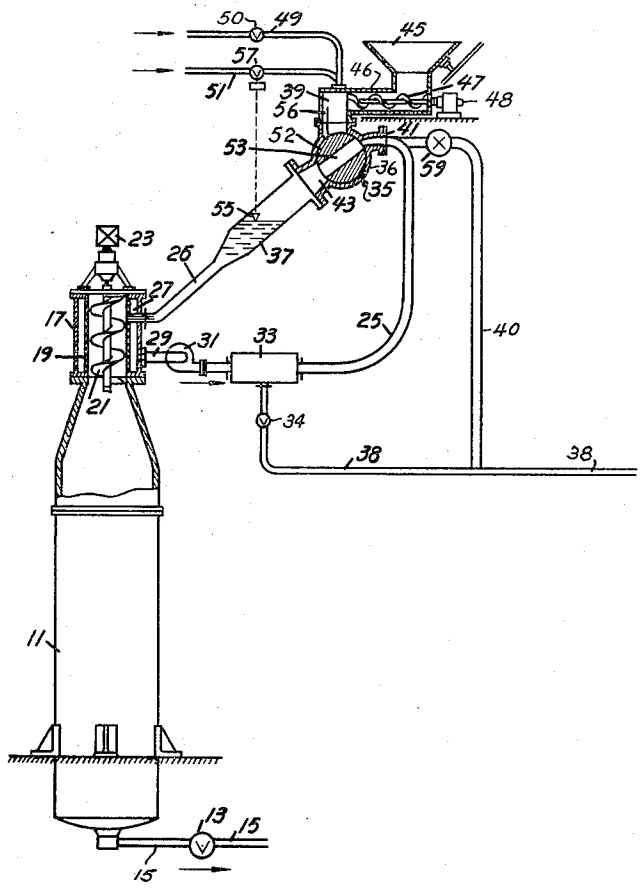
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METHOD OF CONTINUOUS CELLULOSE DIGESTION AND DIGESTER APPARATUS FOR PRACTICING SAID METHOD

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METHOD OF CONTINUOUS CELLULOSE DIGESTION AND DIGESTER APPARATUS FOR PRACTICING SAID METHOD

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This invention relates to a novel method of continuous cellulose digestion and to a digester apparatus for practicing said method. More particularly, this invention relates to a novel cellulose digestion process including a novel method of heating and supplying the digesting liquor and cellulose fiber material in and to a continuous cellulose digestion process, and novel apparatus for carrying out said method.

Continuous cellulose digesters of several types are well known in the prior art and generally comprise the digester and external circulation conduits connected to the digester. The raw cellulose fiber material (for instance, wood chips, straw, etc.) is characteristically charged first into the conduit and carried by the liquor or black liquor circulating therein into the digester. The digester liquor is then separated from the fiber material by drawing it through a sieve attached to the digester and the liquor returned to the circulation conduit. The heat required to maintain the desired temperature in the digester is generally supplied by continuously circulating the digester liquor in a second external circulation conduit, provided with a suitable heat exchanger, and then returning the heater liquor to the digester. For this purpose, the digester chamber has to be provided with internal sieve girdle. Such a method has been described in U.S. Patent No. 2,459,180, issued to one of us.

Charging the fiber material has been accomplished by providing a suitable charging valve in the first circulation conduit. The digester liquor is discharged therein and returned to the digester by means of a high pressure pump. In such cases, any high degree of heating of the digester liquor cannot be performed in connection with that charging and the discharged cooking liquor from the digester would obviously boil violently on account of the high pressure drop connected with its discharge.

In some instances, it is also known to provide a digester apparatus where the fiber material is supplied thereto by circulating black liquor from the digester through the fiber supply means, in some instances with a heat exchanger in the black liquor circulation path. Operating in this manner, the fiber material is introduced at the bottom of the digester and flows upwardly therein countercurrent to the flow of a digesting liquor which is introduced at the top of the digester. In this method of operation, the black liquor is circulated at very high velocity through a narrowed conduit to carry the fiber material (of lighter specific gravity) downward to be introduced at the bottom of the digester. This technique will not, however, supply adequate heat to operate the digester, the temperature therein being maintained primarily by first heating the fresh digesting liquor supply, introduced elsewhere into the digester. Such a method and apparatus is described in U.S. Patent No. 2,359,543.

This invention is designed to overcome the disadvantages present in such prior techniques and apparatus. In particular, the object of this invention is to provide a simplified process of heating and supplying the digester liquor and fiber material to the digester.

An object of this invention is, therefore, to provide in combination with a digester, a digesting liquor circulation path provided with heating means and a charging valve

so designed and situated in the circulation conduit that heating of the liquor therein and the steam formed thereby can be collected directly underneath and adjacent the charging valve. In connection with the accomplishment of this objective, a feature of the invention is to provide a charging valve to deliver the cellulose fiber material directly into an enlarged portion of the circulation path. This enlarged portion is such that a fairly spacious steam container chamber is provided. The steam container chamber and the valve device are located at a higher level than the digester and the flow of steam will be countercurrent to the flow of the supply feed in the charging valve, gravity contributing to the feeding of the fiber material into the circulation path. In this apparatus, the conduit is so designed that it can be maintained filled with steam, the steam thereby being discharged simultaneously with the fiber material being charged.

It will be seen that the invention simplifies the digester apparatus by combining the two circulation conduits previously used, as mentioned above. In addition, since the temperature and the heat required for digestion is supplied to the digester together with the fiber material, digestion starts immediately at the charging end of the digester. As a result of this feature, the volume of the digester can be reduced as compared to known digesters in which the digesting liquor is heated by means of a lye circulation path located at a distance from the charging end, and the sieve girdles and additional circulation lines are eliminated.

The above objects of the invention are accomplished in connection with an upright digester provided with a sieve and screw feeding means at the top thereof and which operates by co-current flow of the digesting pulp and liquor.

A further object of the invention is to provide a novel continuous process for cellulose digestion of comminuted cellulose fiber material, such as wood chips, straw, etc., where successive portions of such material are introduced into a heated circulating digesting liquor and the fiber material is then conveyed to the digester in co-current flow with the digesting liquor, wherein the temperature of the heated circulating digesting liquor is at least substantially equal to the maximum digesting temperature.

Another object of the invention is to provide such a process of fiber material introduction as just described wherein fiber material is introduced into the heated circulating digesting liquor in the presence of steam, the pressure of the steam being substantially equal to the digesting pressure.

Still a further object of the invention is to provide a process where the cellulose fiber material is first heated by condensing steam thereon and is then introduced in the presence of steam at a pressure substantially equal to the digester pressure into heated circulating digesting liquor and conveying co-currently therewith into the digester, the temperature of the digesting liquor being at least substantially equal to the maximum digesting temperature.

In accomplishing the above described processes of the invention, it will be seen that the heated circulating liquor is obtained by sieving off a substantial portion of the digesting liquor from the fiber material as the latter is introduced into the digester, and then heating the liquor in the circulation path prior to re-mixing it with successive portions of the fiber material.

Additional objects of this invention will be apparent from the following description thereof.

The accompanying drawing schematically illustrates one form of the apparatus which may be used in the practice of this invention.

In the drawing, an upright cylindrical digester 11 is illustrated having a sieve housing 17 attached to the upper

end and a pulp discharge line 15 controlled by valve 13 connected to the lower end. Cylindrical sieve 19 is disposed within sieve housing 17 and is provided with a coaxial feeding screw 21 driven by motor 23. Discharge conduit 29 communicates at one end with space 27 between sieve housing 17 and sieve 19 and at the other end with the suction side of circulating pump 31. The pressure side of pump 31 is connected to circulation conduit 25 which is fitted with heater means 33. Circulation conduit 25 empties into a charging valve generally illustrated at 35 through inlet 41. Charging valve 35 comprises a valve housing 36 fitted with inlets 39 and 41 and outlet 43, and rotor 52 having charging passageways 53 is mounted in valve housing 36. Valve outlet 43 empties into steam container chamber 37 which is fitted with a level control 55, schematically shown. The lower end of chamber 37 empties into conduit 26 which penetrates the wall of sieve housing 17 and inside of the sieve 19, as shown. Discharge conduit 29, pump 31, circulation conduit 25 (with heater means 33), charging valve 35, chamber 37, and supply conduit 26, form a loop, for the circulation path for the digesting liquor. It will be noted that the entire loop is above digester 11 and valve 35 and chamber 37 are disposed above sieve housing 17. Feed inlet 39 is supplied with wood chips or straw, etc., from hopper 45 through pipe 46 by supply screw 47, driven by motor 48. Digesting liquor supply conduit 49, fitted with valve 50 and water or black liquor supply conduit 51 fitted with valve 57, are also emptied into feed inlet 39. Partition 56 is arranged in feed inlet 39 to prevent dispersing of the chips and digesting liquor collected in said feed inlet during operation, as will be described hereinafter. Steam conduit 38 supplies steam to the heater device 33 as controlled by valve 34, and through steam line 40, controlled by valve 59, to liquor inlet 41 of housing 36.

In operation, the cellulose starting material, such as wood chips or staw, etc., of suitable particle size are fed to hopper 45 and by means of supply screw 47 into feed inlet 39. Digesting liquor, as needed, is supplied through supply conduit 49. Water or black liquor can also be supplied through supply conduit 51, as will be explained hereinafter. Generally, the quantity of fresh digesting liquor entering through supply conduit 49, will be controlled by valve 50, to correspond to the quantity of chips or straw.

With rotor 52 turned so that passageways 53 are in the vertical position, said passageways will be filled with a supply of chips and digesting liquor from feed inlet 39. After the rotor 52 is turned to the initial shut off position, passageways 53 and the contents thereof will be under atmospheric pressure.

During this short time, it will also be shut off from connection with the circulation conduit 25 which is under digester pressure. Immediately before the charging passageway 53 reaches the position shown in the drawning, its lower end is put into communication with the partly steam-filled container chamber 37. At this point, steam will flow into the passageways 53 and compress its content of chips and air. On further rotation of the rotor 52, passageways 53 reach the position illustrated and the upper end thereof is then open to liquor inlet 41. The heated liquor circulating from conduit 25 then flushes through the passageways 53 and carries the charge therein with it into chamber 37. On further turning of rotor 52, passageways 53 are shut off from liquor inlet 41 and any digesting liquor lye remaining in the passageways flows out through outlet 43 and is replaced by steam from container 37, entering in countercurrent flow. When the passageways are then shut off from valve outlet 43, upon further rotation of the rotor 52, it will contain merely steam of digester pressure. When the passageways are again put into communication with inlet 39, the steam in the passageway will expand and condense on the chips in feed inlet 39 and in supply screw 47 so that the chips are

heated. At this stage, partition 56 serves to convey the steam upwards and undesirable displacement of chips and digesting liquor collected in inlet 39 is avoided.

The supply of cellulose fiber material and digesting liquor from charging passageways 53 is thus delivered to the high pressure side of charging valve 35 into chamber 37. From chamber 37, it will flow through supply conduit 26 into the internal portion of sieve 19 near the upper end of feeding screw 21. Feeding screw 21 will move the mixture downward into digester 11, but during this time the main portion of the digester liquor will be sieved off into space 27 and hence only a concentrated mixture of fiber material and digesting liquor will enter digester 11.

Circulating pump 31 serves to suck the digesting liquor through sieve 19 and withdraw it from space 27 through discharge conduit 29, connected to the suction side of pump 31. From the pressure side of pump 31, the digesting liquor is fed to heater device 33. Preferably, heater device 33 is designed as a heat exchanger for indirect heating of the digesting liquor flowing therethrough, and may be heated by means of steam supplied through steam conduit 38. Alternatively, heater device 33 may be arranged for direct heating by steam; however, the digesting liquor will then be diluted with steam condensate which is often undesirable.

Substantially, the entire heat quantity required for the operation of the digester 11 is supplied to the digesting liquor circulating in circulation conduit 25 through heater device 33 and, as a result, in this invention, sieves in the digester wall or circulation conduits for heating the liquor below sieve housing 17 are eliminated. By way of example, in common sulfate digestion, the temperature in the digester is generally desired to be at a level of about 170° C. and, accordingly, in operation of the invention, the circulation liquor in heater device 33 is raised to a temperature of approximately 176° C. In chamber 37 where the heated liquor is intimately mixed with the introduced feed of chips and fresh digesting liquor and during the supply feeding operation to sieve 19, this temperature will gradually drop to about 171° C., this being the temperature of the circulating liquor on return of the heat exchanger 33 after egress through the discharge conduit 29.

Thus, in a plant for production of 150 tons of air-dry pulp per 24 hours dry wood chips are supplied to hopper 45, at a rate of about 200 kilograms per minute. With normal moisture content for that quantity of wood chips, about 100 to 200 liters of water heated to about 75° C. is simultaneously supplied through digesting liquor supply conduit 49. The quantity of water or black liquor entering through supply line 51 may be up to 50 liters per minute, as will be explained hereinafter. In order to heat this mixture to the desired 170° C. prior to its delivery into sieve housing 17, with a temperature drop in the circulating liquor in the circulation loop 25, 37, 26 of only the order of about 5° C., the lye liquor must be circulated at a rate of about 6,000 to 10,000 liters per minute. Feeding screw 21 forcing the chips downwardly past sieve 19 into digester 11 will keep the sieve clean so that this heavy circulation will not become obstructed.

Since the liquor circulation path forms a loop above the level of the top of the digester, and charging valve 35 is disposed at the uppermost part of the loop, the steam formed by the heated liquor in chamber 37 will collect under and close to the charging valve. That is, the steam formed in the chamber 37 above the liquid level maintained by level control 55 will pass upwardly into passagesways 53. Consequently, when the rotor 52 is turned so that these passageways are again in communication with feed inlet 39 a quantity of steam will be discharged thereinto equal to the quantity of chips and liquor charged.

This condition is maintained by keeping the liquid level of the container 37 at a point such that it will be

partly filled with steam. Level control device **55** accomplishes this by controlling valve **57** in water or black liquor supply line **51**. Should the liquor level in chamber **37** drop, as for instance due to an occasional increased discharge through pulp discharge line **15**, an increased quantity of water or black liquor will be supplied to conduit **51** so that the desired level will be reestablished in the chamber **37**. It will be appreciated that the pressure of the digester corresponds to the vapor pressure above the liquor in container **37** which will in this example correspond to the vapor pressure at a temperature of about 173° C.

When the plant is first started, the steam content of chamber **37** can be supplied through steam line **40** controlled by valve **59**. The rotor **52** is placed in a position so that passageways **53** are in communication with liquor inlet **41** to permit the steam to enter chamber **37**. The steam pressure in steam conduit **38** will be maintained higher than the pressure in digester **11** and, accordingly, steam let by valve **59** will effect the discharge of the feed in passageways **53**. Thus, at this stage of operation, the circulating liquor need not be used for that purpose. Instead, the liquor may be led directly into container **37** by means of a bypass conduit (not shown) from circulation conduit **25**.

It will be appreciated that the above example of this invention is merely for illustrative purposes thereof. The invention is not limited to particular temperatures and pressure to be employed in the digester or circulation conduits. Generally speaking, the apparatus and method of this invention may be carried out under conditions of temperature and pressure as conventionally used in the art of cellulose digestion and no special requirements therefor are imposed on the process by our novel process and apparatus. Of course, the pressure in the digester will be determined by the temperature employed, as indicated above. The temperature to which the circulating liquor is heated in heater device **33** may also be varied as desired within the skill of the art. Obviously, higher temperatures than the 170° C., mentioned above, may be used if desired, particularly where a digester temperature above 170° C. is contemplated. Furthermore, where the insulation of circulation conduit **25**, steam container chamber **37** and inlet conduit **26** are less adequate than in the particular device to which the above example relates, the temperature drop between the liquor exiting from heater device **33** and that entering heater device **33** are greater and, accordingly, a greater differential will have to be maintained, as will be appreciated. It is also apparent that different supply lines for the starting materials can be used equally well, the figures mentioned above being desirable for optimum production and convenience of operation. Obviously, the rate of discharge of digested pulp through discharge line **15** will be determined by adjustment of valve **13** and will be maintained at a value such that the time of passage of the material through the digester corresponds to the time required for complete digestion of the fiber material. The precise optimum rate will vary according to the particular cellulose fiber material being treated. The rate of introduction of the latter through feed inlet **39** will be determined by the said rate of discharge through discharge line **15**.

Equally well, the above-described specific embodiment of the apparatus may also be modified in other respects. For instance, a charging valve device of some other design may be used, or said device may be replaced by a piston or screw feeding device. In addition, if desired, the sieve housing **17** at the upper end of the digester may be modified by placing the sieve **19** and coaxial feeding screw in a horizontal or inclined position.

Accordingly, it will be understood that this invention is not limited to the specific embodiments hereinabove described and illustrated but only by the spirit and scope thereof as defined by the following claims.

We claim:

1. A continuous process for cellulose digestion of comminuted cellulose fiber material which comprises first successively heating successive portions of said fiber material by condensing steam thereon, successively introducing said portions into a single stream of heated circulating digester liquor in the presence of superheated steam and successively conveying said portions of fiber material to a digester in co-current downward flow with said digester liquor wherein the pressure of said superheated steam is at least substantially equal to the digester pressure and the temperature of said heated circulating liquor is at least substantially equal to the maximum digesting temperature.

2. A continuous process for cellulose digestion of comminuted cellulose fiber material which comprises passing said material together with digesting liquor downwardly through an upright digester, withdrawing liquor from the upper end of said digester and circulating the thus withdrawn liquor in an outer loop back to the upper end of the digester, heating said withdrawn circulating liquor in said loop to a temperature such that steam is formed therein, introducing successive portions of said material into the steam in said loop and conveying said portions of fiber material to a digester in co-current downward flow with said heated liquor.

3. A continuous process for cellulose digestion of comminuted cellulose fiber material, which comprises continuously passing said fiber material and digesting liquor in a co-current downward flow through a digester, maintaining a superatmospheric pressure in said digester, withdrawing liquor from a first point in the upper end portion of said digester, circulating the withdrawn liquor through an outer liquor-circulating loop back to a second point in the upper end portion of the digester, heating said circulating digester liquor while in said loop to a temperature exceeding the boiling point of the digester liquor corresponding to the pressure maintained in the digester, whereby steam is formed in the upper part of said loop, introducing successive portions of the fiber material into the steam-filled upper part of said loop, passing said fiber material introduced into said loop in a co-current downward flow with the heated digester liquid in the digester, withdrawing steam from said loop and passing the withdrawn steam in a countercurrent flow to said fiber material as it is introduced into said loop for preheating the fiber material outside of said loop.

4. The continuous cellulose digester apparatus of the character described comprising an upright digester, sieve means at the upper end of said digester, a feeding screw disposed coaxially in said sieve means, an outlet circulation conduit externally communicating with said sieve means, means for heating the liquor circulating in said outlet circulation conduit, an inlet conduit communicating internally with said sieve means, and charging valve means, said charging valve means including a housing arranged intermediate said outlet circulation conduit and said inlet conduit and communicating therewith, and a feed inlet communicating with said housing, for introducing cellulose fiber material into said inlet conduit, said charging valve means being disposed above said inlet conduit and the portion of said inlet conduit in communication with said housing being of substantially greater diameter than the remaining portion of said inlet conduit, so as to provide a steam container chamber immediately below said charging valve means.

5. The continuous cellulose digester apparatus of claim 4, wherein said steam container chamber is higher than the remaining portions of said inlet conduit.

6. The continuous cellulose digester apparatus of claim 4, wherein said steam container chamber is provided with level control means for maintaining said steam container chamber partly filled with liquid and partly filled with steam.

7. Continuous cellulose digester apparatus of the char-

acter described comprising an upright digester and sieve means arranged at the top thereof, a coaxial feeding screw arranged internally of said sieve means, an outlet circulating conduit communicating externally with said sieve means and an inlet conduit communicating internally with said sieve means, pumping means and heater means arranged in said circulation conduit, and charging valve means arranged intermediate and in communication with said circulation conduit and said inlet conduit, a steam container chamber comprising a widened portion of said inlet conduit, arranged below said charging valve means and above the remaining portion of said inlet conduit, a feed inlet communicating with said charging valve means for introducing cellulose fiber material and digester liquor supply means and black liquor supply means for respectively introducing said digesting liquor and said black liquor into said feed inlet, and level control means operatively connected between said steam container chamber and said black liquor supply means for maintaining said steam container chamber partly filled with liquid and partly filled with steam.

8. A continuous cellulose digester apparatus comprising an upright digester, sieve means at the upper end of said digester, a feeding screw disposed coaxially in said sieve means, an outlet circulation conduit externally communicating with said sieve means, heater means for heating liquor circulating in said outlet circulation conduit, an inlet conduit communicating internally with said sieve means, fiber inlet means for introducing the fiber material into the inlet conduit, and charging valve means including a housing having openings in communication with the outlet circulating conduit, the inlet conduit and the fiber inlet means, a steam container chamber comprising a widened portion of said inlet conduit, arranged below and in communication with said charging valve means and above the remaining portion of said inlet conduit and a rotor having an internal passageway therethrough for communicating with said openings, the openings being positioned so that the internal passageway of the rotor communicates in sequence with the inlet conduit and the outlet conduit, with the inlet conduit and with the fiber inlet means, and means for rotating said rotor so that the passageway will communicate with the openings in said sequence, said passageway having an inclined position when communicating with said outlet to thereby facilitate the passage of a charge therefrom.

9. A continuous cellulose digester apparatus of the character described comprising an upright digester, sieve means at the upper end of said digester, a feeding screw disposed coaxially in said sieve means, an outlet circulation conduit externally communicating with said sieve means, means for heating the liquor circulating in said outlet circulation conduit, an inlet conduit communicating internally with said sieve means, and charging valve means, said charging valve means including a housing arranged intermediate said outlet circulation conduit and said inlet conduit and communicating therewith, and a feed inlet communicating with said housing, for introducing cellulose fiber material into said inlet conduit, said charging valve means including means for alternative communication with said feed inlet for introducing cellulose fiber material into said charging valve means, and communication with said outlet circulation conduit and said inlet conduit, for circulating heated digester liquor through said charging valve means and introducing said fiber material into said inlet conduit and a steam container chamber comprising a widened portion of said inlet conduit, arranged below and in communication with said charging valve means and above the remaining portion of said inlet conduit, said feed inlet being provided with conduit means for introducing fresh digesting liquor and conduit means for introducing a supply of black liquor.

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