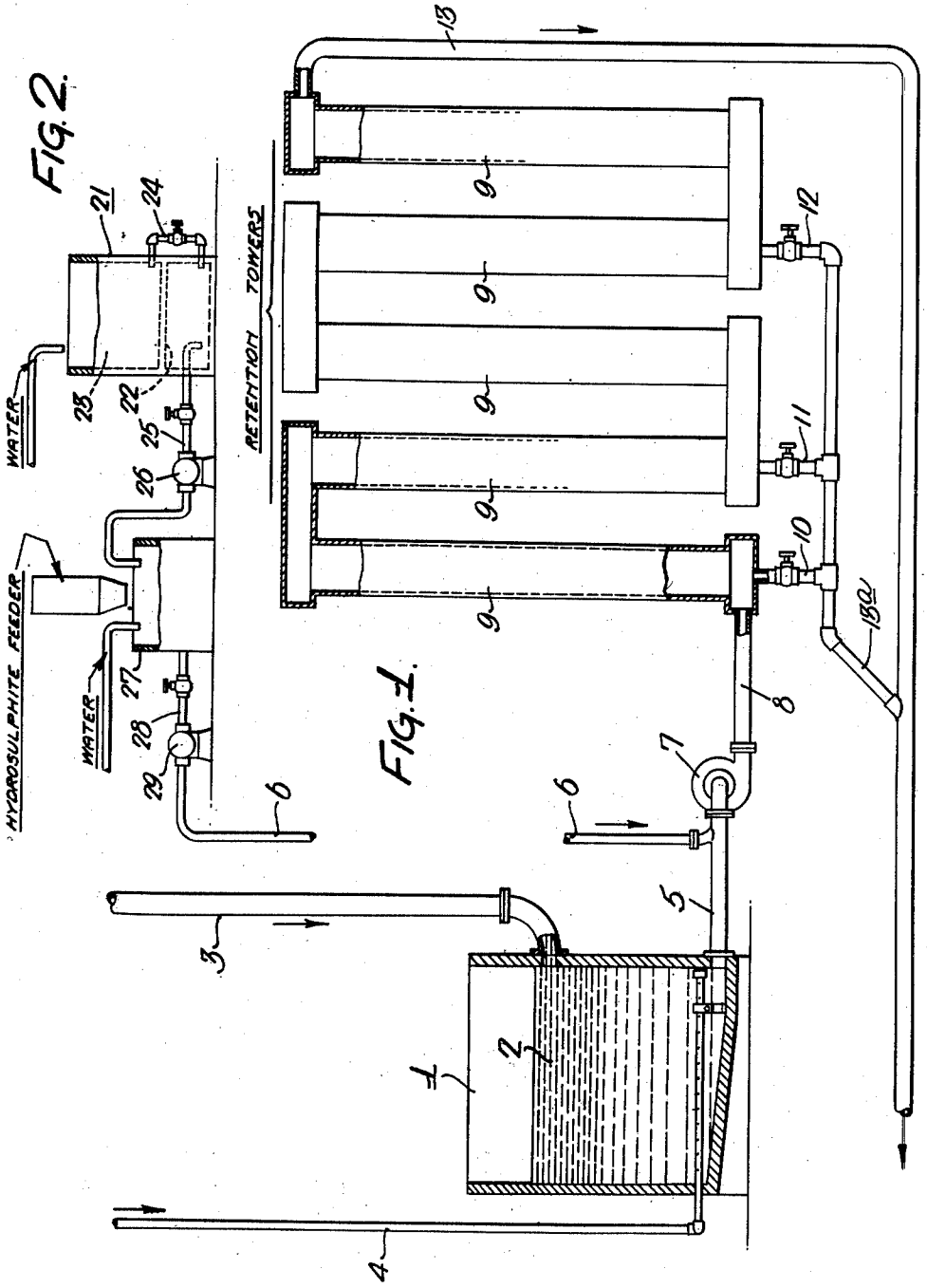
April 26, 1955 T. M. BURTON 2,707,146

METHOD OF BLEACHING MECHANICALLY DISINTEGRATED WOOD PULP

Filed Aug. 8, 1951



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United States Patent Office 2,707,146 Patented Apr. 26, 1955

2,707,146

METHOD OF BLEACHING MECHANICALLY DISINTEGRATED WOOD PULP

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Application August 8, 1951, Serial No. 240,897

11 Claims. (Cl. 8—104)

The present invention relates to an improved process for bleaching wood pulp, and more particularly it relates to a continuous process for bleaching mechanically-disintegrated wood pulp involving the use of a water-soluble hydrosulphite, by which a marked increase in brightness is obtained.

The bleaching of mechanically-disintegrated wood pulp is well-known. One of the bleaching agents which have been suggested for this purpose is a water-soluble hydrosulphite. The procedure suggested in the past for bleaching wood pulp by the use of a water-soluble hydrosulphite has involved the addition of the hydrosulphite, either as a solid or in solution, to the wood pulp, usually accompanied by violent agitation, and permitting the mixture to stand in a vessel until the desired bleaching has been obtained. It has been suggested that the most convenient place to add the hydrosulphite to the pulp is at the grinder pit, in the case of ground wood pulp, particularly with the water employed during the grinding operation. It has also been suggested to add the hydrosulphite in the pulp coming from the grinder. By the use of this procedure, the brightness of mechanically-disintegrated wood pulp, which is normally in the neighborhood of about 60%, when measured by the General Electric Reflectance Meter, may be increased a few points at the most. In attempts to increase this bleaching effect, the use of pH control, temperature control, buffering agents, whitening agents, and the like, has been suggested. However, no substantial improvement resulted from these suggestions.

It is a principal object of the present invention to provide an improved process for bleaching mechanically-disintegrated wood pulp wherein the brightness increase is markedly greater than that obtained by prior suggested methods.

Another object of the present invention is to provide a continuous method for bleaching mechanically-disintegrated wood pulp.

Further objects will be apparent from a consideration of the following specification and claims.

The bleaching of mechanically-disintegrated wood pulp in accordance with the present invention comprises continuously feeding an aqueous solution comprising a water-soluble hydrosulphite, said solution being substantially free of entrained air, into a continuously moving stream of the pulp; then subjecting the pulp and hydrosulphite-containing solution, in a confined, air-tight zone, to combined vigorous agitation, whereby the hydrosulphite-containing solution is rapidly and intimately mixed with said pulp, and propulsion; forcing, by means of said propulsion, said intimate mixture comprising the hydrosulphite and pulp as a continuously-moving stream along a confined, air-tight path comprising a vertical fluid way, until the desired bleaching takes place. The resulting bleached pulp may then be discharged from said confined, air-tight path.

In the preferred practice of the present invention there is also added to, and intimately mixed with, the pulp in conjunction with the water-soluble hydrosulphite, a water-soluble polyphosphate in accordance with the process described and claimed in co-pending application Serial No. 240,982 filed Aug. 8 1951. In accordance with the process there-disclosed, the polyphosphate is intimately mixed with the wood pulp at a time not substantially later than that at which the hydrosulphite is mixed with the pulp. Thus, following the method of the present invention, the water-soluble polyphosphate, as an aqueous solution substantially free of entrained air, may be continuously fed to the continuously-moving stream of pulp at a point before, at or after that at which the hydrosulphite is added to the pulp. However, in the event the polyphosphate is fed to the pulp at a point after the hydrosulphite is fed to the pulp, the delay in time shall not be such that a substantial portion of the hydrosulphite becomes decomposed before the polyphosphate is incorporated in the pulp. In any event, the polyphosphate is fed to the pulp before the pulp and hydrosulphite are subjected to vigorous agitation and propulsion, and, preferably, the polyphosphate is fed to the pulp substantially simultaneously with the hydrosulphite. A particularly preferred procedure for incorporating the polyphosphate and the hydrosulphite in the pulp is to predissolve both the polyphosphate and the hydrosulphite in water and to feed the combined solution, substantially free of entrained air, to the pulp stream. The polyphosphate, as pointed out in the stated co-pending application, markedly enhances the bleaching effect of the hydrosulphite, thus providing a substantially greater brightness increase as compared to when the hydrosulphite is used by itself.

Referring to the drawings, Fig. 1 is a side elevational view of apparatus in which the process of the invention may be carried out; and

Fig. 2 is a side elevational view of apparatus that may be employed for preparing the solution comprising the hydrosulphite for use in connection with the process of the invention.

The bleaching of mechanically-disintegrated wood pulp with a water-soluble hydrosulphite in accordance with the present invention results in a marked increase in brightness in the treated wood pulp, and this increase in brightness is substantially greater than the increase obtained following prior suggested procedures.

Referring to the wood pulp treated in accordance with the present invention, it is, as stated, mechanically-disintegrated wood pulp. There are two types of such wood pulp: (1) ground wood pulp and (2) semi-chemical wood pulp. Ground wood pulp, as is well-known, is obtained merely by grinding logs to reduce the logs to fibers. Semi-chemical wood pulp is obtained by first reducing the log to chips, treating the chips briefly with chemicals, such as sodium sulphite and sodium bicarbonate, at elevated temperature and pressure, preliminarily to soften the chips somewhat, and then grinding the chips to fibers. Both ground wood pulp and semi-chemical wood pulp, by virtue of the fact that at least the preponderant disintegration is accomplished by mechanical means, are relatively high in lignin content, and, accordingly, present a particularly difficult problem, from the standpoint of bleaching, as compared to normal chemical pulp.

The pulp treated in accordance with the present invention may be obtained from several different sources. That is to say, it may be ground wood pulp or semi-chemical pulp coming directly from the grinder, or from a point in the pulp processing remote from the grinder, for example, after suitable dilution to provide the proper consistency, the pulp may be obtained from the wet lap machine. On the other hand, the pulp may be first dried and baled and the bales shipped to a distant point where they are broken up and re-pulped. The pulp treated in accordance with the present invention may also be such re-pulped material. The source of the pulp treated in accordance with the present invention is relativey immaterial so long as during the bleaching process it has the proper consistency. Generally, the consistency of the pulp treated in accordance with the present process will be at least about 0.5%, by weight, and the consistency thereof may range up to the point where satisfactory mixing is not feasible, for example, up to 10% or even 15%, by weight, if desired. Preferably, however, the consistency of the pulp during the treatment is between about 2% and about 5%, by weight. Generally, both the pulp coming directly from the grinder and re-pulped material will have a consistency within these ranges, while pulp obtained from other points in the pulp processing procedure may require dilution or even concentration to provide the desired consistency. The consistency of the pulp may readily be adjusted to the desired level by simply adding or removing water.

The treatment in accordance with the present invention is at an elevated temperature, that is, the temperature of the pulp during the treatment will be above normal room temperature, and generally will be above about 120° F., more generally above about 135° F. While the temperature of the pulp may range as high as about 212° F., no advantage is to be gained by operating at such temperatures, and a preferred operating range is between about 160 and about 190° F. The provision of the stated temperatures will offer no problem to those skilled in the art. In the event fresh ground wood pulp, that is, the slurry coming directly from the grinder, is being treated, such pulp will generally be at a satisfactory temperature, due to the heat generated during the grinding operation. In the event it is desirable or necessary to add heat to the pulp such may be accomplished by conventional means, such as by the use of steam.

In accordance with the process of the present invention there is added to the pulp in the manner stated, a water-soluble hydrosulphite at least as the main bleaching agent. Water-soluble hydrosulphites employed for bleaching wood pulp are well-known and include zinc hydrosulphite, the alkali metal hydrosulphites, such as sodium hydrosulphite and potassium hydrosulphite, ammonium hydrosulphite and the like. Of the various water-soluble hydrosulphites, sodium hydrosulphite and zinc hydrosulphite, particularly the former, are preferred. The amount of hydrosulphite incorporated in the pulp may vary somewhat depending upon the type of pulp treated, the degree of brightness increase desired, and other factors known to those skilled in the bleaching art. Generally, the amount of hydrosulphite mixed with the pulp will be at least about 0.25%, by weight, based on the weight of the dry pulp. While amounts of hydrosulphite as high as about 5% or even higher, may be employed, no significant advantage is to be gained by using amounts substantially in excess of about 3% by weight. Preferably, the amount of hydrosulphite employed will be between about 0.5% and about 1.5% by weight, based on the dry weight of the pulp.

As stated, in accordance with the preferred practice of the present invention, there is also added to the continuously-flowing stream of pulp, a water-soluble polyphosphate, that is, a polyphosphate having the formula $(M_2O)_xP_2O_5$ wherein M is a monovalent cation providing water-solubility to the compound and wherein x is less than 3. Examples of monovalent cations providing water-solubility to the compound are hydrogen, NH_4, the alkali metals, such as sodium and potassium, and the like. The polyphosphate employed may be of the crystalline type or of the glassy type. Mixtures of polyphosphates may be used if desired. Examples of polyphosphates that may be employed (using sodium for M for the purpose of illustration) are sodium pyrophosphate ($Na_4P_2O_7$) wherein x is 2, sodium tripolyphosphate ($Na_5P_3O_{10}$) wherein x is 1.6, sodium tetraphosphate ($Na_6P_4O_{13}$) wherein x is 1.5, sodium hexapolyphosphate ($Na_8P_6O_{19}$) wherein x is 1.33, sodium heptapolyphosphate ($Na_9P_7O_{22}$) wherein x is 1.29, sodium decapolyphosphate ($Na_{12}P_{10}O_{31}$) wherein x is 1.2, and the like. Of the polyphosphates, those in which x in the above formula is between about 1 and about 2, and particularly where M is an alkali metal, especially sodium, are preferred. As specific preferred polyphosphates, sodium tetraphosphate and sodium pyrophosphate, especially the former, may be mentioned.

The amount of polyphosphate employed may vary somewhat depending upon the type of pulp treated, and the degree of brightness increase desired. In most cases the amount of polyphosphate employed will be at least about 0.1%, by weight, based on the weight of the dry pulp. While amounts of polyphosphate as high as about 5%, or even higher, may be employed, no significant advantage is obtained in using amounts substantially in excess of about 2–3%. Preferably the amount of polyphosphate employed will lie between about 0.3% and about 1%, by weight, based on the dry weight of the pulp.

The pH of the pulp during the process should not be permitted to become substantially alkaline, that is to say, the pH of the medium during the bleaching treatment should not be substantially in excess of about 8.5. A pH on the acid side of neutrality may be, and preferably is, employed and a pH as low as about 3 is satisfactory. In most cases the pH will range between about 4 and about 6.5, with a pH between about 5 and about 6 being preferred. The adjustment of the pH, if, after the addition of the hydrosulphite, and polyphosphate if employed, such adjustment is desired, will offer no problem to those skilled in the art, and conventional alkaline or acidic materials may be employed.

As stated, in accordance with the present invention, the hydrosulphite fed to the pulp is in the form of an aqueous solution and is substantially free of entrained air. To accomplish this, the water-soluble hydrosulphite may be premixed with water and flowed from a body of the solution through a conduit to the point of intersection with the flowing stream of pulp. By connecting the conduit below the surface of the body of solution, the stream flowing through the conduit will be substantially free of entrained air. The pulp, as stated, will also be in the form of a continuously-flowing stream substantially free of entrained air at the time the hydrosulphite-containing solution is fed thereto. This may be accomplished, as in the case of the hydrosulphite-containing solution, by flowing the pulp, at the proper consistency, from a body thereof through a conduit connected at a point below the surface of the body of pulp. The conduit containing the hydrosulphite-containing solution may be connected to the conduit through which the pulp is flowed, thus insuring the incorporation of the hydrosulphite-containing solution in the pulp without danger of entraining air in the mixture.

After the hydrosulphite-containing solution has been incorporated in the pulp, the mixture is subjected to combined vigorous agitation and propulsion in a confined, air-tight zone. The vigorous agitation provides intimate mixing of the solution comprising the hydrosulphite with the pulp. The propulsion forces the intimate mixture comprising the hydrosulphite and pulp along the stated confined, air-tight path more fully discussed hereinafter. The means providing the combined vigorous agitation and propulsion may be selected from a wide variety of mechanisms, a conventional pump such as a centrifugal pump, rotary pump, and the like being particularly satisfactory.

The flow of the mixture through the confined, air-tight path is preferably characterized by streamline, plug flow, as distinguished from turbulent channelling flow. In other words, the mixture, in flowing through the confined, air-tight path, will move along said path as a mass throughout the entire cross-section of the path, without substantial turbulence, and without a substantial portion of the solids settling to one portion of the path thereby forming an obstruction and causing channelling through another portion of the path. It will be realized that some turbulence may be encountered in particular portions of the path, such as at bends in the path.

The confined, air-tight path will be primarily vertical in direction of flow. That is to say, at least the major portion of the flow of the mixture comprising a hydrosulphite and the pulp, after it is subjected to vigorous agitation and propulsion will be in the vertical direction until the desired bleaching has taken place. As will be discused more fully hereinafter in connection with the drawings, it is preferred that the path comprise an alternately vertically ascending fluid way and vertically descending fluid way. The provision of vertical fluid ways in the path prevents settling of solids and channelling since the force of gravity, which would cause settling, must work against the propulsion force (in the case of a vertically ascending fluid way) and with the flow (in the case of a vertically descending fluid way). Moreover, with vertical fluid ways, the intimate mixture comprising the hydrosulphite and pulp completely fills the cross-section thereof, insure no contact of the mixture with air.

The length and cross-section of the path are such that the time taken by the intimate mixture comprising the pulp and hydrosulphite to traverse the path, is sufficient to cause the desired bleaching under the conditions obtaining. This means that, under the conditions of temperature, concentration of hydrosulphite and of polyphosphate, if employed, and the like, the time of flow will be such that, at a point downstream in the path, the desired bleaching will have taken place. At or beyond this point the bleached pulp may be discharged from the path and directed to other steps in the pulp-processing procedure.

The operation of the process of the invention may be more readily understood from a consideration of the drawings. In Fig. 1, **1** represents a constant level vessel for holding the pulp at the desired consistency. The pulp **2**, may be fed to the vessel as through conduit **3**.

The pulp in vessel 1 may come directly from the grinder or from a point further along the pulp-processing procedure or from a re-pulper in the event balded pulp is employed. The consistency of the pulp may be adjusted to the required level, if necessary, before the pulp is fed to vessel 1 or in vessel 1. In the event the pulp must be heated or re-heated constant level vessel 1 may be equipped with heating means such as a steam injection line 4.

The pulp is drawn from constant-level vessel 1 through conduit 5. By virtue of the fact that conduit 5 is connected to vessel 1 at a point well below the surface of the body of pulp, the pulp flowing through conduit 5 will be substantially free of entrained air.

The hydrosulphite-containing solution is fed into the pulp in conduit 5 as by a conduit, 6. Conduit 6, as shown, is located at the intake end of pump 7. In pump 7, the mixture of hydrosulphite-containing solution and pulp is subjected to vigorous agitation, whereby the hydrosulphite-containing solution becomes intimately mixed with the pulp, and to propulsion forcing the intimate mixture through conduit 8.

As shown in Fig. 1, conduit 8 leads to a confined, air-tight path, 9, comprising vertical fluid ways, shown in the drawing as retention towers through which the intimate mixture of pulp and hydrosulphite-containing solution is flowed. The bleached pulp leaves the retention towers through conduit 13. The retention towers may be equipped with valved take-off conduits 10, 11 and 12 respectively, all leading into common conduit 13*a*, which in turn is connected to conduit 13. These valved take-off conduits may be used in the event it is desired to drain the towers or may be used to vary the effective length of the path. The bleached pulp may be led through conduit 13 to further conventional processing, for example, it may be dewatered in the usual manner.

The confined, air-tight path may be constructed of a wide variety of materials, although it is preferred that the surface contacting the pulp be of a non-corrosive material, such as wood, glass, stainless steel, synthetic resins, and the like.

As stated, the hydrosulphite-containing solution which is fed to the paper pulp, is also substantially free of entrained air. This may be accomplished by leading the solution through a conduit from a body of hydrosulphite-containing solution, as shown in Fig. 2.

Referring to Fig. 2 of the drawing, this figure shows a system for preparing the bleaching solution. As shown in the drawing, the water-soluble hydrosulphite is continuously mixed with water, as in mixing tank 27. The mixing tank may be equipped with conventional agitating means (not shown). Valved exit conduit 28 is connected to tank 27 near the bottom thereof so that the solution flowing therethrough will be substantially free of entrained air. The solution is forced as by pump 29, through conduit 6 for feeding to the pulp stream in conduit 5. When it is desired to employ a polyphosphate in conjunction with the hydrosulphite, the polyphosphate may be mixed with water and led to conduit 5 in the same manner as the hydrosulphite solution as described above. Preferred means, however, are shown in Fig. 2. As shown in this figure, the water-soluble polyphosphate may be mixed with water as in mixing chamber 23 of tank 21. Tank 21 is provided with a constant-level storage section 22 in fluid flow connection with mixing chamber 23 by means of valved conduit 24. Chamber 23 may be equipped with conventional agitating means (not shown). The aqueous solution of polyphosphate may be withdrawn from section 22 by means of valved conduit 25. Pump 26 is provided to force the solution into mixing tank 27 where it becomes mixed with the hydrosulphite. Pump 29 thus forces the combined solution of hydrosulphite and polyphosphate to conduit 6 for feeding to the wood pulp.

While reference has been made herein only to a water-soluble hydrosulphite as bleaching agent, it will be realized that the process is not limited to the use of that material as the sole bleaching agent and that other bleaching agents may be used to supplement the bleaching action of the hydrosulphite. Likewise, agents other than or in addition to the polyphosphate for whatever beneficial effect they may have in the bleaching effect of the hydrosulphite may be employed.

The following specific example of the operation of the process in accordance with the present invention is given for the purpose of illustration only and is not intended to limit the scope of the invention in any way.

Example

Pulp coming from a ground wood grinder, at a temperature of about 160–185° F. and at about 3% consistency, is fed to a constant-level vessel.

In a first mixing tank, sodium tetraphosphate is mixed with water, and the resulting solution is drawn to a second mixing tank wherein additional water and sodium hydrosulphite are added. The resulting solution contained 8%, by weight, of sodium hydrosulphite and 4%, by weight, of sodium tetraphosphate. The resulting solution, drawn by means of a pump and conduit from beneath the surface of the body of solution in the second mixing tank, is fed, at the rate of about 1 gallon per minute, into the pulp which is flowing through a conduit connected to the bottom of the constant-level pulp storage vessel.

Directly beyond the point where the hydrosulphite-polyphosphate solution is fed to the pulp stream, is positioned a rotary pump which intimately mixes the hydrosulphite-polyphosphate solution with the pulp and which forces the intimate mixture into a series of wooden columns 25 feet high and 24 inches I. D. There are 5 columns all together, the first two being in fluid flow connection at the top, the second and third being in fluid flow connection at the bottom, and so on, as shown in Fig. 1 of the drawings. The intimate mixture of pulp and hydrosulphite-polyphosphate solution is pumped, through the columns at the rate of about 300 gallons per minute, and by the time the pulp has reached the end of the last column, maximum bleaching has taken place. The original pulp had a brightness of about 60%, when measured on the General Electric Reflectance Meter, and the bleached pulp had a brightness of about 71%.

Considerable modification is possible in the selection of the various ingredients employed as well as in the particular technique followed in carrying out the process of the invention without departing from the scope of the invention.

I claim:

1. The method of bleaching mechanically-disintegrated wood pulp which comprises continuously feeding a water-soluble hydrosulphite and a water-soluble polyphosphate, in aqueous solution substantially free of entrained air, into a continuously-moving stream of mechanically-disintegrated wood pulp, substantially free of entrained air, the said polyphosphate being fed to said pulp at a point not substantially later than that at which the hydrosulphite is fed to said pulp whereby the hydrosulphite and polyphosphate are in admixture with said wood pulp during bleaching; subjecting said pulp, hydrosulphite and polyphosphate to combined vigorous agitation, whereby the hydrosulphite and polyphosphate are rapidly and intimately mixed with said pulp, and propulsion; forcing, by means of said propulsion, said intimate mixture comprising said pulp, hydrosulphite and polyphosphate as a continuously-moving stream characterized by streamline, plug flow along a confined, air-tight path comprising a vertical fluid way, until the desired bleaching takes place.

2. The process of claim 1 wherein said hydrosulphite comprises sodium hydrosulphite; wherein said polyphosphate comprises an alkali-metal polyphosphate; and wherein said confined, air-tight path comprises an alternately vertically ascending and vertically descending fluid way.

3. The method of bleaching mechanically-disintegrated wood pulp which comprises feeding substantially simultaneously a water-soluble hydrosulphite and a water-soluble polyphosphate, in aqueous solution substantially free of entrained air, into a continuously-moving stream of mechanically-disintegrated wood pulp substantially free of entrained air; subjecting said pulp, hydrosulphite and polyphosphate to combined vigorous agitation, whereby said hydrosulphite and polyphosphate are rapidly and intimately mixed with said pulp, and propulsion; forcing, by means of said propulsion, said intimate mixture comprising the hydrosulphite, polyphosphate and pulp as a continuously-moving stream characterized by a streamline, plug flow along a confined, air-tight path com-

prising a vertical fluid way, until the desired bleaching takes place.

4. The process of claim 3 wherein said hydrosulphite comprises sodium hydrosulphite; wherein said polyphosphate comprises an alkali-metal polyphosphate; and wherein said confined, air-tight path comprises an alternately vertically ascending and vertically descending fluid way.

5. The method of bleaching mechanically-disintegrated wood pulp which comprises mixing a water-soluble polyphosphate and a water-soluble hydrosulphite with water; continuously feeding the resulting solution, substantially free of entrained air, into a continuously-moving stream of mechanically-disintegrated wood pulp substantially free of entrained air; subjecting said pulp and solution comprising the hydrosulphite and polyphosphate in a confined, air-tight zone, to combined vigorous agitation, whereby said solution is rapidly and intimately mixed with said pulp, and propulsion; forcing, by means of said propulsion, said intimate mixture comprising the pulp, hydrosulphite and polyphosphate as a continuously-moving stream characterized by streamline, plug flow along a confined, air-tight path comprising a vertical fluid way, until the desired bleaching takes place.

6. The process of claim 5 wherein said hydrosulphite comprises sodium hydrosulphite; wherein said polyphosphate comprises an alkali metal polyphosphate; and wherein said confined, air-tight path comprises an alternately vertically ascending and vertically descending fluid way.

7. The process of claim 5 wherein said hydrosulphite comprises sodium hydrosulphite; wherein said polyphosphate comprises a sodium polyphosphate; and wherein said confined, air-tight path comprises a series of alternating vertically ascending and vertically descending fluid ways.

8. The process of claim 7 wherein said polyphosphate comprises sodium tetraphosphate.

9. The method of bleaching ground wood pulp which comprises mixing sodium hydrosulphite and sodium tetraphosphate with water; continuously feeding the resulting solution, substantially free of entrained air, into a continuously-moving stream of ground wood pulp, substantially free of entrained air, having a consistency of between about 0.5% and about 10% and a temperature between about 120° F. and about 212° F., the amount of said hydrosulphite and of said polyphosphate being between about 0.25% and about 5%, and between about 0.1% and about 5%, respectively, by weight, based on the weight of the dry pulp; subjecting said pulp and said solution to combined vigorous agitation, whereby said solution is intimately mixed with said pulp, and propulsion; forcing by means of said propulsion, said intimate mixture as a continuously-moving stream along a confined, air-tight path comprising a series of alternating vertically ascending and vertically descending fluid ways in streamline, plug flow, until the desired bleaching takes place, and discharging the bleached pulp from said path.

10. The method of claim 1 wherein the consistency of said mechanically-disintegrated wood pulp is between about 2 and about 5%; wherein the temperature of the pulp during treatment is between about 160 and about 190° F.; wherein the amount of water-soluble hydrosulphite employed is between about 0.5 and about 1.5%, by weight, based on the weight of the dry pulp; wherein the amount of water-soluble polyphosphate employed is between about 0.3 and about 1%, by weight, based on the weight of the dry pulp, and wherein the pH of the pulp during treatment is between about 4 and about 6.5.

11. The method of claim 3 wherein the consistency of said mechanically-disintegrated wood pulp is between about 2 and about 5%; wherein the temperature of the pulp during treatment is between about 160 and about 190° F.; wherein the the amount of water-soluble hydrosulphite employed is between about 0.5 and about 1.5%, by weight, based on the weight of the dry pulp; wherein the amount of water-soluble polyphosphate employed is between about 0.3 and about 1%, by weight, based on the weight of the dry pulp, and wherein the pH of the pulp during treatment is between about 4 and about 6.5.

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