

WOOD PULP ~ ~ DEPARTMENT

CHEMICAL WOOD PULP.*

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The word pulp is a term which generally may be applied to a number of materials, which are quite variable in character but more or less similar in appearance, therefore if we first classify these in a general way, we shall have a somewhat clearer conception of that special kind that we are about to discuss. We may divide them into four classes according to quality, namely:

I. Rag Pulp—which is made from cotton, linen or hemp fibres.

II. and III. Wood Pulps—which are of two kinds, chemical and mechanical.

IV. Straw Pulp—which is a chemical product of inferior quality.

As the manufacture of mechanical wood pulp was very ably described in a paper read before this Society last year, the subject matter of this article will deal exclusively with its half-brother of the chemical species, which is in reality another product from the same substance.

Mechanical pulp is simply wood ground to a fine powder and consists chemically of a combination of celluloses and lignocelluloses. Now if instead of grinding, we treat the wood with a chemical solution, which disintegrates it and dissolves out the lignocelluloses, we then have left what is commonly called chemical pulp, and this consists of those celluloses which have resisted the action of the solvent. As about half of the woody substance is thus removed and destroyed, the remaining product must necessarily be more costly than the ground pulp, but the fibres remaining are white and unbroken and are only comparable with the cheaper product when quality is not required. Mechanical pulp has a very short fibre, little felting power, is quickly discolored in air and light, and is only used as a filling material in news, wrapping, and other papers of a temporary character. Chemical wood pulp, however, makes a good, white, permanent paper, and is the source of most of our writing materials, although it makes neither as strong nor as resistant a paper as do the rag pulps.

The pulps prepared from straw are pronounced oxycelluloses, and have considerably more chemical activity than those prepared from the woods.

There are two distinct methods of preparing the chemical wood pulp, which may be designated as the alkaline and the acid. In the alkaline or soda process the usual method employed is to pack the wood in the form of chips into a horizontal cylindrical rotating digester, which has a capacity of about three cords. Here it is digested, with about seven hundred gallons of a six to nine per cent. solution of sodium hydrate, which is heated to high temperatures by means of live steam. The boiling lasts from eight to ten hours, at pressures which may vary from sixty to two hundred and ten pounds per sq. in. The products resulting from this "cook" are grayish brown pulp and a dark brown liquor, which are dumped into iron washing tanks, and after the liquor is drained off, the pulp is thoroughly washed. But as these wash waters are finally evaporated in order to recover the contained soda, they are used until they become quite concentrated, the pulp being washed continuously with a less concentrated solution until all the alkali is removed. The pulp is now treated with a bleaching solution, which contains twelve to fourteen pounds of bleaching powder for every hundred

pounds of pulp, and this removes the remaining ligneous matter, leaving a pure white cellulose.

The recovery of the soda from the waste liquor is accomplished by evaporation in vacuum pans until it has a density of 40 degrees Baume, when it is burned in a special furnace to remove the organic matter. The remaining ash contains the soda in the form of a carbonate, and when this is heated in tanks with slaked lime, in the proportion of one hundred of soda to sixty of lime, the lime is precipitated as calcium carbonate and the soda becomes caustic again.

Another method of recovering the soda, which has been lately adopted, consists in heating three parts of ferric oxide with one of soda carbonate, when sodium ferrate is formed. And on heating this with hot water, it decomposes, forming sodium hydrate and ferric oxide once more. The liquors of the alkaline process, sometimes contain large quantities of the sulphate or carbonate which are cheaper although weaker in action than the hydrate. In addition to the recovery of the soda from these liquors, a valuable product in the form of acetate, may be obtained from the organic matter of the solution. As perhaps you are aware, one of the standard methods for the manufacture of oxalic acid, is the treatment of wood or sawdust with alkaline hydrates at temperatures ranging from 200 degrees to 250 degrees C.

Now if the heating is prolonged and oxidation is allowed to take place, either from contact with air or oxidizing agents, a large percentage of acetic acid is formed. Therefore if the soda liquor is evaporated and charred at temperatures from 350 degrees to 400 degrees C, the organic matter reacts with the soda to form sodium acetate ($\text{Na C}_2\text{H}_4\text{O}_2, 3\text{H}_2\text{O}$). This product comprises about 38 per cent. of the soluble portion of the char, and about 16 per cent. of the residue. With Esparto liquor five to six per cent. of the weight of the original fibre was obtained.

In the soda process poplar is largely used, although maple, cottonwood, white birch and basswood, are also employed. The spruce, pine and hemlock yield a long fibre, but are a little more difficult to treat. The main objections to the process are:

1. The high temperatures and pressures required.
2. The formation of dark colored products which are difficult to remove from the pulp.
3. The destructive action that the alkalis have on the celluloses themselves, as the less resistant are attacked and dissolved in the severe treatment required to remove the ligneous portion.

The acid or sulphite process:—

This is the process which is now being most commonly introduced into this country, because it has several important advantages over the alkaline treatments just described. In the first place, the cost in chemicals is less; and a larger yield of fibre is obtained, which is not weakened by the treatment. And secondly, the paper, which is made from this pulp is harder and more transparent and durable than that from wood pulps made by other methods. The treatment consists in digesting the wood at high temperatures with an acid sulphite solution. The acid radical unites with the products of hydrolysis to form soluble sulphonated derivatives, while the base unites with the acid products of the decomposition. The hydrolytic action is greatly increased by the presence of sulphurous acid, and for this reason, the bi-sulphite (Na H SO_3) so-

lution effects a reduction in less time, and at lower temperatures, than a neutral sulphite solution would.

Now, turning our attention to some of the details of the treatment, we find that the bark and knots and also the resinous matters of the wood are very slightly acted upon by these sulphite solutions, and must in consequence be carefully removed. Sound knots may be allowed to pass through the digester and be afterwards removed from the pulp by screens. Before very high temperatures are reached it is necessary that the wood be thoroughly impregnated by the solution, and the absorption is hastened by previously crushing the wood. Dry and green woods, of woods of different species, should not be treated together in the same digester as they will be unequally reduced and leave chips in the pulp.

The first step in the preparation of the sulphite liquor is the formation of sulphur dioxide (SO_2) from the combustion of either sulphur or its compounds. As this gas must be absorbed by water to form sulphurous acid (H_2SO_3), it is evident that the less it is diluted with other gases the more complete will be its absorption. Therefore the sulphur is burned in specially constructed furnaces with the object of obtaining a complete combustion with the smallest possible draught. If the combustion of the sulphur is incomplete, a part of it sublimes and reacts with the sulphur dioxide to form thiosulphuric acid ($\text{H}_2\text{S}_2\text{O}_3$) which in turn forms thiosulphates. These will decompose on boiling, and precipitate the sulphur into the pulp, which, being practically insoluble, it is impossible to remove. When the sulphur becomes oxidized to sulphuric acid it is very injurious to the paper making machinery as well as the pulp.

When pyrites is used in the production of sulphur dioxide more complicated burners are used, and additional care taken to avoid overheating, as slags are easily formed which impede the draught and are difficult to remove. Blowers or exhaust fans are used to improve the draught through the furnace, and these cause a lot of fine dust to be carried over with the burned gases. This dust never reaches the pulp, however, as the gases pass directly from the furnace into a dust chamber where it settles before the gases enter the cooler.

From the fact that one volume of water at ten centigrade will absorb sixty-nine volumes of sulphur in oxide, and at forty degrees will absorb but seventeen volumes, it is evident that the temperature of both gases and liquor will be kept down as much as possible during absorption. To practice the temperature of the cooler varies from ten to fifteen degrees. The absorption apparatus are of two kinds, namely, that in which the gas is absorbed by water holding the base in suspension or solution; and that in which the gas and water react together upon lumps of the carbonate of the base. The latter method, which is the simpler and simpler, consists of a high shaft or tower packed with limestone or dolomite, which is covered by a thin film of water that enters from above. The gases enter the base of the tower under pressure sufficient to force them through the limestone and out at the top. The sulphur dioxide meeting the moist limestone, reacts with it, forming at first sulphurous acid (H_2SO_3), and then calcium sulphite (Ca SO_3), while the insoluble product unites with more sulphur dioxide to form calcium bi-sulphite ($\text{Ca H}_2(\text{SO}_3)_2$), which being soluble is washed out by the descending water. The former or tank apparatus is the one generally used in this country, and consists of a series of tanks filled with water which holds the carbonate in solution in suspension.

In this case the chemical reaction is practically the same as just described, for as the sulphur dioxide is absorbed, the insoluble calcium sulphite is precipitated, but becomes redissolved as it reacts with more sulphur dioxide to form the bi-sulphite ($\text{Ca H}_2(\text{SO}_3)_2$). In practice more or less of the insoluble sulphate (Ca SO_4) is formed by oxidation, which is allowed to settle and the

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