

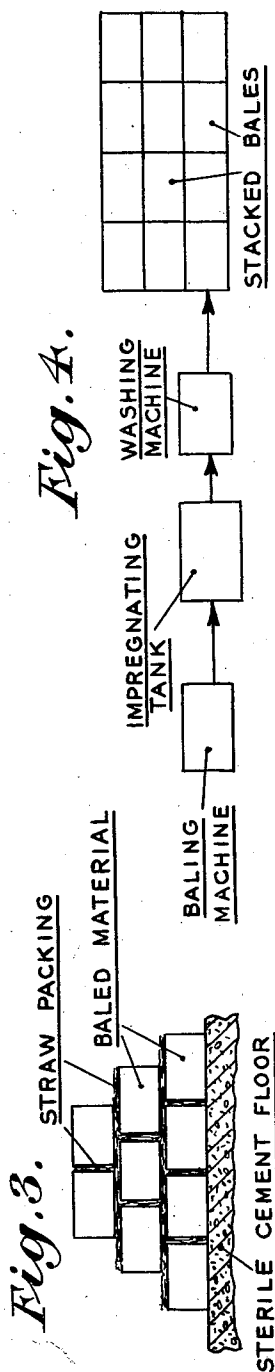
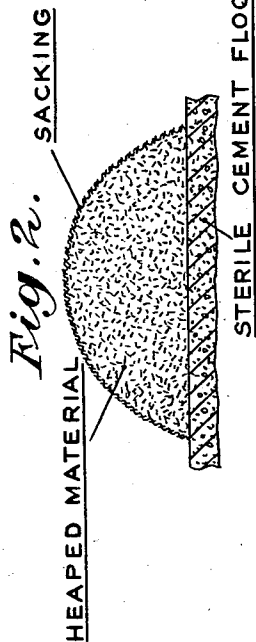
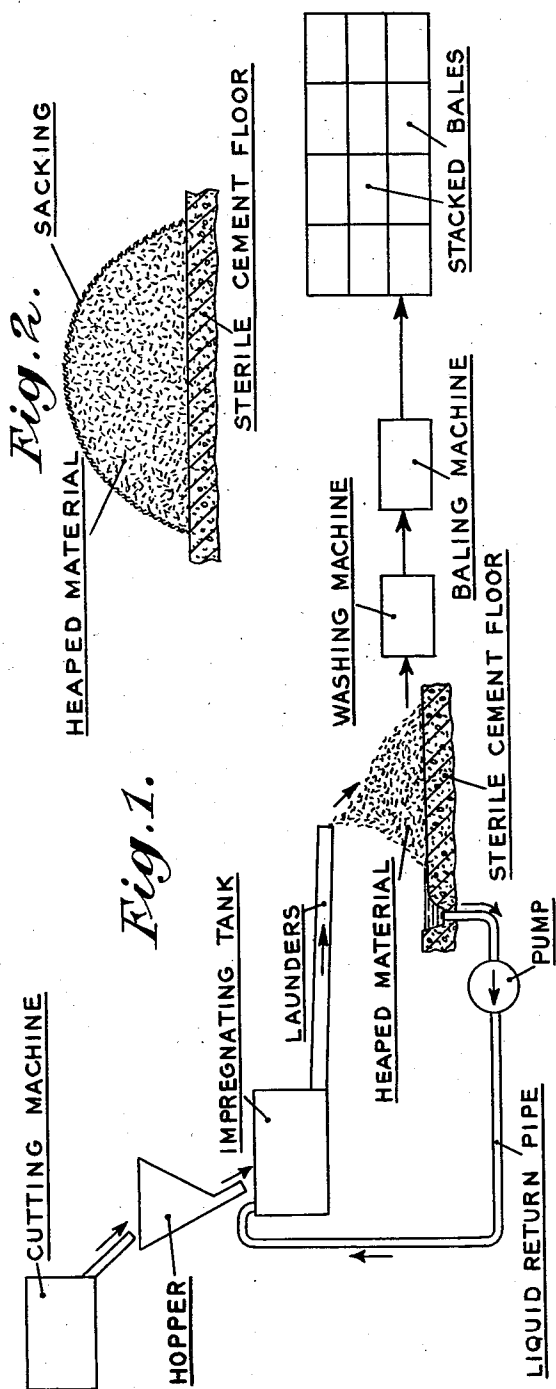
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FERMENTATION PROCESS FOR THE PREPARATION OF PAPER PULP FROM
BAGASSE AND SIMILARLY INCRUSTED CELLULOSE FIBERS

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FERMENTATION PROCESS FOR THE PREPARATION OF PAPER PULP FROM BAGASSE AND SIMILARLY INCRUSTED CELLULOSE FIBERS

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This invention is for improvements in or relating to a fermentation process for the preparation of paper-pulp from bagasse and similarly incrustated cellulose fibers.

5 In the preparation of paper-pulp from various cellulose fibers which are incrustated with materials such as lignin, pectose and like substances, it has hitherto been usual to cut, crush or shred the cellulosic material and subject it to treatment with various chemical reagents such as caustic lyes and sulphite liquors and these processes have been carried out in large tanks. These prior processes have the natural disadvantage that a large capital outlay is necessary to establish the plant whilst at the same time, owing to the high consumption of chemicals, the cost of operating the processes has been very high.

10 It has now been found that a very large number of cellulosic materials which are incrustated with lignin and pectose are capable of being treated by a fermentation process which will remove the whole or the greater part of the incrustants from the fiber without incurring any expense in the purchase of chemicals and also renders any subsequent digestion, bleaching or other treatment which may be required, much easier and much cheaper.

15 According to this invention a fermentation process for the preparation of paper-pulp from bagasse and similarly incrustated cellulose fibers consists in impregnating the cut, crushed or shredded incrustated cellulosic material, with a liquor, containing bacteria cultured upon or derived from said cellulosic material, controlling the amount of nutrient in the fermentation mass to such a value as will result in a controlled fermentation to yield a good quality cellulose, allowing the impregnated mass to ferment in the presence of a limited quantity of air and then finally washing the material and compressing it into bales which are air-dried in an open stack whereby the cellulosic material is preserved against disintegration.

20 The fermentation process of this invention may be carried out with the minimum of apparatus and consequently the process can be more economically operated than those hitherto used.

25 The invention may alternatively be stated to be a process for the removal of incrustants from the cellulosic fibrous material incrustated with lig-

nin, pectose and the like, such as bagasse, which consists in impregnating the incrustated cellulosic material with a liquor containing a bacteria culture, derived from the natural bacteria of the said material, controlling the amount of nutrient in the fermentation mass, stacking the impregnated material to allow a limited access of air to the mass, leaving the stacked material to ferment until the whole or greater part of the incrustants are removed and then washing. Preferably, the treated material is compressed into bales which are air-dried in an open stack.

5 A suitable liquor for use in the process is dunder-water (the effluent from the sugar-extraction process).

10 An important feature of the invention consists in that the impregnated cellulosic material is fermented in stacks on a sterile floor. In this way the bacteria culture does not become adulterated with any contaminating bacteria and consequently the fermenting bacteria can develop unhindered by the presence of foreign bacteria.

15 The temperature of the fermenting material rises rapidly from about 90° F. to about 160° F. and is preferably maintained between these limits.

20 In order to prevent the outer layers of the stack from becoming dry, the stack may be covered with sacking, straw or other suitable material; in this way, also, the access of air to the fermenting mass may be controlled particularly where wood or wood-chips are being treated.

25 The process may be applied to baled material, in which case it is a feature of the invention that the cellulosic material, in bales, is impregnated with the liquid, is then stacked and the interstices are then packed with loose, impregnated straw.

30 It is a further feature of the invention that the air supply to the fermenting mass is controlled either by forcing air through the stacked mass when the temperature is too low or by compressing the stack when the temperature is too high.

35 The process will now be described by way of example with reference to the treatment of bagasse from a sugar mill. The bagasse which comes from the mill, already crushed, contains about 50% moisture and a certain amount of sugar (for instance between ½ and 3%) which serves as

part of the nutrient for the bacteria. If a higher fermentation temperature is desired (to intensify the bacterial action) further nutrient (for example molasses) may be added to an amount up to about 5% of the liquor. This increases the bacterial activity and produces a higher temperature which further intensifies the bacterial action. The bagasse is impregnated with water containing a nutrient and a bacteria culture which has been derived from the natural bacteria present on the bagasse fiber. The bagasse is circulated along overhead launders together with the water and then from these launders is allowed to fall on to a cement floor where it becomes stacked. The water drains off and runs back to the original tank so that it may be re-circulated.

As the water drains off, air flows into the mass and then, by reason of the open nature of the material, a certain limited supply of air circulates through the mass of the material and provides the necessary air for the bacteria.

In the treatment of materials having a high content of nutrient, such as for example, rice-straw or maize-straw, it may be necessary when it is not possible to treat such materials immediately they are gathered to adopt some precautions to prevent an uncontrolled fermentation taking place. This may be done by stacking the material and compressing it and excluding air therefrom by covering it with earth as when making ensilage from hay or grass-cuttings.

The use of a cement floor is preferred since thereby a sterile surface is obtained and contamination of the mass is avoided. If a cement floor is not used it is essential that the surface of the ground or any other surface upon which the material is stacked should be sterilized either by heating or by chemical treatment.

The stacked material is allowed to remain fermenting for a period of from 14 days to 4 months according to the cellulose content which it is finally desired to obtain, and to suit any variations in the conditions of supply of raw material and demand for treated product. In any event, the fermentation process is arrested before the bacteria attack the actual cellulose fibers themselves.

When the fermentation of the stack has proceeded to the desired extent the external layer of about 1" to 2" thickness is removed for treatment with the succeeding batch of material and the remainder of the stack material is washed from the floor to a tank or washing machine where it is washed for a period of about 20 minutes whereby the bacteria are removed from the material and the fermentation is arrested. The washed material is allowed to drain and is then passed to a conveyor which delivers it to a baling press where a considerable quantity of the moisture is expressed from the material, the bales then being stacked open so as to allow a free air circulation over and through them so that they may dry to a water content from about 12% to about 20%. The bagasse in this condition may be stored for years without further disintegration or deterioration; Baobab, rice-straw, maize-straw and banana and other raw materials which readily decay can also be stored indefinitely when treated in this way.

It is possible that the fermentation process described above will not completely remove the whole of the lignin and in order to remove this the cellulosic material is re-impregnated with enzymes e. g. papain obtained from the paw-paw

tree, and/or a bacterial culture derived from the bacteria secreted by the paper-wasp.

It will be appreciated that the process has many advantages as compared with the known chemical treatment processes, for example, by treating the raw material on the site the cost of transporting the material to a distant treatment site is avoided. The necessary equipment is so reduced as to permit the plant being erected on the site of the factory producing the raw material. The normal cost of transport is in effect, also reduced since the cellulose is concentrated and the valueless incrustants removed.

Furthermore, by removing the greater part of the incrustants, any subsequent digestion which may be necessary is much reduced in cost owing to the great saving in chemicals required both by reason of the reduction in the amount of incrustants to be removed and by reason of the fact that the remaining incrustants are less resistant to the chemicals whilst at the same time the size of the boiler or digestion tanks may be lessened as a result of the high percentage of cellulose in the mass.

A further important advantage of the process lies in the fact that owing to the mildness of the treatment as compared with the usual chemical processes, the resultant pulp is stronger and it is possible to prepare a semi-pulp for cardboard or building board pulp, solely by the present process without any chemical treatment whatsoever.

If desired, the baled material may be given a further treatment preparatory to the usual final bleaching treatment of an ordinary paper-pulp process. This may be accomplished by dipping the bales into solutions of diluted soda, sulphate, sulphite or monosulphite, and re-stacking. The use of the monosulphite is particularly advantageous since it is milder and cheaper than the other processes and furthermore, since no costly regeneration process is necessary with the monosulphite process as with other processes, the combination of the present process with the subsequent monosulphite treatment provides a very economic treatment, and one which is available for substances which hitherto have not been amenable to the monosulphite process. Moreover, the cellulosic material, after treatment by the fermentation process of the present invention, does not absorb such large quantities of chemicals as the raw materials. The re-stacked bales may be allowed to stand for a period of from 3 weeks to 2 months or so and during this time, owing to the gradual drying of the mass, there is a gradual concentration of the reagent.

The process is readily applicable to a very large number of other incrustated cellulosic materials amongst which may be mentioned esparto grass, tambookie grass, reeds, rushes and straw particularly rice-straw and maize-straw which may be cut or crushed before impregnation and also to the more solid materials such as banana, eucalyptus, pine, bamboo, wattle wood, wood chips (such as chestnut wood-chips after the tannin has been extracted) sawdust and wattle bark waste which must be cut or otherwise reduced to small pieces; peat and various barks and bark-trimmings can also be treated successfully. The wood of the Baobab tree (*Adansonia digitata*) has also been very successfully treated and provides a product which is intermediate in properties between cotton and wood and which forms a very useful basis for propellant explosives of the nature of cordite.

When treating any one particular cellulosic

material it is advantageous, if not essential, to utilize a bacteria culture which is specifically adapted for the distintegration of the incrustants on the fiber to be treated and thus it is advisable to prepare a special culture for any particular material.

The following is a description of the preparation of a special bacterial culture for bagasse. Water is sterilized by means of chlorine so as to eliminate any bacteria which may be present. Bagasse, together with a nutrient such as molasses, is added to the water which is maintained at about blood heat. The temperature of the liquor is then gradually reduced over a period of about 14 days to a temperature of from 10 to 15° F. below the lowest likely ambient temperature and each day, during the cultivation of the bacteria, the temperature of the liquor is raised and lowered roughly to the extent of the difference between the daily maximum and minimum temperatures. The use of bacteria cultured in this way results in a much greater increase in the percentage of cellulose in the final product and it is possible to obtain material having an 85% content of cellulose as against a content of 65% cellulose when uncultured bacteria are utilized. It will be appreciated that the above procedure may be used with materials other than bagasse to provide the desired bacteria culture.

In dealing with materials such as woods which have no nutrient present it is found that the enzymes derived from the sap of the paw-paw tree and/or the bacterial culture derived from the secretions of the paper-wasp greatly assists the fermentation process. A greater percentage of nutrient is always added to the liquor in which woods and other materials low in nutrients are immersed.

With certain materials, such as rice-straw, it may be necessary to leach out excess nutrient to prevent a premature and uncontrollable fermentation taking place which would destroy the cellulose or render it useless.

The accompanying drawing is a diagrammatic representation illustrating the mode of carrying the invention into effect, but the drawing is in no way limiting the scope of the invention.

Figure 1 is a diagrammatic representation illustrating the process as a whole.

Figure 2 shows the heaped material on a cement floor covered with sacking, and

Figure 3 shows the impregnated material stacked in bale form.

Figure 4 shows an alternative series of steps to those of the last two steps of Figure 1.

Referring to Figure 1, the cellulosic material to be treated is conveyed to a cutting machine where it is cut into suitably sized pieces, although it will be understood that instead of a cutting machine, a crushing or shredding device may be employed. The material which has been cut, crushed or shredded may be passed into a hopper and thence into an impregnating tank where the liquor containing the bacteria becomes mixed with the material. The material flows along the overhead launders and is then allowed to pour on to a sterile cement floor from which the surplus liquid, which drains out of the mass, may be pumped back to the impregnating tank. The heaped material may be covered with sacking and allowed to ferment until the desired degree of fermentation has been attained when it is washed and passed to a baling machine and subsequently stacked in the open air to dry. The bales, instead of being stacked, may be given a

second fermentation prior to their being stacked for drying, as shown diagrammatically in Figure 4.

The fermentation may be carried out entirely with the material in bale form, in which case the bales are stacked on a cement floor and the interstices packed with impregnated straw, as shown diagrammatically in Figure 3.

I claim:

1. A process for the preparation of paper-pulp from rice-straw having a high content of nutrient which consists in leaching out excess nutrient, impregnating said rice-straw with a liquor containing bacteria derived from said rice-straw and a controlled amount of nutrient therefor, circulating said rice-straw in the liquor through launders and discharging the mass on to a sterile cement floor, allowing the stacked rice-straw to drain and to ferment until the greater part of the non-cellulosic material is removed, washing, compressing and baling the treated rice-straw and allowing it to dry in an open stack to a moisture content of between about 12 and 20%.

2. A process for the preparation of paper-pulp from rice-straw having a high content of nutrient which consists in leaching out excess nutrient, impregnating said rice-straw with a liquor containing a bacteria culture derived from the natural bacteria of said rice-straw and a controlled amount of nutrient therefor, circulating said rice-straw in the liquor through launders and discharging the mass on to a sterile cement floor, allowing the stacked rice-straw to drain and to ferment until the greater part of the non-cellulosic material is removed, washing, compressing and baling the treated rice-straw and allowing it to dry in an open stack to a moisture content of between about 12 and 20%.

3. A process for the removal of incrustants from cellulosic fibrous material incrustated with lignin, pectose and the like which consists in impregnating said material with a liquor containing a bacteria culture derived from the natural bacteria of said material and containing up to about 5% of nutrient for the bacteria, stacking the material in a compressed state on a sterilized floor, draining the excess liquor from the impregnated mass, allowing the impregnated mass to ferment, washing the fermented mass and stacking it in bales in an open stack to dry.

4. A process for the removal of incrustants from cellulosic fibrous material incrustated with lignin, pectose and the like which consists in impregnating said material with a liquor containing a bacteria culture derived from the natural bacteria of the material and containing up to about 5% of nutrient for the bacteria, flowing said material on to a sterilized floor by an excess of said liquor which closely stacks the material thereon, draining the excess liquor from the impregnated mass and allowing a limited access of air to the material, allowing the impregnated mass to ferment, washing the fermented mass and stacking it in bales in an open stack to dry.

5. A fermentation process for the preparation of paper-pulp from bagasse which consists in baling the bagasse, impregnating the bales with a liquor containing a bacteria culture derived from the natural bacteria of the bagasse and containing up to about 5% of sugar-containing nutrient for the bacteria, stacking the impregnated bales on a sterilized floor and packing the interstices between the bales with loose impregnated straw, allowing the bagasse to ferment in

the presence of a limited quantity of air, washing the fermented bagasse and air-drying the bales by stacking them in an open stack.

6. A process for the removal of incrustants from cellulosic fibrous material incrustated with lignin, pectose and the like which consists in impregnating said material with a liquor containing a bacteria culture derived from the natural bacteria of the said material and containing up to about 5% of nutrient for the bacteria, stacking the material in a compressed state on a sterilized floor, draining the excess liquor from the impregnated mass, allowing the impregnated mass to ferment, washing the fermented mass, performing the additional step of subjecting the cellulosic fibrous material to a treatment with enzymes derived from the paw-paw tree to remove residual lignin, washing the material and stacking it in bales in an open stack to dry.

7. A process for the removal of incrustants from cellulosic fibrous material incrustated with lignin, pectose and the like which consists in impregnating said material with a liquor containing a bacterial culture derived from the natural bacteria of the said material and containing up to about 5% of nutrient for the bacteria, stacking the material in a compressed state on a sterilized floor, draining the excess liquor from the impregnated mass, allowing the impregnated mass to ferment, washing the fermented mass, performing the additional step of subjecting the cellulosic fibrous material to a further fermentation by bacteria derived from the secretions of the paper-wasp to remove residual lignin, washing the material and stacking it in bales in an open stack to dry.

8. A process for the removal of incrustants from cellulosic fibrous material incrustated with lignin, pectose and the like which consists in impregnating said material with a liquor containing bacteria cultured on said material and containing up to about 5% of nutrient for the bacteria, stacking the material in a compressed state on a sterilized floor, draining the excess liquor from the impregnated mass, allowing the impregnated mass to ferment, washing the fermented mass, carrying out a further treatment by dipping the material into a solution of a disinfecting agent of the class consisting of diluted soda, sulphate, sulphite and monosulphite solutions and re-stacking it in bales in an open stack to dry.

9. A process for the preparation of paper-pulp from bagasse which consists in impregnating said bagasse with a liquor containing a bacteria culture derived from the natural bacteria of the said material and containing up to about 5% of sugar-containing nutrient for the bacteria, circulating said bagasse through launders by an excess of said liquor and discharging the mass onto a sterilized floor to closely pack the bagasse thereon, draining the excess liquor from the impregnated mass, allowing the impregnated bagasse to ferment until the greater part of the non-cellulosic bagasse is removed, washing, compressing and baling the bagasse and allowing the bales to dry in an open stack to a moisture content of between about 12 and 20%.

10. A process for the preparation of paper-pulp from bagasse and similarly incrustated cellulosic materials which consists in impregnating said material with a liquor containing a bacteria culture derived from the natural bacteria of the said bagasse and containing up to about 5% of nutrient for the bacteria, circulating said material

through launders by an excess of said liquor and discharging the mass onto a sterilized floor to closely pack the bagasse thereon, draining the excess liquor from the impregnated mass, allowing the impregnated bagasse to ferment until the greater part of the non-cellulosic material is removed, washing, compressing and baling the treated bagasse, carrying out a further treatment by dipping the bales into a solution of a disinfecting agent of the class consisting of diluted soda, sulphate, sulphite and monosulphite solutions and allowing the bales to dry in an open stack to a moisture content of between about 12 and 20%.

11. A process for the preparation of paper-pulp from bagasse and similarly incrustated cellulosic materials which consists in impregnating said material with a liquor containing a bacteria culture derived from the natural bacteria of the bagasse and containing up to about 5% of sugar-containing nutrient for the bacteria, circulating said bagasse through launders by an excess of said liquor and discharging the mass onto a sterilized floor to closely pack the bagasse thereon, draining the excess liquor from the impregnated mass allowing the impregnated bagasse to ferment until the greater part of the non-cellulosic material is removed, washing the fermented bagasse and performing the additional step of subjecting the fermented bagasse to a treatment with enzymes derived from the paw-paw tree to remove residual lignin, washing, compressing and baling the treated bagasse and allowing the bales to dry in an open stack to a moisture content of between about 12 and 20%.

12. A process for the preparation of paper-pulp from bagasse and similarly incrustated cellulosic materials which consists in impregnating said material with a liquor containing a bacteria culture derived from the natural bacteria of the bagasse and containing up to about 5% sugar-containing nutrient for the bacteria, circulating said bagasse through launders by an excess of said liquor and discharging the mass onto a sterilized floor to closely pack the bagasse thereon, draining the excess liquor from the impregnated mass, allowing the impregnated bagasse to ferment until the greater part of the non-cellulosic material is removed, washing the fermented bagasse and performing the additional step of subjecting the fermented treated bagasse to a further fermentation by bacteria derived from the secretions of the paper-wasp, washing, compressing and baling the treated bagasse and allowing the bales to dry in an open stack to a moisture content of between about 12 and 20%.

13. A process for the preparation of paper-pulp from rice-straw having a high content of nutrient which consists in leaching out excess nutrient from said rice-straw, impregnating said rice straw with a liquor containing a bacteria culture derived from the natural bacteria of the rice-straw and containing up to about 5% nutrient for the bacteria, circulating said material through launders by an excess of said liquor and discharging the mass onto a sterilized floor to closely pack the rice-straw thereon, draining the excess liquor from the impregnated mass and allowing a limited access of air to the rice-straw, allowing the impregnated material to ferment until the greater part of the non-cellulosic treated rice-straw is removed, washing, compressing and baling the material and allowing it to dry in an open stack to a moisture content of between about 12 and 20%.

14. A process for the removal of incrustants from cellulosic fibrous material incrustated with lignin, pectose and the like which consists in impregnating said material with a liquor containing a bacteria culture derived from the natural bacteria of said material and up to about 5% of nutrient for the bacteria, which bacteria were cultured on said material for a period of about 14 days during which period the temperature of

the liquor is reduced from blood heat to a temperature from 10° to 15° F. below the likeliest ambient air temperature, stacking the material in a compressed state on a sterilized floor, draining the excess liquor from the impregnated mass, allowing the impregnated mass to ferment, washing the fermented mass and stacking it in bales in an open stack to dry.

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