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METHOD OF MANUFACTURING CHEMICAL PULP OR CELLULOSE

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This invention relates to a method of making chemical pulp or cellulose by digesting wood chips or other suitable fibrous materials with chemicals which have the effect of dissolving the non-cellulose constituents, leaving cellulose in an insoluble state to be recovered.

An underlying conception of the invention is that by the use of a sustained pressure, preferably of nitrogen (or other suitable inert or non-oxidizing gas) upon the surface of the liquor used for cooking the wood chips or fibre, extent and rapidity of penetration are increased, while at the same time oxidation is decreased, as compared with methods now in use. The pressure of propellant gas is obtained by injecting it, for instance, into the top of a freshly charged and covered digester until the inside pressure has reached 20 to 100 lbs. per square inch (gauge). This initial pressure, reached at the start of the cook, is to be sustained while the cook continues in the usual way.

The new step of process to which I have referred may be utilized in connection with the familiar sulfite process, in which shipped wood is placed in a digester together with a solution of sulfur dioxide, including some alkaline earth bisulfite such as calcium bisulfite, magnesium bisulfite, or both together. Such solution will have approximately one per cent combined sulfur dioxide (associated chemically with lime to form the alkaline earth bisulfite) and 3½ per cent of uncombined sulfur dioxide. Above this liquor and the chips will be a certain amount of air. According to the old practice, the cover of the digester is then lowered and bolted in place, and the contents of the digester heated by injecting steam at the bottom.

In accordance with the present invention a pressure of nitrogen gas (or other suitable inert or non-oxidizing gas) is introduced into the digester at the beginning of the cook. It is known that the higher the average gas or digester pressure during the impregnation period (before any part of the chips have been heated above the critical temperature of 110° C.), the shorter will be the time required to reach maximum penetration. The use of nitrogen gas, because of its relative insolubility in water (under elevated pressures) permits the attainment of as high a pressure as desired within a freshly charged digester in a brief interval of time. The digester pressure may be brought immediately to 75 pounds per square inch (gauge) or more if desired, and once the desired pressure is attained there is no tendency for it to fall. In fact, it continues to rise after the injection of nitrogen gas into the digester has been stopped. This further rise in pressure is caused by the increased partial pressure of the sulfur dioxide in the gas or vapor portion of the digester, resulting from the gradual liberation of sulfur dioxide gas from the sulfite cooking acid during the period of rising temperature. Preferably after the penetration-promoting gas has been introduced into the digester, the combined gas pressure should at no time before the end of the cook be less than 20 lbs. per square inch (gauge), and in fact it should preferably be substantially greater during any part or all of the cook, than is normally obtained in the customary way of conducting such cooks; nor should the ratio of oxygen to nitrogen within the digester be greater than 1 to 6 by volume.

Optimum pressure conditions, which by old methods are not attained until after the cook has proceeded for a considerable time, are by my process established within the digester at a very much earlier stage, and even at the very beginning, of the cook, and maintained.

Important practical advantages result from the use of the new process. In the first place, it is found that the use of the propellant non-oxidizing gas markedly decreases the bleach consumption of the resulting pulp. This is due in part at least to the fact that nitrogen (if nitrogen be the gas) is an inert gas which dissolves but little in the hot cooking liquor, or even at the beginning in the cold cooking liquor. Furthermore, since the normal content of air in the digester has been in part at least flushed out and replaced by the gas, the usual oxidation is diminished

On this point it has been found in a series of small scale experiments that if digester runs which have been cooked with an initial pressure of nitrogen gas of approximately 75 pounds (gauge) before the heating up began, be taken as standard, then (1) the cooking in the ordinary way (that is, without booster gas) required 67% more of bleaching material; (2) cooking with compressed air required 134% more bleaching material; (3) cooking with compressed carbon-dioxide, 64% more bleaching material; and (4) cooking with compressed sulfur dioxide, 24% more bleaching material.

Another advantage which the use of nitrogen exhibits in comparison with sulfur dioxide, and, to a less extent, in comparison with carbon dioxide (particularly at the beginning of the cook when the liquor is cold), is that one can maintain as high an initial pressure as desired without having any of the gas condense or go into solution. Moreover, sulfur dioxide and carbon dioxide are comparatively expensive gases, and there is a tendency toward falling pressures, due to their solution in the liquor.

Still another advantage resulting from the non-oxidizing gas pressure sustained from the beginning of the cook is that the gas has a propellant function and increases the speed with which the cooking liquor penetrates the chips or fibres, whereby the chance of "screenings" formation is decreased. It is well known that "screenings" formation takes place to an extent inversely proportioned to the degree of chip penetration at the time the charge reaches a temperature of 110° C. Pulp "screenings" constitutes a worthless product, and is often formed at the sacrifice of wood pulp when chip penetration at the critical stage of a cook is incomplete.

A further advantage resulting from the use of this invention is that because the gas pressure is put on at the beginning of the cook it is possible to shorten the digestion period and hence to effect economy as to fuel and overhead, and also to increase plant production.

It will be evident that the increased speed of penetration of the liquor into the chips, the inhibition of deleterious oxidation, the maintenance of pressure conditions, and other results following upon the application of the gas pressure, are functions of each other and interactively effective to produce important individual and combination advantages which will be obvious to those skilled in the art. For example, shortening of the time necessary for the completion of the cook means that costs are reduced, output increased, and quality of the final product improved. Furthermore, it is known that prolonged cooking or bleaching operations, besides being expensive, are apt to decrease the yield and affect adversely the quality of the fibre.

Nitrogen has been mentioned as possibly the preferred non-oxidizing gas; but it is contemplated that other gases may be employed, for instance, carbon dioxide, or mixtures of nitrogen and carbon dioxide in any ratio. Although carbon dioxide is about 56 times more soluble in water than nitrogen at room temperature, it is only about 1/45 as soluble in water as sulfur dioxide at that temperature. Trouble from falling digester pressure due to the gradual solution of the injected gas, while totally absent in the case of nitrogen, is only slightly noticeable in the case of carbon dioxide. With sulfur dioxide, however, the tendency is very pronounced; though of course this particular objection could be overcome by continuing the injection of the heated sulfur dioxide gas into the top of the digester, so as to replace the gas condensed or dissolved in the unsaturated cooking acid. For reasons of economy and general effectiveness, however, I prefer to use nitrogen or some other gas that is both non-oxidizing and relatively insoluble in the digestive agent at ordinary room temperatures and pressures.

Air as the penetration-booster is objectionable, as compared with nitrogen, for instance, because the oxygen content thereof affects deleteriously the quality of the pulp and increases the bleaching expense.

Carbon dioxide might be considered a substantially inert gas, but it is not so inert as nitrogen, and it is relatively expensive, and also somewhat soluble in the cooking liquor.

The use of the sustained gas pressure for aiding chip penetration at the start of the cook will undoubtedly be found to be most beneficial in the case of chips that are air dried (having a moisture content of 10% or less), and least beneficial in the case of water saturated chips (having a moisture content of 50% or more). Between these limits the value of this treatment should be inversely proportional to the moisture content of the chips being cooked. If all the pores and cavities of a chip are initially filled with water accompanying the green or freshly cut wood, it would be physically impossible to force more liquid (in the form of cooking liquor) into the chip by the application of pressure, no matter how high that pressure. Freshly cut wood, such as spruce or balsam fir will frequently be found to carry 50% or more of moisture. For this reason, in many mills the wood is allowed to dry in the air, or season, for periods of a year or more. This naturally leads to a reduction in the moisture content to 20 or 30%. It has also been proposed that wood chips be dried artificially by means of such agents as hot flue gas. Artificially dried chips or chips from seasoned wood will benefit greatly from the application of the non-

oxidizing gas under pressure, giving maximum yield of good quality pulp, minimum yield of "screenings", and minimum bleach consumption.

The needed nitrogen gas can be obtained in sufficient purity by taking the present waste gases available from the stack at the outlet of the "acid making plant" where water and lime compounds are treated with the burner gas from the sulfur burners. The sulfur burns with the oxygen of the air to give sulfur dioxide, and this sulfur dioxide is absorbed by the lime compounds and water to give the cooking acid, and there is a residue of nearly pure nitrogen. By running this through a compressor the nitrogen can be obtained at the desired pressure at almost no cost in the plant.

There are other sources of reasonably pure nitrogen available around a mill which will undoubtedly serve excellently in accomplishing the effect desired by this modified pressure treatment. For instance, scrubbed or just filtered flue gas would act nearly as well as pure nitrogen, even though it would contain 10 to 20% of carbon dioxide. Such gas would be much superior to air on account of its much lower oxygen content.

Although I have referred particularly in the foregoing description to the use of the non-oxidizing gas treatment in connection with the sulfite process, it is to be understood that other methods of producing pulp, as for instance, the soda or sulfate processes, may also be improved by adding the step of introducing a pressure of non-oxidizing gas at the beginning of the cook.

In order to further reduce oxidation during the cook, I may produce a vacuum as preliminary to introduction of the booster gas.

In applying a vacuum to a sulphite digester previous to the injection of a non-oxidizing gas, it is desirable that it be done before the addition of the cooking liquor to the digester, in order to avoid the loss of free sulfur dioxide from said liquor. This vacuum is next displaced by an atmosphere of nitrogen (or other inert gas) before running in the liquor.

The preliminary vacuum treatment is effective in eliminating all traces of oxygen accompanying the air inside the digester. The advantage of doing this may prove of sufficient value to warrant the added expense involved.

In the appended claims by sulfite process is meant the "familiar sulfite process" described on page 1 of this specification where lime, magnesia, or other base is used as the base of the bisulfite constituent of the solution.

I claim:

1. The method of producing pulp which comprises subjecting wood chips or the like material to the action of a suitable digestive agent under an initial penetration-boosting pressure of non-oxidizing gas, which is a permanent gas at ordinary temperature and pressure and is not substantially absorbed in the digestive process.

2. The method of producing pulp which comprises subjecting wood chips or the like material to the action of a suitable digestive agent under a penetration boosting pressure of a relatively non-absorbable non-oxidizing gas which is a permanent gas at ordinary temperature and pressure, said pressure being sustained until digestion is complete.

3. As a step in the manufacture of pulp by the sulfite process, introducing non-oxidizing gas under penetration-boosting pressure into the digester at the beginning of the cook.

4. As a step in the manufacture of pulp by the sulfite process, introducing non-oxidizing gas under penetration-boosting pressure into the digester at the beginning of the cook, and maintaining the pressure of gas until penetration is complete.

5. The method of producing pulp which comprises subjecting wood chips or the like material to the action of a suitable digestive agent under a penetration-boosting pressure of a non-oxidizing gas that is relatively insoluble in said agent.

6. The method of producing pulp which comprises subjecting wood chips or the like material to the action of a suitable digestive agent under a penetration-boosting pressure of relatively inert gas.

7. The method of producing pulp which comprises subjecting wood chips or the like material to the action of a suitable digestive agent under a penetration-boosting pressure of nitrogen.

8. The method of producing pulp which comprises subjecting dry wood chips or the like material to the action of a suitable digestive agent under sustained penetration-boosting pressure of relatively inert gas.

9. As a step in the manufacture of pulp by the sulfite process introducing a non-oxidizing gas under suitable pressure into the digester at the beginning of the cook, and maintaining the pressure until the cook is complete, thereby effecting substantially complete chip penetration prior to the stage of the cook when the digester charge reaches a temperature of 110° C.

10. As a step in the manufacture of pulp by the sulfite process, the establishing of optimum penetration-boosting conditions within the digester at the beginning of the cook by introducing into the digester under suitable pressure a non-oxidizing gas or combination of gases, and maintaining the pressure until the cook is complete.

11. As a step in the manufacture of pulp by the sulfite process, artificially building up the pressure in the digester, at the beginning of the cook, without access of oxygen, to a point at which chip penetration is boosted,

and maintaining the boosting pressure at least to the stage of the cook at which a temperature of 110° C. is reached in the digester.

12. The method of producing pulp which comprises subjecting wood chips or the like material to the action of a suitable digestive agent, under penetration-boosting pressure of a relatively non-absorbable non-oxidizing gas, which is a permanent gas at ordinary temperature and pressure, and maintaining the pressure from the beginning of the cook until the end thereof.

13. The method set forth in claim 12, in which the gas is chosen for its relative insolubility in the digestive agent.

14. The method of producing pulp by the sulfite process, which comprises applying a vacuum to the chip filled digester, then introducing a non-oxidizing gas at substantially atmospheric pressure, then introducing the digestive agent, then adding more non-oxidizing gas until a penetration-boosting pressure is reached, and then beginning and completing the cook while maintaining the pressure, said non-oxidizing gas being a permanent gas at ordinary temperature and pressure.

15. The method of producing pulp by the sulfite process which comprises the following steps; applying a vacuum to the filled digester, inserting the digestive solution, and adding a non-oxidizing gas until a penetration-boosting pressure is reached.

16. The method of producing pulp which comprises subjecting wood chips or the like material to the action of a suitable digestive agent, under penetration-boosting pressure of a non-oxidizing gas introduced in the gaseous phase, and maintaining the pressure from the beginning of the cook until the end thereof.

In testimony whereof I affix my signature.

DONALD E. CABLE.