite, Hypochlorite

Economy and better bleaching is often practised by use of two stage treatment. Initial use of hypochlorite eliminates reducing sugars, enzimes, etc. in order to use less peroxide. Figure No. 1 illustrates this.

Peroxide followed by hydrosulfite achieves whiter pulp than either reagent alone. **Fig. 2** illustrates a typical system. The table below illustrates maximum brightness obtained with Na_2O_2 and ZnS_2O_4 and added brightness obtained with two stage sequential treatment.

High Yield Bagsse Pulp

Several subtropical countries supporting a substantial sugar industry and lacking other sources of celluloose, utilize the bagasse. A wide range of prodoucts are produced ranging from coarse board, corrugating medium to highly bleached writing papers. In these same countries there is scarcity of newsprint which prompts the idea to oproduce this 100 % from bugasse. A mill in Mexico has experimented on commercial scale and a very acceptable newsprint was obtained. Printability was good but "show through" was slightly more than for standard North American conifer groundwood-semi-bleached kraft type newsprint.

Depithed bagasse was treated with 7.5% NaOH at 2.0 to 2.5 Kg/cm² for 10 minutes. Refining and screening gave a yield of 70—73% on the depithed bagasse. The TAPPI Permanganate No. was 20 to 21, GE Brightness 33. Treatment with 6% hypochlorite reach-

Wood	Treatment Sequence	GE Brightness
Picea	Unbleached	58.4
	2% Na_2O_2	68.4
	1% ZnS_2O_4	69.5
	2% Na_2O_2 + 1% ZnS_2O_4	74.5
Populus	Unbleached	67.5
	2.2% Na_2O_2	75.0
	1.0% $Na_2S_2O_4$	77.0
	2.2% Na_2O_2 + 1.0% $Na_2S_2O_4$	82.0

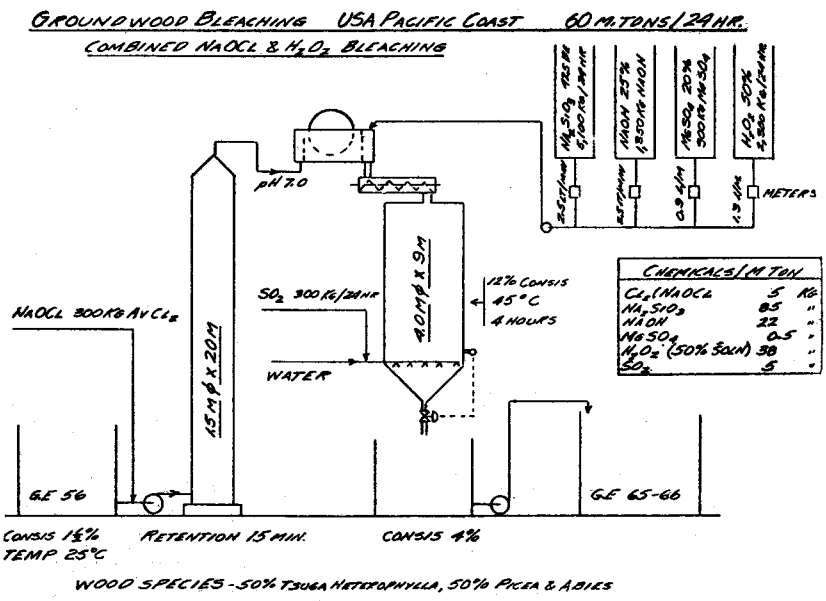

Fig. 1 Groundwood Bleaching NaOCl + H_2O_2

ed GE 53. Further treatment with 1 to 2% Na_2O_2 reached 60 to 63 GE brightness.

Cold Caustic Soda — Mechanical Pulp

This pulp is made from softer textured hardwood tree species such as populus, acer, salix, castanea. If the wood is white, a bright bleached pulp can be produced. The soft absorbent pulp added to a quantity of 40% with bleached NSSC and bleach kraft results in good paper board for food packaging. The coated board has good appearance, strength and stiffness. Populus from Canada and North Central USA finds favourable use for cold soda pulping. Note **Fig. 3.**

Small chips 10 to 15 mm. length are fed into a high pressure mechanical screw. At the point of release, 5% caustic soda (basis drywood) is applied as a 4% NaOH solution to the expanding chips which it penetrates. The crushed chips appear like damp, yellow chopped straw, GE 45. This mass drops into a "live bottom bin" which is a tank with a series of parallel screw conveyors across the bottom, where it remains for 60 minutes impregnation. This keeps the mass in motion and discharges it to a vertical elevator, and thence into two primary refiners where a solution of 3/4% H_2O_2 and 5% Na_2SiO_3 (dry wood basis) is added. Thence the pulp passes through a secondary refiner and into a live bottom bin. The holding time is 60 minutes at 65°C, pH 10 to 10.5. The mass is raised to a high pressure liquid extractor to remove the caustic liquor and into a tank where water is added along with SO_2 gas to neutralize residual H_2O_2 and alkalinity to pH 7. Screening and cyclone cleaning prepare the pulp for final use with GE brightness 65 to 68.

NSSC Pulp

This pulp is usually made from hardwoods principally for stiff unbleached paper used as corrrugating medium. The yield is 75 to 85% of the wood for unbleached uses, but it is usually cooked to 65% yield for bleaching. Older plants used globular rotating batch digesters; later, continuous systems used horizontal tubes with internal helical flights to move the chips from one tube to the other. The latest systems consist of an impregnating vessel discharging to a downflow vertical steaming tower.

A serious drawback for NSSC pulp is the cost of chemicals which are not recoverable in the sulfite form. There are recovery systems to directly concentrate and burn the waste liquor, but the smelt consist of Na_2SO_4 which must find kraft pulp mills to purchase it. Several smaller mills have closed down because a re-

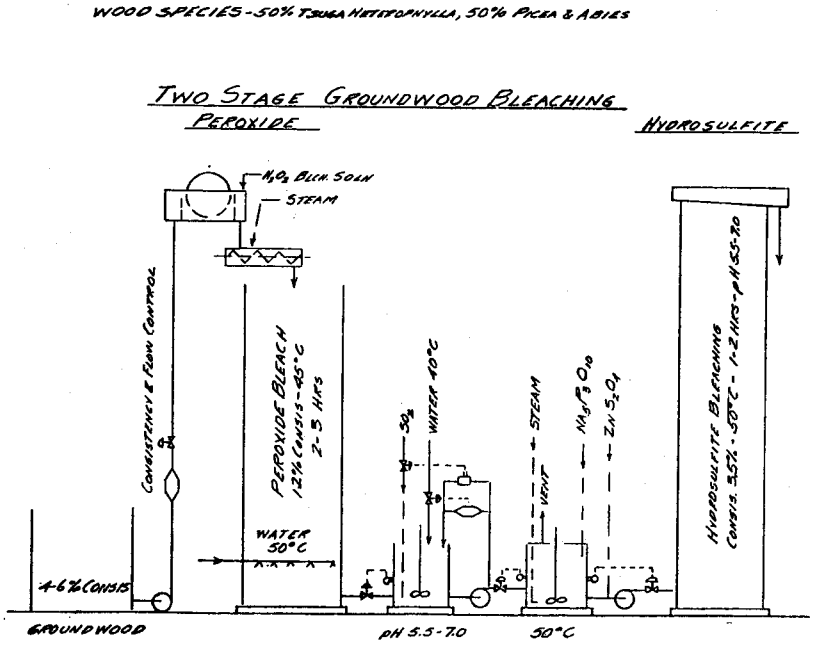

Fig. 2 Groundwood Bleaching $H_2O_2 + ZnS_2O_4$

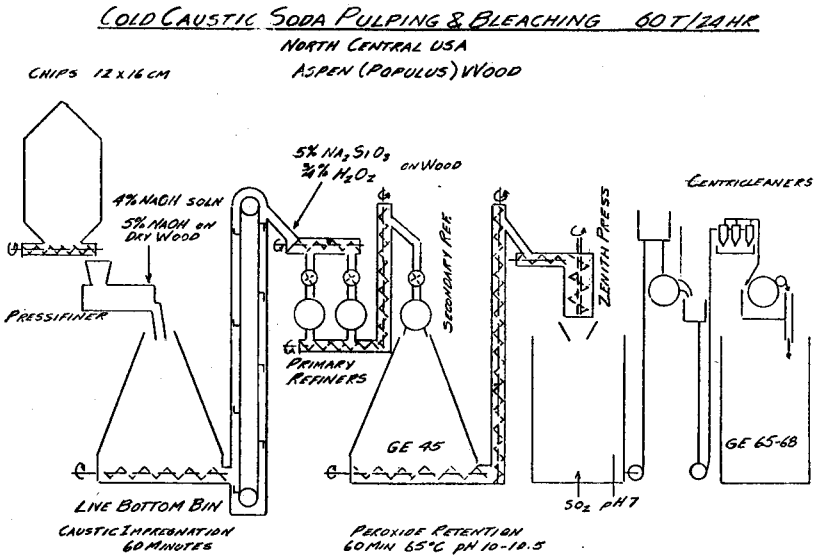

Fig. 3 Cold Caustic Soda Production and Bleaching

covery system was not economical for the chemical recuperation and stream pollution laws have prohibited the discharge of waste liquors to the streams.

Chemicals for cooking with no recovery, plus the bleaching chemicals amount to 45 to 50% on the weight of the bleached pulp which has discouraged small isolated plants. The chemical consumption can be noted below for a typical plant.

Generally cooking solution on dry wood basis is 22% Na_2SO_3 and 3% Na_2CO_3. Cooking liquor is on the press to extract spent cooking liquor which contains a residual of 7% Na_2SO_3 which is then refortified for reuse in the digester.

chips in the impregnating zone for 15 minutes at 10 Kg/cm² pressure, followed by steaming for 60 minutes. The pH is 7 at termination. The treated chips go to a defibrator or refiner to reduce to fibre. Then to a high pressure

1.	chlorination — 16% Cl_2, 3% consis.	40 minutes,	25°C
2.	caustic extraction 3% NaOH, 12% consis.	40 ,,	60°C
3.	hypochlorite 1½ to 2% Av 12% consis.	60 ,,	35°C
4.	hypochlorite ½ to 1% Av 12% consis.	90 ,,	35°C

Brightness 80 GE Yield on wood 55%

Standard screening and cleaning systems are used.

The pulp with 40 to 45% TAPPI permanganate number, i.e., 18 to 20% chlorine demand is relatively easy to bleach by standard methods for example:

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rural population.

Consequently, any solution to the stagnant, often declining economic situation of these countries must aim to attack most of the above problems.

In order to find a solution which takes into account the above-

ject which serves the following conditions:

1) It produces something which agriculture can use to increase its yield.
2) It uses agricultural waste as raw material, thus contributing towards higher income for agriculture.
3) It is situated in an agricultural district and brings jobs to unemployed or underemployed rural population, and of population to towns and cities.

In an attempt to find out such an industry which fulfils the conditions mentioned above, many process industries have been studied. Investigations show that pulp industry, which normally uses wood as the main raw material, has many of the potentials and can, after some modification, claim to satisfy most of the conditions.

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