CONTINUOUS PULPING PROCESSES AND SYSTEMS

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ABSTRACT

A set of spaced apart screen assemblies are provided within a continuous kraft digester. Liquor is extracted from a first screen assembly of the set without recirculation of at least a portion of the extracted liquor into the digester above the first screen. In such a manner, the need for circulation flow below the first screen assembly of the set to the second screen assembly of the set is minimized, thereby also minimizing (if not eliminating entirely) the packing problems such flow may cause. The liquor extracted from the first screen assembly in the set could be reintroduced, however, into the digester at some other location in the cooking system (e.g., at a location just above the bottom screen). By employing the present invention, the distance between the first and second screen assemblies is greater than one digester diameter (D). In addition, the liquor discharge below the first screen assembly, to which the circulated liquor from the second screen assembly (plus added dilution liquor and heat, if desired) may be at a distance of less than one-half (1/2) of a digester diameter (D) below the first screen. A small upflow can thus be used to displace the liquor at the first screen assembly, with a relatively short upflow zone. Multiple sets of such first and second screen assemblies may also be provided within the digester along with other conventional screen assemblies to effect desired internal liquor flows.
WOOD CHIPS FROM FEED SYSTEM

LIQUOR TO CHIP IMPREGNATION VESSEL

EXTRACTED LIQUOR TO RECOVERY OR CHIP FEED SYSTEM

DILUTION LIQUOR

Fig. 1

PULP TO FURTHER PROCESSING

**EXTRACTED LIQUOR TO RECOVERY OR CHIP FEED SYSTEM**

**Fig. 2**
CONTINUOUS PULPING PROCESSES AND SYSTEMS

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application is based on, and claims domestic priority benefits under 35 USC §119(c) from, U.S. Provisional Application Serial No. 60/348,367 filed on Jan. 16, 2002, the entire content of which is expressly incorporated hereinto by reference.

FIELD OF THE INVENTION

[0002] The present invention relates generally to the chemical pulping (e.g., kraft cooking) of fibrous, cellulosic material for the production of paper products. In preferred embodiments, the present invention relates to the continuous pulping of such cellulosic material which is especially well suited for modifying existing pulp digesters without the need for incorporating additional liquor extraction screens. In such a manner, existing digesters may more economically be upgraded so as to be capable of performing more modern post-impregnation liquor-exchange techniques during the kraft cooking process.

BACKGROUND AND SUMMARY OF THE INVENTION

[0003] It is known that accomplishing a liquor exchange after impregnation is beneficial to the kraft cooking process. For example, the following prior-issued U.S. Patents disclose various advantages that can be obtained from one or multiple such liquor exchanges in a pulping digestor: U.S. Pat. Nos. 5,489,363; 5,547,012; 5,536,366; 5,575,890; 5,558,181; 5,824,188; and 6,132,556 (the entirety of each such prior-issued U.S. Patent being expressly incorporated hereinto by reference). Some of the benefits that ensue from such liquor-exchange in the digesters include better control of the chemical profile, increased yield, improved paper strength and, in some cases, better steam economy.

[0004] One problem that has been found when converting older digesters to the more modern liquor-exchange digesters is that many do not have the number of screens normally needed in order to implement the liquor-exchange process schemes. That is, many of the existing digesters that are not operated with a liquor exchange do not have the requisite number of screens in order to make liquor-exchange a feasible design alternative.

[0005] In a typical liquor-exchange digester (for example, a digester which is operating with a process design commercially available from Andritz Inc. of Glens Falls, N.Y. and known as Lo-Solids® pulping as described in U.S. Pat. Nos. 5,489,363; 5,536,366; 5,547,012; 5,575,890; 5,620,562; 5,662,775; 5,824,188; 5,849,150; 5,849,151; 6,086,712; 6,132,556; 6,159,337; 6,280,568; and 6,346,167, the entirety of each of which is expressly incorporated hereinto by reference), liquor enters with the chips at the top of the digester and is extracted at the first screen. Below the first screen, and above the second screen, there is a small liquor downflow, which is extracted at the third screen. Below the third screen, there is a free liquor upflow, used for the final stage of cooking and washing. Liquor is typically added at the fourth screen which is heated together with the upflow liquor coming from below the fourth screen.

[0006] Many variations on the flow schemes discussed briefly above can and have been envisioned. For example, the digester may be provided with only three screens, in which case the digester basically ends below the third screen. There are also digesters variations where there is a downflow liquor exchange between screens 1 and 2, which are located in proximity of each other. This variation is not as efficient as the upflow liquor exchange, as cold impregnation liquor is allowed to mix with the hot, fresh liquor added at the second screen, which brings deficits to the ability to control chemical profiles and steam consumption.

[0007] Digesters are also known where the cooking has been started by adding heat before the liquor exchange, due to the inability to add the heat before the second screen is reached, and thereby losing valuable retention time to properly conduct the cook. That is, the screens in this type of digester are so located that they do not allow enough retention time after the second screen.

[0008] Each circulation of liquor in a liquor-exchange digester requires that liquor be removed from the digester vessel through a set of peripheral strainers, from which it flows to a pump. Other liquors may be added to the extracted liquor, as well as heat, if needed. The liquor is then directed through a pipe to the center of the digester in the vicinity of the screen but typically spaced above the screen a distance of less than about one-quarter (¼) of a digester diameter (D) as measured at the screen.

[0009] Hardwood mills, which have digesters, in which the liquor exchange cannot be performed counter-currently between the first and second screens, after a reasonable impregnation time (e.g., between about 15 to about 60 minutes), and reasonable temperature (e.g., less than about 140°C.), do not experience the yield improvements realized in the digesters, in which this liquor exchange can be conducted properly.

[0010] The liquor exchange could be performed counter-currently between the first and second screens, even if the distance is larger than one digester diameter (D), but such a system has resulted in unstable operation, especially at higher production rates and digester loadings, due to the counter-flowing liquor causing hesitations in the downward moving chip column. The solution to such a problem has to date been to add one set of screens with associated circulation below the first screen, in order to accomplish the liquor exchange in a short upflow zone. The cost of this modification is high, and the loss of production associated with the time it takes to do the work inside the production unit is also expensive.

[0011] Broadly, the present invention aims to solve such a problem by withdrawing liquor from the first screen without recirculation of at least a portion of the extracted liquor into the digester above the first screen. In such a manner, the need for circulation flow below the first screen to the second screen is minimized, thereby also minimizing (if not eliminating entirely) the packing problems such flow may cause.
The liquor extracted from the first screen could be reintroduced, however, into the digester at some other location in the cooking system (e.g., at a location just above the bottom screen) or even elsewhere in the feed system.

By employing the present invention, the distance between the first and second screens is greater than one digester diameter (D). In addition, the liquor discharge below the first screen, to which the circulated liquor from the second screen (plus added dilution liquor and heat, if desired) may be at a distance of less than one-half (½) of a digester diameter (D) below the first screen. A small upflow can thus be used to displace the liquor at the first screen, with a relatively short upflow zone.

In such a manner, therefore, according to the present invention the need for one set of screens may be eliminated. This means in the case of a typical four screen digester as discussed above, is that only three sets of screens would suffice in order to achieve the benefits of a liquor exchange digester system. Similarly, in the case of a three screen digester, only two sets of screens would be required to achieve such benefits. While the invention is particularly well suited for modifying existing digesters in a less expensive manner so as to achieve modern liquor exchange benefits in a kraft pulping process, having fewer circulation screens would also reduce the capital costs associated with new digester designs.

These and other aspects and advantages will become more apparent after careful consideration is given to the following detailed description of the preferred exemplary embodiments thereof.

**BRIEF DESCRIPTION OF THE ACCOMPANYING DRAWINGS**

Reference will hereinafter be made to the accompanying drawing wherein like reference numerals through the various FIGURES denote like elements, and wherein:

**FIG. 1** is a schematic view of one exemplary embodiment of a continuous kraft digester system in accordance with the present invention; and

**FIG. 2** is a schematic view of another exemplary embodiment of a continuous kraft digester system in accordance with the present invention.

**DETAILED DESCRIPTION OF THE INVENTION**

The accompanying drawing FIG. 1 shows schematically a kraft digester 10 that embodies the present invention. As can be seen, the digester 10 includes a series of longitudinally (relative to the long axis of the digester 10) separated screen assemblies 12, 14, 16 and 18. In this regard, the digester 10 is depicted as having four such screen assemblies 12, 14, 16 and 18, but it will be understood by those in this art that a greater or fewer number of screen assemblies may be employed.

As is conventional practice, the digester 10 is fed via line 20 with a slurry of comminuted cellulosic material (e.g., wood chips) and liquor. The wood chips in the slurry introduced via line 20 may have previously been treated in an impregnation vessel (not shown). Liquor is removed from the slurry via line 22 and is preferably sent to the chip feed system or the impregnation vessel, if used. In this regard, the liquor removed from the slurry via line 22 is passed through a heater and then sent to the impregnation vessel (not shown).

In accordance with the present invention, a set of screen assemblies 12, 14 are provided. Liquor is extracted at the first screen assembly 12 of the set via line 24 without at least a portion of the extracted liquor being recirculated above the first screen assembly 12. Instead, a part of the extracted liquor from the first screen assembly 12 may be reintroduced to another location in the digester 10 below the second screen assembly 14. For example, as shown in the accompanying FIG. 1, a part of the extracted liquor from the first screen assembly 12 may be directed via line 26 to the liquor extracted from the fourth screen assembly 18 via line 28. Dilution liquor may be added to such extracted liquor from the fourth screen assembly via line 30. In this regard, dilution liquor may be one selected from water, white liquor, wash liquor and/or bleach plant filtrate. The combined liquor streams may then be passed through a heater 32 and then be reintroduced in the vicinity above the fourth screen assembly 18 via line 34. The remainder of the liquor extracted from screen set 12 via line 24 and not directed via line 26 to another location within the digester may be directed to recovery of the chip feed system via line 27.

Liquor may likewise be extracted from the third screen assembly 16 via line 36 and combined with the extracted liquor in line 27.

In accordance with the present invention, liquor is extracted from the second screen assembly 14 via line 40 and pump 42, passed through a heater 44, and then reintroduced into the digester 10 at a location above the second screen assembly 14. Dilution liquor may be added to the liquor recirculation line 40 via line 48. Important to the present invention, the first and second screen assemblies 12 and 14, respectively, are longitudinally separated from one another by a distance which is greater than one digester diameter (D), while the outlet of the liquor recirculation line 46 is spaced from the bottom of the first screen assembly 12 by a distance which is less than one-half the digester diameter (½D). Such an arrangement therefore results in a small upflow that can be used to displace the liquor at the first screen assembly 12, with a relatively short upflow zone as shown by arrow A1. At the same time, the rest of the zone between screen assemblies 12 and 14 is converted to a downflow as noted by arrow A2. A downflow also exists below the second screen assembly 14 (direction noted by A3).

Accompanying FIG. 2 shows another continuous kraft digester system 100 in accordance with the present invention. In this regard, as will be observed, the system 100 differs principally from the system 10 depicted in FIG. 1 by the presence of another set of screens 12', 14' below the set of screens 12, 14. The operation of the set of screen assemblies 12, 14 (as well as the screen assembly 16) is as described above. Thus, only a discussion with respect to the screen assemblies 12', 14' and related components appears below.

In a similar manner to the screen assemblies 12, 14, it will be observed in FIG. 2 that liquor is extracted at the first screen assembly 12 of the set via line 24 in the absence of at least a portion of the extracted liquor being recirculated above the first screen assembly 12'. Instead, a part of the
extracted liquor from the first screen assembly 12 may be reintroduced to another location in the digester 10 below the second screen assembly 14. For example, as shown in the accompanying FIG. 2, a part of the extracted liquor from the first screen assembly 12 may be combined with the liquor extracted via the screen assembly 12 and directed via line 26 to the liquor extracted from the fourth screen assembly 18 via line 28. Dilution liquor may be added to such extracted liquor from the fourth screen assembly via line 30. The combined liquor streams may then be passed through a heater 32 and then be reintroduced in the vicinity above the fourth screen assembly 18 via line 34.

[0026] It will of course be appreciated that additional screen assemblies (e.g., similar to screen assembly 16) may be provided with the digester 10 above and/or below the set of screen assemblies 12, 14 and/or 12, 14. Moreover, those in this art will recognize that a variety of other modifications may be made to the present invention, for example, so as to effect operation in accordance with the above-noted Lo-Solids® pulping techniques.

[0027] Therefore, while the invention has been described in connection with what is presently considered to be the most practical and preferred embodiment, it is to be understood that the invention is not to be limited to the disclosed embodiment, but on the contrary, is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the appended claims.

What is claimed is:

1. A continuous kraft pulping process comprising:
   (a) passing a slurry of wood chips and liquor in a digester sequentially through a screen set which includes first and second screen assemblies longitudinally spaced apart from one another by a distance which is greater than a diameter of the digester;
   (b) extracting liquor from the first screen assembly of said set without recirculation to the digester to a location above the first screen assembly, while simultaneously
   (c) extracting liquor from the second screen assembly of the set and recirculating at least a portion of the extracted liquor from the second screen assembly to a discharge location within the digester which is above the second screen assembly and spaced below the first screen assembly by a distance which is less than one-half the digester diameter.
   2. The process of claim 1, wherein dilution liquor is added to the liquor extracted from the second screen assembly and recirculated to the digester.
   3. The process of claim 1, wherein at least a portion of the liquor extracted from the first screen assembly is reintroduced to the digester at a location below the second screen assembly.
   4. The process of claim 1, 2 or 3, wherein there is at least one additional screen assembly set below the first mentioned screen assembly set, wherein said at least one additional screen assembly set includes third and fourth screen assemblies positioned in longitudinally spaced relationship by a distance which is greater than a diameter of the digester, and wherein said process includes:
      (d) extracting liquor from the digester at the third screen assembly set without recirculation to the digester to a location above the third screen assembly, while simultaneously
      (e) extracting liquor from the second screen assembly of the set and recirculating at least a portion of the extracted liquor from the fourth screen assembly to a discharge location within the digester which is above the fourth screen assembly and spaced below the third screen assembly by a distance which is less than one-half the digester diameter.
   5. The process of claim 4, wherein at least a portion of the liquor extracted from the first screen assembly is combined with the liquor extracted from the third screen assembly.
   6. The process of claim 5, wherein step (c) is practiced by introducing a dilution liquor into the portion of liquor extracted from the second screen assembly and recirculated to the digester to a location between the first and second screen assemblies.
   7. The process of claim 6, wherein said dilution liquor is selected from water, white liquor, wash liquor, bleach plant filtrate and mixtures thereof.
   8. The process of claim 1, wherein step (c) is practiced by replacing some or all of the extracted liquor with a liquor containing a substantially lower effective dissolved organic material level than the extracted liquor.
   9. The process of claim 8, wherein the digester has multiple other screen assemblies, and wherein liquor is extracted respectively at least at one of the multiple other screen assemblies and recirculated to the digester at a location above the at least one of the multiple other screen assemblies.
   10. The process of claim 9, which comprises introducing a dilution liquor to the liquor extracted respectively at least at one of the multiple other screen assemblies and recirculated to the digester at a location above the at least one of the multiple other screen assemblies.
   11. The process of claim 10, wherein the dilution liquor is selected from water, white liquor, wash liquor, bleach plant filtrate and mixtures thereof.
   12. A continuous kraft pulping system comprising:
      a digester having a screen assembly set which includes first and second screen assemblies which are longitudinally spaced apart from one another by a distance which is greater than a diameter of the digester;
a feed line for feeding a slurry of wood chips and liquor to a top of the digester above the screen assembly set so that the slurry can pass sequentially therethrough said first and second screen assemblies thereof;

a first extraction line for extracting liquor from the first screen assembly of the set in the absence of recirculation to the digester to a location above the first screen assembly;

a second extraction line for simultaneously extracting liquor from the second screen assembly of the set and recirculating at least a portion of the extracted liquor to a discharge location between the first and second screen assemblies of the set which is spaced below the first screen assembly of the set by a distance which is less than one-half the digester diameter.

13. The system of claim 12, comprising a dilution liquor line for adding dilution liquor to the liquor extracted from the second screen assembly and recirculated to the digester.

14. The process of claim 12, wherein at least a portion of the liquor extracted from the first screen assembly is reintroduced to the digester at a location below the second screen assembly.

15. The system of claim 14, further comprising:

at least one additional screen assembly set positioned within the digester below the second screen assembly of the first mentioned set, said at least one additional screen assembly set including third and fourth screen assemblies longitudinally spaced apart from one another by a distance which is greater than a diameter of the digester,

a third extraction line for extracting liquor from the third screen assembly in the absence of recirculation to the digester to a location above the third screen assembly; and

a fourth extraction line for simultaneously extracting liquor from the fourth screen assembly and recirculating at least a portion of the extracted liquor to a discharge location between the third and fourth screen assemblies which is spaced below the third screen assembly by a distance with is less than one-half the digester diameter.

16. The system of claim 15, wherein at least a portion of the liquor extracted from the first screen assembly is combined with the liquor extracted from the third screen assembly.

17. The system of any one of claims 12-16, comprising multiple other screen assemblies, at least one other extraction line for extracting liquor from at least one of the multiple other screen assemblies, and at least one other recirculation line for recirculating at least a portion of the liquor extracted to the digester at a location above the at least one of the multiple other screen assemblies.