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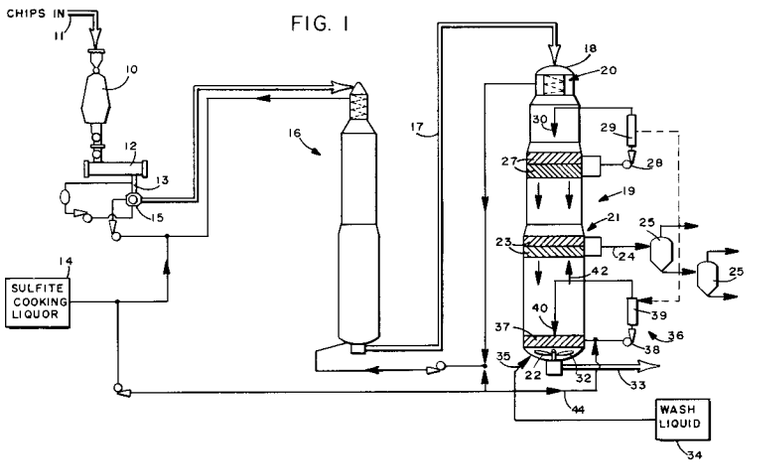
(54) Sulfite modified continuous digesting.

(57) In the production of paper pulp by the sulfite pulping process, the amount of sulfite cooking chemical consumed per ton of pulp produced is significantly lowered, a much lower K-No. can be achieved without screen plugging, the wash circulation temperature is lowered, and the digester (19) runs better, in the practice of the invention. According to the invention, the wood chips entrained in sulfite cooking liquor are fed into the top of a digester, and flow co-currently to a central portion (21) of the digester, at which portion waste liquor is extracted and passed to flash tanks (25). An effective amount of the sulfite cooking liquor (preferably about 5-20%) utilized for producing the pulp is introduced into the vessel in the wash circulation (36), adjacent the bottom of the digester, to flow countercurrently to the material moving downwardly in the vessel. The produced sulfite pulp is withdrawn (at 33) from the bottom of the digester. The invention is primarily applicable to acid or bisulfite pulping, but also can be utilized with alkaline or neutral sulfite pulping. In some circumstances the entire cooking flow can be countercurrent (e.g. 5% up to close to 100% of the sulfite cooking liquor flows countercurrently to the material).

FIG. 1



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BACKGROUND ANDSUMMARY OF THE INVENTION

The production of paper pulp from comminuted cellulosic fibrous material, such as wood chips, by sulfite pulping has been known since 1874. Continuous sulfite pulping has been known since the 1950s. By far the most common continuous sulfite pulping techniques are acidic, which are typically practiced with a pH of about 1.5-5.0. Neutral sulfite pulping and alkaline sulfite pulping are also known, however.

According to the invention, an improved continuous sulfite pulping process is practiced in which conventional sulfite cooking liquor is utilized, which liquor may be formed in a number of different ways and have a number of different compositions, but typically includes sulfur dioxide as the active ingredient, and also may include -- at one point or another -- calcium sulfite or bisulfite, magnesium sulfite or bisulfite, sodium sulfite or bisulfite, and/or ammonium sulfite or bisulifte. The most common acid continuous sulfite pulping is typically in the pH range of 1.5-2.0, and a bisulfite pulping modification thereof is in the pH range of 4.5-5.0, with the highest temperature usually in the range of 140°-160° C. When neutral or alkaline sulfite pulping are practiced, various additives must be provided, such as anthraquinone (AQ), as is conventional.

In continuous sulfite pulping, a problem that is always present is the polycondensation of lignin which can occur if the buffering agent in the sulfite cooking liquor is exhausted, for example if the chemical consumption is greater than anticipated, or there is a localized aberration. When polycondensation of lignin occurs, dark colored and insoluble compounds are formed to essentially produce a "burnt" or "charcoaled" product, which useless. This condition can occur if greater chemical consumption than desired occurs by the sulfur dioxide reacting in side reactions to form thiosulfate ($H_2S_2O_3$), or if there is an undercharge of SO_2.

Another problem with continuous sulfite pulping processes is if the K-No. at the extraction screens is too low, extraction screens may plug.

According to the present invention, a method and apparatus are provided which overcome the problem associated with extraction screen plugging -- as set forth above -- and additionally have the totally unexpected effects of reducing the sulfite cooking chemical consumption by a significant amount (e.g. about 10%), and making the digester run better in general. Also, according to the invention, since the effective sulfite cooking time is increased the temperature can be lowered by at least about 5° F compared to if the invention is not practiced. For example, if the typical cooking temperature for a continuous sulfite pulping process is 310-315° F, according to the invention the temperature is reduced to about 305° F. The wash temperature is raised from about 250-280° F to about 300° F, however there is a net energy savings.

Not only does the invention achieve unexpected advantages, prior to actual testing of the method according to the invention it was predicted by experts in the art that the invention would be inoperable. It was predicted that lignin polycondensation would occur resulting in "charcoaling" of the material, as described above. As earlier indicated, however, not only did the inventive method work to eliminate the screen plugging problem described above, but the unexpected advantages of better digester operation, significant reduction in chemical consumption, and lower temperature operation were achieved. Why the invention reduces chemical consumption is not understood -- it is speculated, however, that side reactions which normally produce thiosulfate may be reduced.

According to one aspect of the present invention, a method of producing cellulosic pulp by sulfite pulping, utilizing comminuted cellulosic fibrous material, and an upright digesting vessel having a top, bottom, and central portion, is provided. The method comprises the steps of continuously: (a) Feeding comminuted cellulosic fibrous material entrained in sulfite cooking liquor into the top of the vessel under pressure. (b) Flowing the material and sulfite cooking liquor co-currently into the central portion of the vessel. (c) Introducing an effective amount of the sulfite cooking liquor utilized for producing pulp into the vessel adjacent the bottom thereof to flow countercurrently to the material moving downwardly in the vessel. (d) Extracting waste (red) liquor from the central portion of the vessel. And, (e) withdrawing sulfite pulp from the bottom of the vessel. In the practice of step (c) about 5-20% of the sulfite cooking liquor is introduced, e.g. about 10%. The sulfite cooking liquor is introduced, here, preferably in a wash recirculation loop, prior to heating of the recirculated liquor, and the temperature at the wash zone may be maintained at least 5° F lower than it would conventionally be maintained for the same material, K-No. and other parameters if sulfite cooking without step (c) were practiced.

Steps (a)-(e) are preferably practiced to produce a pulp with a final K-No. preferably about 20 or below. However they are also practiced so that the K-No. at the withdrawal screens at the central portion of the digester is high enough, so that plugging of the screens does not occur (e.g. about 24 or above). The waste liquor withdrawn from the central portion of the digester is flashed in flash tanks. Prior to introduction of the material and sulfite cooking liquor into the top of the digester, it is steamed, and introduced to a high pressure

feeder. An impregnation vessel may optionally be utilized too.

According to another aspect of the present invention apparatus for practicing sulfite pulping is utilized. The apparatus comprises: An upright digesting vessel having a top, bottom, and central portion. Means for introducing material entrained in sulfite cooking liquor into the top of the vessel. Withdrawal screens at the central portion of the vessel for withdrawing waste liquor and feeding the waste to flash tanks or the like. An extraction screen located between the central portion of the vessel and the bottom thereof and operatively connected to an extraction loop, for withdrawing and recirculating liquor from the vessel so that the liquor passes upwardly in the vessel countercurrent to the flow of material downwardly in the vessel, to the central extraction screens. Means for introducing sulfite cooking liquor utilized for producing sulfite pulp into the extraction loop between the bottom of the vessel and the central portion thereof, so that the sulfite cooking liquor flows upwardly in the vessel countercurrent to material flow. And, means for withdrawing sulfite pulp from the bottom of the vessel.

It is also possible that according to the invention to practice a method of reducing the consumption of sulfite cooking liquor per ton of pulp produced by having an entirely countercurrent treatment in a digesting vessel. This method modification according to the invention may comprise the steps of: (a) Causing comminuted cellulosic fibrous material entrained in sulfite cooking liquor to flow in a first direction through a cooking zone. (b) Passing an effective amount of the sulfite cooking liquor countercurrent to the flow of material in the cooking zone. And, (c) withdrawing waste liquor from the cooking zone at the point where the countercurrent flow of sulfite cooking liquor terminates. Step (b) is preferably practiced with from 5% up to almost 100%, e.g. 20% or more, of the sulfite cooking liquor to be utilized.

For all embodiments of the invention, the sulfite pulping is preferably acid or bisulfite pulping, and the reduction in consumption of cooking liquor is approximately 10%.

It is the primary object of the present invention to provide for an improved sulfite pulping, particularly acid or bisulfite pulping. This and other objects of the invention will become clear from an inspection of the detailed description of the invention, and from the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a side schematic view showing an exemplary sulfite pulping apparatus according to the invention.

DETAILED DESCRIPTION OF THE DRAWING

An exemplary system for sulfite pulping according to the invention is illustrated in FIGURE 1. Entirely standard components include a chips bin 10 for receiving a feed of chips 11 or like cellulosic comminuted fibrous material. From the chips bin 10, the material goes to a horizontal steaming vessel 12, and a vertical conduit 13, sulfite cooking liquor being added to the material in the conduit 13 from source 14 to slurry the material as it is fed to high pressure feeder 15. From high pressure feeder 15 the material entrained in sulfite cooking liquor may pass to an optional impregnation vessel 16, and then in line 17 to the top 18 of a continuous digester 19. At the top of the digester 19 there is a liquid/material separation device 20, which may comprise a screw within a cylinder, a plurality of bull screens with switching withdrawal from the screens, or the like. It is preferred that the digester 19 be a steam digester rather than hydraulic digester, although a functioning hydraulic digester can be constructed.

At the central portion 21 of the digester 19, approximately mid way between the top 18 and the bottom 22 thereof, means are provided for extracting waste liquor. Such means include one or more screens 23 and a conduit 24 extending from the screens. The waste liquor typically is flashed to form steam and more concentrated waste liquor by passing it to a series of flash tanks 25, as is conventional. Between the central portion 21 and the top 18 of the digester there also is an extraction and recirculation loop 26, wherein some liquor is withdrawn through screens 27 under the influence of pump 28, passes through a heater 29 where it is indirectly heated with steam or the like, and then is returned to the interior of the digester as indicated at 30, preferably above the withdrawal point from screens 27. In the top of the digester, between the liquid/solid separator 20 and the screens 23, the sulfite cooking liquor and the cellulosic material flow co-currently.

At the bottom 22 of the digester 19 is an outlet scraper 32 or the like, and a discharge conduit 33 for sulfite pulp. Wash liquid from source 34 is added at 35 to the bottom 22. Also a wash circulation loop 36 is provided, including a screen 37, pump 38, and indirect heater 39, the recirculated liquid being returned to point 40 just above the screen 37.

What has heretofore been described is basically conventional for a continuous sulfite pulping apparatus. The most significant aspect of the present invention is the introduction of an effective amount of sulfite cooking liquor from source 14 into the digester 19 to flow countercurrently to the material (chips) flow, as indicated by arrow 42. This

is most easily accomplished by feeding sulfite cooking liquor from source 14 in line 44 so that it enters the wash circulation loop 36, just before pump 38 and heater 39. The amount of sulfite cooking liquor added in line 44 will depend upon the particular material being handled, and other parameters, but normally is at least about 5% of the total amount of sulfite cooking liquor utilized for producing sulfite pulp. About 5 to 20% is a desirable range, with about 10% preferred.

In the present specification and claims the term "sulfite cooking liquor" is intended to encompass all conventional sulfite cooking liquors, whether for bisulfite pulping, acid sulfite pulping, neutral sulfite pulping, or alkaline sulfite pulping, and regardless of the exact chemical source of the active or inactive components.

The effect of adding the sulfite cooking liquor into the bottom portion of the digester 19 so that it flows countercurrently as indicated at 42 up to the screens 23, is to effectively extend the cooking time. For example for a typical digester 19 the cooking time may be three hours, but by the practice of the invention the same vessel 19 can be used in practicing a five hour cook. This means that the temperature in the cooking zone can be lowered, and thus an energy savings can be realized. For example in a typical prior art sulfite digester 19, the temperature in the cooking zone between screens 23 and 27 was about 310-315°F. That temperature was reduced at least 5°F, e.g. an entirely workable temperature in the practice of the invention was 305°F in that zone. While the wash zone temperature was raised from the conventional level of about 250-280°F to about 300°F, since the downflow volume is larger than the upflow volume, and net energy savings ensues.

Not only does the invention go against expected thinking by working at all, in fact numerous unexpected advantages occur. Perhaps the most significant advantage is that the amount of cooking chemical necessary is significantly reduced. In the practice of one conventional sulfite pulping installation, the acid charge, total SO_2, was about 15.5%. Making no other changes to the digester aside from practicing the invention, the acid charge was lowered to about 14.2% total SO_2, a reduction of about 10% [this occurs with about 10% of the cooking acid added in line 44, and with a cooking temperature of about 305°F instead of 310°F-315°F].

Another significant benefit, which is difficult to quantify, is that the digester 19 runs better. That is operators report that the chip and liquor levels are easier to control.

Another benefit from the practice of the invention is the solving of the problem of plugging of the extraction screens 23. As previously described, even though a digester may have difficulty in achieving a K-No. target without plugging, with the invention, the K-No. at the extraction screens can be much larger than at the discharge, so that the chance of plugging is minimized. A K-No. as low as 8 has been achieved according to the invention, which was never possible in conventional sulfite pulping using that same equipment. The chance of plugging of the screens 23 is minimized since the K-No. at the screens 23 is about 24 or above (e.g. 30).

While the digester 19 illustrated in FIGURE 1 is the most feasible apparatus for the practice of the invention, and allows ready retrofitting of existing installations, according to the invention it is possible to produce sulfite pulp by running an entire vessel countercurrently. That is in an entire vessel the material may move downwardly while the sulfite cooking liquor moves upwardly, with extraction near the top of the vessel (that is at the end of the countercurrent flow of cooking liquor). In such a situation, from 5% up to close to 100% of the sulfite cooking liquor utilized can flow countercurrently, e.g. over about 20%.

It will thus be seen that according to the present invention a sulfite pulping process is provided that is improved in a number of ways compared to conventional sulfite pulping. While the invention has been herein shown and described in what is presently conceived to be the most practical and preferred embodiment thereof, it will be apparent to those of ordinary skill in the art that many modifications may be made thereof within the scope of the invention, which scope is to be accorded the broadest interpretation of the appended claims so as to encompass all equivalent methods and apparatus.

Claims

1. A method of producing cellulosic pulp by continuous sulfite pulping, utilizing comminuted cellulosic fibrous material, sulfite cooking liquor, and an upright digesting vessel (19) having top (18), bottom (22), and central (21) portions, comprising the steps of continuously:

   (a) feeding comminuted cellulosic fibrous material entrained in sulfite cooking liquor into the top of the vessel under pressure;

   (b) flowing the material and sulfite cooking liquor co-currently into the central portion of the vessel; and (c) withdrawing sulfite pulp from the bottom of the vessel;

   (d) introducing an effective amount of the sulfite cooking liquor (14) utilized for producing pulp into the vessel (at 44) adjacent the bottom thereof to flow countercurrently to the material moving downwardly in the

vessel; and

(e) extracting waste liquor (at 23) from the central portion of the vessel.

2. A method as recited in claim 1 characterized in that step (d) is practiced by introducing about 5-20% of the sulfite cooking liquor into the vessel to flow countercurrently to the material flow.

3. A method as recited in claim 1 characterized by the further step of -- between the central portion of the vessel and the top thereof -- withdrawing (via 27, 28) a portion of the sulfite cooking liquor, heating it (via 29), and introducing it (via 30) back into the digester vessel above the point of withdrawal.

4. A method as recited in claim 1 further characterized in that steps (b) through (e) are practiced at a temperature at least 5°F below the temperature of sulfite cooking without step (d), for the same material, K-No., and other parameters.

5. A method as recited in claim 1 characterized by the further step of, between the central portion of the vessel and the bottom thereof, withdrawing (via 37, 38) a portion of the liquor in a wash loop, heating it (via 39), and recirculating it (via 40) to the interior of the vessel between the central portion and the point of withdrawal.

6. A method as recited in claim 5 characterized in that step (d) is practiced by adding the sulfite cooking liquor to the wash loop between the bottom and the central portion of the vessel.

7. A method as recited in claim 6 further characterized in that step (d) is practiced by introducing about 10% of the sulfite cooking liquor to flow countercurrently to the material flow.

8. A method as recited in claim 1 characterized in that the sulfite cooking liquor is selected from the group consisting of acid and bisulfite cooking liquors.

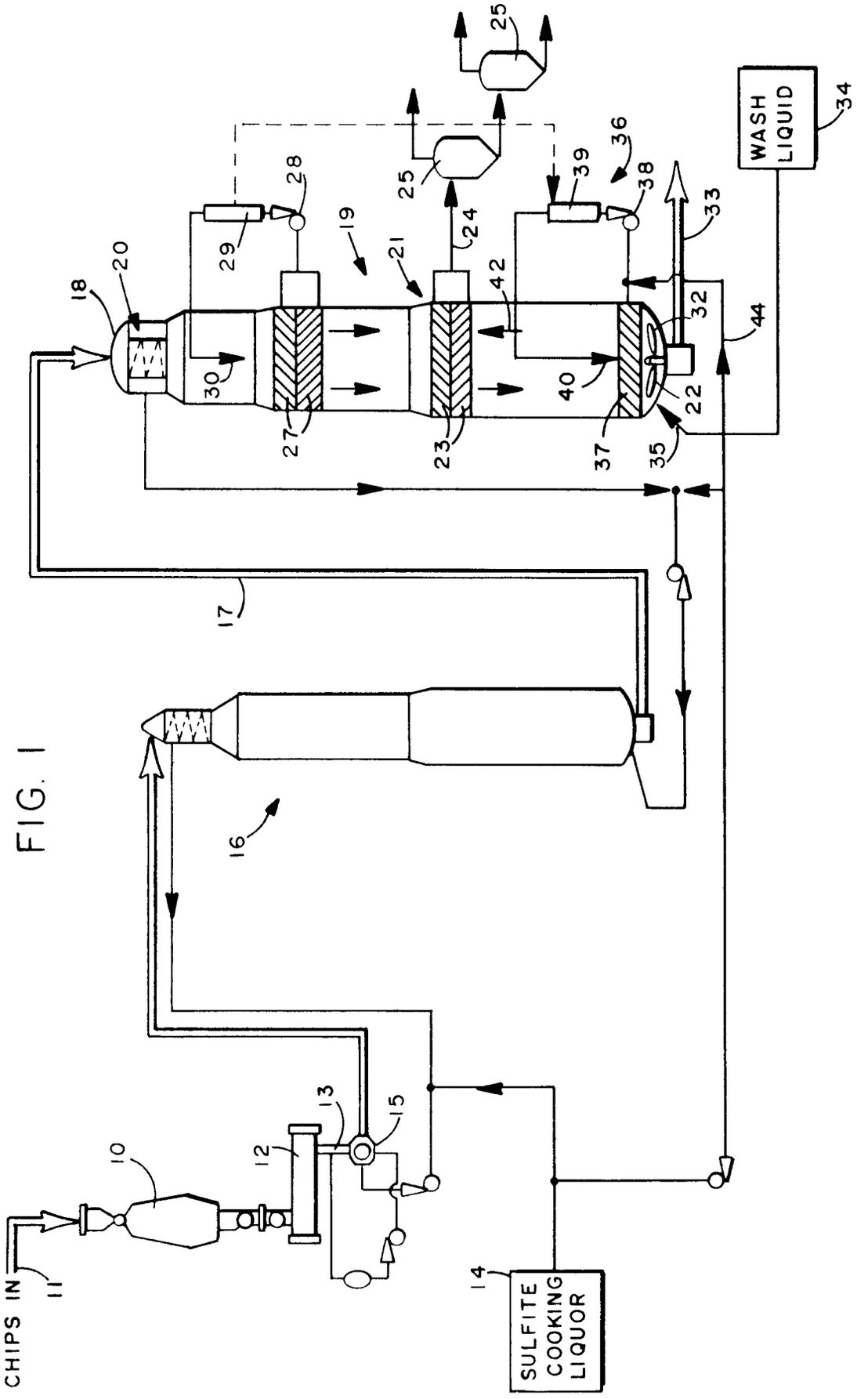
9. Apparatus for producing cellulosic pulp by sulfite pulping, from comminuted cellulosic fibrous material, said apparatus comprising:

an upright digesting vessel (19) having top (18), bottom (22), and central (21) portions; means (17) for introducing material entrained in sulfite cooking liquor into the top of the vessel; withdrawal screens (23) at the central portion of the vessel for withdrawing waste liquor and feeding the waste liquor to flash tanks (25) or the like; and means (33) for withdrawing sulfite pulp from the bottom of the vessel; characterized by:

an extraction screen (37) located between the central portion of the vessel and the bottom thereof and operatively connected to an extraction loop (36), for withdrawing and recirculating liquor from the vessel so that the liquor passes upwardly in the vessel countercurrent to the flow of material downwardly in the vessel, to the central extraction screens; and

means (14, 44) for introducing sulfite cooking liquor utilized for producing sulfite pulp into the extraction loop between the bottom of the vessel and the central portion thereof, so that the sulfite cooking liquor flows upwardly in the vessel countercurrent to material flow.

10. Apparatus as recited in claim 9 further characterized by means (10) for steaming the material, operatively connected to a high pressure feeder (15) in which the material is entrained in sulfite cooking liquor, and means (16, 17) for connecting the high pressure feeder to the top of the digesting vessel, including an impregnation vessel (16).


CHIPS IN
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WASH LIQUID
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FIG. 1