

UNITED STATES PATENT OFFICE

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CHEMICAL PULPING PROCESS

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This invention relates to a chemical pulping process and more particularly one involving the use of an alkaline cooking liquor for dissolving out the ligneous, resinous or other encrusting components of wood chips and other fiber-bearing raw cellulosic materials and thereby liberating the ultimate fibers as a pulp suitable for paper-making and other purposes. An objective of the present invention is the production of a pulp which is superior to the usual kraft pulp in such qualities as strength, tear resistance, freedom from shives and resins, and bleachability. Another objective is the accomplishment of the pulping or cooking operation, which takes place as ordinarily under pressure in closed digesters, in a period of time as short as, or even shorter than, that required for the production of the usual kraft pulp so that high pulp production may be realized with a given digester capacity. Still another objective is a cyclic process that includes economical steps of regenerating from the spent cooking liquor the chemicals entering into the cooking operation.

Generally speaking, my process involves first the impregnation of the wood chips with alkali which may be partly and, if desired, largely in the form of sodium sulphide and may be sufficient in amount to effect the desired pulping action, and second the cooking of the impregnated chips at elevated temperature and under pressure in a solution of sodium sulphite to bring about the desired pulping or fiber-liberating action. In some cases, less alkali may be introduced as an impregnant into the chips and the amount of sodium sulphite used in the cooking liquor increased so as to ensure the desired pulping or fiber-liberating action. The step of impregnation may be performed with an alkaline liquor of suitable strength under various conditions, for instance, at room or at elevated temperature, under atmospheric or super-atmospheric pressure, by applying suction to exhaust the air from the chips before the liquor is brought in contact therewith, or by forcing the liquor into the chips under hydraulic pressure, but the temperature of the impregnating liquor is in any case distinctly below that at which pulping or fiber liberation can be effected. Indeed, inasmuch as alkali is, according to my invention, distributed throughout the chips before they are subjected to pulping or fiber-liberating temperatures, I am enabled to realize a pulp of lower shive content and better bleachability than kraft pulp produced as ordinarily by cooking the unimpregnated chips in a kraft liquor. In such

latter case, a nonuniform chemical action on the chips takes place, the outer portion of the chips first being reached and acted upon by the fiber-liberating chemical and undergoing an appreciably longer action than the interior of the chips. Moreover, in the absence of fiber-liberating or pulping chemical, the ligneous content of the wood tends, under the influence of the high temperatures used to cause pulping or fiber-liberating action, to become more resistant to the action of the pulping chemical with the result that the pulping chemical does not uniformly attack the ligneous content of the wood and the resulting pulp contains considerable shives and a substantial portion of fiber higher in ligneous matter and hence more difficultly bleachable than the rest of the pulp. Indeed, the portions of the chips that are deficient in chemical become partially hydrolyzed under the action of heat and moisture; and the resulting pulp is not only high in its shive content but has poorer physical or papermaking characteristics. The solution of sodium sulphite serving as the environment or medium in which the alkali-impregnated chips undergo cooking not only promotes fiber-liberating action especially in the presence of the alkali but leads to a pulp particularly high in Mullen or bursting strength and readily bleachable to whiteness while retaining excellent physical or papermaking characteristics.

As illustrative of practice falling within the purview of my invention, I may cite the following specific procedure. Wood of any suitable pulp-making character, for instance, not only such woods as spruce, but also pine and other resinous woods, hardwoods, etc., may be cut into chips of the usual size or even larger. The chips may be impregnated under suitable time, temperature and pressure conditions with an alkaline liquor whose alkalinity is furnished at least partly, if not largely, by sodium sulphide. The rest of the alkalinity may be furnished by caustic soda and/or sodium carbonate. Such alkaline liquor may be one which has been prepared from regenerated chemicals as will presently be described. The alkaline liquor may be one whose total alkalinity may amount in terms of Na_2O equivalent to about 4 to 5 pounds per cubic foot and the impregnating conditions may be such as to get into the chips about 0.10 to 0.20 pound of Na_2O equivalent per pound of bone-dry wood, which amount of alkali may be substantially all that is necessary to liberate the fiber from the wood. After impregnation with the alkaline

liquor has been concluded, the excess liquor may be drained from the chips and the chips charged directly, that is, without washing, into the usual type of alkaline digester. The chips may be about 30% dry at the time they enter the digester. In some instances, both the step of impregnating the chips and that of cooking the impregnated chips may be performed in the same digester, in which case provision is made for draining the excess impregnating liquor from the chips before the cooking liquor is added thereto. To the digester charged with the chips may be added a sodium sulphite cooking solution of about 4% to 10% strength in amount to associate, say, about 0.2 to 0.8 pound of sodium sulphite per pound of bone-dry wood. The digester may then be closed and its contents heated to a temperature ranging from, say, about 335° to 360° F. For instance, the digester contents may be brought to a temperature of about 350° F. and this temperature maintained for about three hours. At the end of this time, it will be found that a pulp of excellent physical characteristics, including particularly high Mullen or bursting strength and good tear resistance, is produced. The pulp contains comparatively few shives, and can be bleached into a white product of excellent paper-making properties.

The spent cooking liquor separated by washing the pulp as ordinarily after the digester contents have been discharged can be put through the initial recovery steps customarily performed in a kraft mill. The spent liquor can be considered as having resulted from a fresh cooking liquor containing sodium sulphide and sodium sulphite and, if desired, caustic soda and/or sodium carbonate, even though these chemicals are not commingled in a single solution to begin with but are used in such a way that the alkali, namely, the sodium sulphide, and, if desired, caustic soda and/or sodium carbonate, is present inside the chips at the very beginning of the cooking operation and the sodium sulphite occurs in solution in the cooking medium surrounding the chips. Irrespective of whether such spent liquor is first put through a rotary kiln and calciner to produce so-called black ash or whether the liquor is first concentrated as in multiple effect evaporators and the concentrated liquor delivered into a smelting furnace, the net result is that as in the ordinary kraft recovery process, the organic content of the spent liquor is consumed by combustion and its inorganic content smelted in a reducing atmosphere to produce a smelt containing essentially sodium sulphide and sodium carbonate. The sodium carbonate can be abstracted in any desired amount or practically in entirety from the smelt and serve as the base for the preparation of the sodium sulphite solution used as the cooking or pulping medium. Thus, the smelt may in accordance with the practice of the present invention be dissolved in water to form a solution from which the sodium carbonate, on account of its lower solubility than sodium sulphide, may be crystallized out selectively in the desired amount or practically in entirety. The sodium carbonate crystals separated from the solution may be treated with sulphur dioxide and water to produce a solution of sodium sulphite of the strength requisite for the cooking or pulping of the alkali-impregnated chips. The mother liquor whose sulphidity has been increased by the removal of the sodium carbonate and which in fact may be of a sulphidity approaching 100% may be used as the alkaline liquor for impregnating

the wood chips preparatory to the cooking or pulping operation. On the other hand, most or all of the sodium carbonate present in the smelt solution may be permitted to remain therein, in which case the sodium sulphite necessary for the cooking liquor may be prepared from sodium carbonate that enters as make-up chemical into the process. Should an appreciable amount of sodium carbonate be left in the mother liquor, it may, if desired, be partly or completely causticized as usual with lime to produce an alkaline impregnating liquor containing caustic soda. It is thus seen that even when all of the sodium carbonate of the mother liquor is causticized, my process dispenses with the use of lime to an extent determined by the amount of sodium carbonate removed from the smelt and converted into sodium sulphite, and that the use of lime is entirely done away with when the impregnating liquor contains essentially only sodium sulphide and sodium carbonate. My process does, however, call for the burning of sulphur or iron pyrites to form such sulphur dioxide as may be necessary for converting the sodium carbonate into sodium sulphite. A substantial amount, if not most, of the required sulphur dioxide is available in the flue gases emanating from the smelting furnace, particularly when the make-up chemical for the process is salt cake.

While the make-up chemical in my process may be so-called salt cake (sodium sulphate) which may be added as ordinarily to the spent liquor and thus be reduced to sodium sulphide during the smelting operation, nevertheless it is possible, as already indicated, to use sodium carbonate to good advantage for such purpose, the make-up sodium carbonate going into the preparation of the sodium sulphite solution along with the sodium carbonate abstracted from the smelt solution. Such sodium carbonate as remains in the smelt solution may be kept as such or be causticized partly or completely so as to appear as caustic soda in the alkaline impregnating liquor. The use of sodium carbonate as the make-up chemical is advantageous particularly over such practice as involves the addition of salt cake as a make-up chemical to a concentrated spent liquor that is sent to a combined smelting and boiler furnace, as such latter practice lowers the heat-recovery efficiency of the furnace and makes it difficult to operate the furnace under the best reducing conditions. Caustic soda may, if desired, be used as part or all of the make-up chemical for the process and be added to the smelt solution, that is, the impregnating liquor.

I claim:

1. In a process of pulping wood chips involving the smelting of the inorganic content of spent cooking liquor to produce a smelt containing sodium sulphide and sodium carbonate and dissolving the smelt in water, those steps which comprise abstracting sodium carbonate from the solution and converting it into sodium sulphite, impregnating the chips with the solution from which the sodium carbonate has been abstracted, and pulping the impregnated chips in a solution of the sodium sulphite.

2. In a cyclic process of pulping wood chips involving the smelting of the inorganic content of spent cooking liquor to produce a smelt containing sodium sulphide and sodium carbonate and dissolving the smelt in water, those steps which comprise abstracting sodium carbonate from the solution and converting it into sodium sulphite

phite, impregnating the chips with the solution from which the sodium carbonate has been abstracted, pulping the impregnated chips in a solution of the sodium sulphite, separating the spent liquor from the resulting pulp, and smelting the inorganic content of the spent liquor to produce the smelt for the repetition of the cycle.	
3. In a cyclic process of pulping wood chips involving the smelting of the inorganic content of spent cooking liquor to produce a smelt containing sodium sulphide and sodium carbonate and dissolving the smelt in water, those steps which comprise abstracting only part of the sodium carbonate from the smelt solution and converting it into sodium sulphite, causticizing at least some of the sodium carbonate remaining in the smelt solution, impregnating the chips with the causticized smelt solution, pulping the impregnated chips in a solution of sodium sulphite, separating the spent liquor from the resulting pulp, and smelting the inorganic content of the spent liquor to produce the smelt for the repetition of the cycle.	
4. In a cyclic process of pulping wood chips involving the smelting of the inorganic content of spent cooking liquor to produce a smelt containing sodium sulphide and sodium carbonate and dissolving the smelt in water, those steps which comprise abstracting sodium carbonate from the solution and converting it into sodium sulphite, impregnating the chips with the solution from which the sodium carbonate has been abstracted, pulping the impregnated chips in a solution of the sodium sulphite, separating the spent liquor from the resulting pulp, smelting the inorganic content of the spent liquor to produce the smelt for the repetition of the cycle, and adding sodium carbonate as a make-up chemical in the process to the sodium carbonate abstracted from the solution prepared from the smelt.	80
5. A process of pulping wood chips which comprises impregnating the chips with an alkaline liquor containing sodium sulphide, caustic soda, and sodium carbonate, and then pulping the impregnated chips in a solution of sodium sulphite.	85
6. A process of pulping wood chips which comprises impregnating the chips with an alkaline liquor containing sodium sulphide and then pulping the impregnated chips in a solution of sodium sulphite.	90
7. A process of pulping wood chips which comprises impregnating the chips with an alkaline liquor containing caustic soda and then pulping the impregnated chips in a solution of sodium sulphite.	95
8. A process of pulping wood chips which comprises impregnating the chips with an alkaline liquor containing sodium sulphide and caustic soda and then pulping the impregnated chips in a solution of sodium sulphite.	100
9. A process of pulping wood chips which comprises impregnating the chips with an alkaline liquor containing sodium carbonate and then pulping the impregnated chips in a solution of sodium sulphite.	105
10. A process of pulping wood chips which comprises impregnating the chips with an alkaline liquor containing sodium sulphide and sodium carbonate and then pulping the impregnated chips in a solution of sodium sulphite.	110
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