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PULPING PROCESS

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This invention relates to a pulping process for fibrous vegetable materials containing cellulose, including wood, straw and other agricultural residues.

There is a great deal of prior art concerned with the converting of such fibrous materials to a pulp suitable for making paper and other fibrous products. This prior art is reviewed briefly.

Historically, pulp was first produced from wood by simply pressing a log against a grindstone and the wood was reduced to a fibrous pulp. By this process a yield approaching 95% was obtained but the resulting pulp contained all of the lignin and other impurities in the wood. Such a pulp is difficult to bleach and the fiber length is seriously altered in the grinding process. To meet the demand for higher grade pulps the so-called chemical pulping processes such as sulfite, sulfate, and soda were developed. In these processes the wood is reduced to chips and the chips are treated with chemicals at elevated temperature and pressure. In the cooking process the lignin, as well as some of the carbohydrate material, is solubilized and removed so that the yield is usually between about 45 and 50%. These pulps are frequently bleached with chlorine, caustic, and hypochlorite to remove the last traces of lignin and other colored impurities.

More recently, pulping processes which are a compromise of the groundwood and the chemical processes have been developed. For example, in the neutral sulfite semi-chemical process (NSSC), wood is chipped, the chips are subjected to a mild chemical treatment, and then the chips are disintegrated mechanically in some type of attrition mill. In this way, yields from 60 to 90% can be obtained depending on the severity of the chemical treatment. If the pulp is to be bleached, the chips are cooked so that an unbleached yield of 70% is obtained. After bleaching with chlorine, caustic, and hypochlorite, the bleached yield may be 55 to 60%. The wood is cooked to a final yield of around 75% if the pulp is to be used in unbleached form.

Very recently, processes in which the chips are given a very mild chemical pre-treatment generally at super-atmospheric pressures and then mechanically disintegrated, to give a yield of from 85–95%, have gained industry acceptance. These pulps have many properties which make them acceptable and desirable in such products as printing and tissue paper. However, they contain all or most all of the lignin originally present in the wood, and for this reason are difficult to bleach. The lignin can be removed in subsequent bleaching steps with chlorine and caustic but this is prohibitively expensive for most purposes, and the yield is no better than in the bleached NSSC process (i.e., around 60%). For this reason bleaching agents which will remove the colored material and will not remove the lignin are employed. Such chemicals are expensive and the degree of brightening which can be obtained is relatively limited. Thus this high-yield process gives a pulp which is not always suitable for making high-brightness products such as tissues, etc., where pulp of high brightness is required. It would be desirable, therefore, to be able to make a pulp of a good brightness by a high-yield process requiring a minimum amount of treating, particularly a minimum amount of chemical reactants.

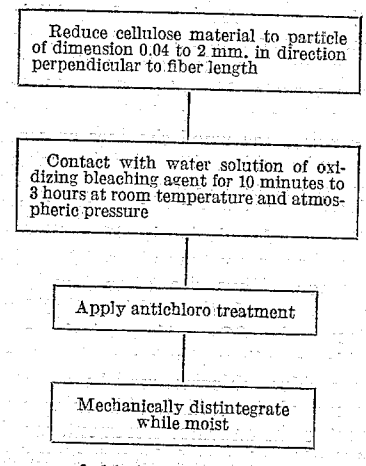
It is, therefore, an object of this invention to provide a process by which fibrous vegetable materials containing cellulose, and particularly wood, can be converted to a pulp of high brightness with a minimum amount of treatment, and using a minimum amount of chemicals. It is another object of this invention to provide a process whereby a combination of chemical and mechanical treatments can be applied to wood to produce a pulp of high brightness. Still another object of this invention is to provide a high-yield process for forming a relatively bright pulp. These and other objects will be apparent in the following discussion.

The process of this invention for pulping cellulosic materials comprises the steps of reducing the cellulosic material to be pulped to particulate matter to the extent that the dimension of substantially all of the individual particles, which is perpendicular to the direction of the fibers contained therein, is between about 0.04 and 2 mm., treating the particulate matter with an oxidizing-bleaching agent for a relatively brief period of time, e.g., from about ten minutes to three hours at essentially room temperature and atmospheric pressure, and finally mechanically disintegrating the resulting softened material to fibrous pulp. An antichlor treatment may be incorporated after the cellulosic material has been removed from the oxidizing-bleaching treatment. The use of the oxidizing-bleaching agent on the fine particulate matter makes possible relatively rapid softening and eliminates any heating or cooking of the fiber-producing material.

In the case where wood is used as the source of cellulosic material, the wood is reduced to shavings ranging in thickness from about 0.04 to 2 mm. Where raw materials such as straw or bagasse are used, they may be reduced in size by milling, chopping or by other suitable procedures. Where straw is used, it is preferable to cut it in about ½ inch lengths. Although the process of this invention is applicable to different cellulosic materials, it will be described in detail with reference to its application to wood. This is done for convenience of presentation and it is not meant to limit the process to wood.

The process of this invention embodies the advantages of operating at atmospheric pressure, and of replacing the usual cooking chemicals with a bleach. It yields a pulp which may require little, if any, bleaching subsequent to the mechanical disintegration. Each of the steps of the process of this invention may be performed over a relatively short period of time and the entire process may be a continuous one. By pre-bleaching wood reduced to shavings, it is possible to obtain a final color of high brightness without destroying the lignin contained in the wood, thus providing an exceptionally high-yield process.

A flowsheet of the improved process is as follows:



In the process of this invention, the wood is reduced to

shavings, the maximum thickness across the grain being not more than about 2 millimeters; while the minimum is preferably around 0.04. This is to be contrasted with the conventional wood chips normally used in pulping processes which are generally from ¼ to ½ inch (about 6 to 13 mm.) thick, with a small percent perhaps being as thin as ⅛ inch (about 3 mm.). The use of shavings or other forms of particulate matter means that the oxidizing-bleaching agent penetrates rapidly and completely through the shavings. In contrast, when a bleaching agent is applied to the conventional-sized chips, the bleach is exhausted rapidly on the surface of the chips resulting in the overtreating of the outside and undertreating of the centers of the chips.

Woods which are suitable for reduction to shavings, and hence adaptable to the process of this invention, include both the hardwood and softwood species. However, for economic reasons the hardwoods such as poplar, aspen, maple, oak, gum, birch, and beech are preferably employed. The wood, or other cellulose material, may be reduced to shavings of the size specified by any suitable mechanical apparatus designed for the purpose.

The oxidizing-bleaching agent used to treat the wood shavings may be any of the chemicals which are known to soften these woods. Such chemicals include, but are not limited to, the alkaline hypochlorites such as sodium and calcium hypochlorites, sodium peroxide, chlorine dioxide, and the like. If the shavings are not soft enough the resulting pulp will have very little fibrous characteristic and will be comparable to wood flour. To obtain the desired degree of softening, wood shavings are preferably treated with the oxidizing-bleaching agent for from about 10 minutes to 3 hours at room temperature and atmospheric pressure. This treatment may be carried out by immersing the shavings in a water solution of the oxidizing-bleaching agent used in a quantity sufficient to cover the shavings, the ratio of the weight of water to the weight of wood shavings being of the order of 10 to 1. Alternatively, water solutions of the oxidizing-bleaching agents may be sprayed on the shavings on a conveyor bed passing under a sprayhead.

The concentration of the oxidizing-bleaching agent depends upon the agent used. For example, when an aqueous solution of an alkaline hypochlorite is employed, the amount of hypochlorite may range from about 5 to 20%, expressed in terms of active chlorine, and based upon the weight of the dry cellulosic material to be pulped. If sodium peroxide is used, this oxidizing-bleaching agent is preferably present in an aqueous solution in concentrations ranging from about 1 to 3% by weight based upon the weight of the dry cellulosic material to be pulped. If chlorine dioxide is used, the aqueous solution employed as an oxidizing-bleaching agent preferably contains the equivalent of from about 0.5 to 1.5% of the chlorine dioxide based on the dry weight of the cellulosic material. It will generally be preferable to use the lower water-solution concentrations of oxidizing-bleaching agents when the wood, or other cellulosic material, is to be treated by immersion in water; while the higher concentrations are preferable when the oxidizing-bleaching agent is sprayed on a moving bed of cellulosic material.

After bleaching, the wood shavings or other cellulosic materials, may be subjected to a brief antichlor treatment which may consist of washing the shavings in a dilute sulfite solution. This can be done by draining off the bleaching liquor and replacing it with a dilute sulfite solution containing not more than about 0.3% SO_2 by weight of the dry wood. Thus if a 10 to 1 ratio of antichlor liquid to wood is used, the antichlor liquid will contain 0.3% or less active SO_2. Alternatively, a quantity of sulfur dioxide or sodium bisulfite, sufficient to react with and destroy residual chlorine, may be added to the solution at the end of the oxidizing-bleaching step.

Subsequent to the antichlor treatment, the shavings are drained of liquid and passed through a mechanical disintegration apparatus while they are still in a moist condition.

In the mechanical disintegration process the softened shavings, straw, bagasse or other cellulosic materials, are reduced to fibers suitable for paper making, more particularly as furnish components for printing papers, tissue papers, and other fine papers.

The process of this invention may be further illustrated by the following example, which is meant to be illustrative and not limiting.

A 2-pound batch of aspen wood shavings having an average thickness of about 0.5 millimeter was treated by soaking the shavings for 3 hours in 20 lbs. of a 2% hypochlorite solution (20% active chlorine based on dry wood) as the oxidizing-bleaching agent. The initial pH of the treating solution was 12. A control batch of similarly sized shavings was treated with a dilute caustic solution (not a wood-softening agent) at pH 12 under the same conditions.

The two batches of wood shavings were each treated with sodium bisulfite as an antichlor agent, and after draining were separately passed through an 8-inch disc mill for pulping. Although the peripheral speed of the discs of this mill was much lower than commercial equipment, it was possible to evaluate comparative results from these two batches. After several passes with a relatively coarse set of plates the hypochlorite-treated shavings were found to be softer and they developed a fibrous pulp more rapidly than the caustic treated shavings. After several more passes with finer plates, the pulps were examined and it was found that the caustic treated wood chips gave a flour like material with very little fibrous character, while the pulp from the hypochlorite treated chips was a fibrous product.

Hand sheets were made from both pulps. That from the caustic treated pulp was brittle and crumbled on bending while that from the hypochlorite treated pulp exhibited a measurable degree of tear strength.

This example illustrates the role of the oxidizing-bleaching agent required in the process of this invention, and the necessity for this agent to penetrate and soften the entire shaving. If chips of the normal size (e.g., from about 6 to 13 mm. thick) had been used, the oxidizing-bleaching agent would not have penetrated beyond probably about 1 to 2 mm. of the chips in the time (3 hours. If the treating time were extended in handling chips, then their outer surfaces would be oversoftened at the expense of achieving added penetration.

I claim:

Process of pulping cellulosic material, comprising the steps of reducing cellulosic material to small particles the dimension perpendicular to fiber direction of substantially all of which is between 0.04 and 2 mm., contacting said particles with a water solution of an oxidizing-bleaching agent selected from the group consisting of alkaline hypochlorites, sodium peroxide and chlorine dioxide thereby to rapidly and uniformly soften said particles without any substantial destruction and removal of lignin from said particles, the amount of said solution amounting to about ten times the weight of said particles, said contacting being carried out from 10 minutes to 3 hours at essentially room temperature and atmospheric pressure; subjecting the resulting softened particles to an antichlor treatment; and mechanically disintegrating said soft particles in a moist condition thereby to produce fibers.

References Cited in the file of this patent

UNITED STATES PATENTS

701,271	Lee	May 27, 1902
1,557,338	Runkel	Oct. 13, 1925
1,816,394	Muller	July 28, 1931
1,894,501	Taylor	Jan. 17, 1933
2,007,348	Scharmann	July 9, 1935