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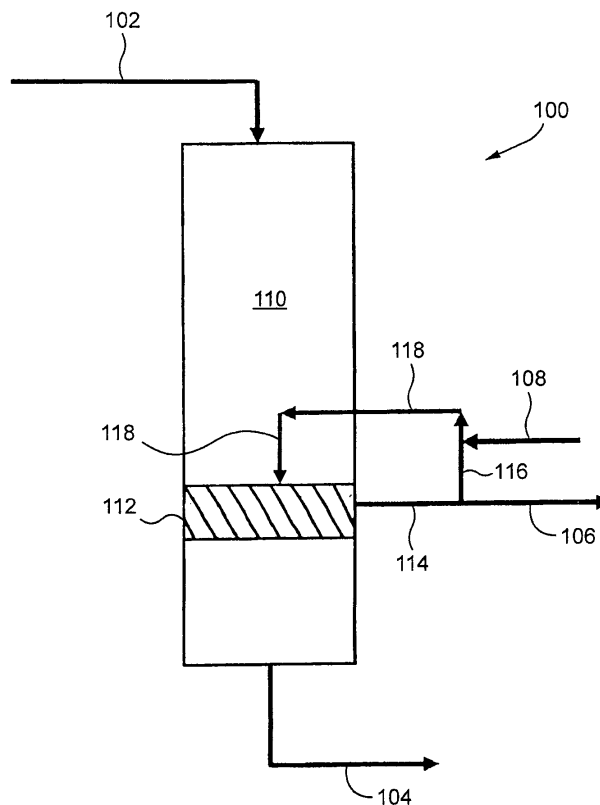
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(54) **Method and apparatus for semi-chemical pulping**

(57) Method and apparatus for minimizing adherence of lignin to an extraction screen in a semi-chemical pulping process. The method and apparatus generally

relate to supplying white liquor and NaOH to as to increase the pH of cooking liquor at or near an extraction screen.



**Fig. 1**

## Description

### CROSS RELATED APPLICATION

**[0001]** This application claims the benefit of U.S. Provisional Patent Application Serial No. 60/954,446 filed August 7, 2007, the entirety of which is incorporated by reference.

### BACKGROUND AND SUMMARY OF THE INVENTION

**[0002]** The present invention generally relates to a method and system for making a semi-chemical pulp from lignocellulosic material.

**[0003]** Semi-chemical pulping processes are known. See, e.g., U.S. Patent No. 4,229,251 to Temler; U.S. Patent No. 4,073,678 to Hammond et al. Semi-chemical pulping processes have different requirements and different operating conditions than pulping processes involving Lo-Solids® Cooking, such as those disclosed in U.S. Patent No. 5,489,363 to Marcoccia et al.

**[0004]** When making semi-chemical pulps (pulps with yields in the 65-85% yield range, typically used for production of corrugated medium used in box making), several different chemicals can be used, such as NaOH, Na<sub>2</sub>CO<sub>3</sub>, Na<sub>2</sub>SO<sub>3</sub>, kraft white liquor or kraft green liquor. In some instances, high temperatures (greater than 160°C) and short cooking times (an hour or less) may be used for making semi-chemical pulps.

**[0005]** In a stand alone semi-chemical pulp mill, NaOH, Na<sub>2</sub>CO<sub>3</sub>, and Na<sub>2</sub>SO<sub>3</sub> may be used separately or in combination or subcombinations. These chemicals may be advantageous because they have a minimum smell and may be regenerated in relatively simple recovery systems typically used for kraft liquor, especially when NaOH and/or Na<sub>2</sub>CO<sub>3</sub> are used. Each chemical or combination thereof may produce its own pulp characteristics from the different types of wood used (e.g., various types of hardwood). Accordingly, the particular combination or subcombination may be selected based on the individual criteria of a producer.

**[0006]** The simple process and relatively short retention time may make it impractical to try to perform multi-stage cooking processes.

**[0007]** When a semi-chemical production facility is operated in a kraft mill, it may make sense from a chemical make-up point of view to use green liquor. Green liquor is produced by combusting kraft black liquor and dissolving the resultant smelt into white liquor. White liquor generally includes a mixture of NaOH and Na<sub>2</sub>S, and green liquor includes those chemicals in addition to the chemicals in the smelt resulting from the combustion of the black liquor. When using green liquor in a digester equipped with extraction screens, through which the spent liquor is extracted, quite often the extraction screens become coated with lignin.

**[0008]** This clogging or coating may be caused by lignin that has precipitated out of solution due to the lower

pH at the end of the cook. The pH decrease may result from the consumption of carbonate ion (CO<sub>3</sub><sup>2-</sup>). As the solubility of lignin, which as been exposed to alkaline cooking conditions, decreases with lower pH, it may form a sticky tar-like substance, which coats the digester screens and may make them non-functional to the point that the digester has to be shut down and cleaned.

**[0009]** To combat this potential problem, many mills with this type of equipment may add substantial amounts of kraft white liquor with the green liquor (e.g., up to 20-30% of the total chemical charge), in order to keep the pH higher at the end of the cook. A higher pH at the beginning of the cook, however, may have a negative impact on the pulp yield and may make the operation less economical, as white liquor is more expensive to produce than green liquor.

### BRIEF DESCRIPTION OF THE INVENTION

**[0010]** In an aspect, certain embodiments of the present invention generally relate to a method for inhibiting fouling of a black liquor extraction screen in a cooking vessel for semi-chemical pulping. The method may comprise the steps of: feeding lignocellulosic material and green liquor to the cooking vessel for semi-chemical pulping; cooking the lignocellulosic material in the cooking vessel for semi-chemical pulping such that some or all lignin is separated from the lignocellulosic material, and wherein lignin is dissolved into a cooking liquor; extracting via an extraction screen black liquor comprising dissolved lignin, wherein the black liquor is formed during the semi-chemical pulping process from the cooking vessel; and adding white liquor or a base to the cooking vessel at or near the extraction screen, such that a pH at or near the extraction screen is elevated and inhibits lignin from adhering to the extraction screen.

**[0011]** In an aspect, certain embodiments of the present invention generally relate to a cooking vessel for a process of semi-chemical pulping of lignocellulosic material that inhibits fouling of a black liquor extraction screen in the cooking vessel. The cooking vessel may comprise: a first input conduit to the cooking vessel that carries green liquor; a second input conduit to the cooking vessel that carries lignocellulosic material; a cavity in which lignin is separated from the lignocellulosic material and dissolved into a cooking liquor; an extraction screen connected to an extraction conduit that extracts black liquor comprising dissolved lignin, wherein the black liquor is formed during the semi-chemical pulping process from the cooking vessel; and a third input conduit for delivering white liquor or a base to the cooking vessel at or near the extraction screen, such that a pH at or near the extraction screen is elevated and inhibits lignin from adhering to the extraction screen.

**[0012]** In one aspect, certain embodiments of the present invention generally relate to increasing the pH at the end of the cook. This may keep the screens cleaner for a longer period of time. The increased pH may be

accomplished by adding white liquor or NaOH (or any other base) through a circulation and/or central pipe at the end of the cook.

**[0013]** The pH of the cooking liquor (e.g., black liquor with lignin) at the end of the cook should be 10 or higher, preferable between 10 and 13, and most preferably between 10 and 12.

**[0014]** In accordance with certain embodiments of the present invention, the pH at or near the extraction screen (s) may be elevated when compared with the pH of liquor above the extraction screens. This, in turn, may increase the solubility of the lignin at or near the extraction screen (s).

**[0015]** In certain embodiments, the pH level is raised of a liquid at or near an extraction screen of a vessel in which semi-chemical pulping is performed. In certain embodiments, this may cause an increase in the solubility of lignin and may also decrease the tendency of an extraction screen to clog.

#### BRIEF DESCRIPTION OF THE DRAWINGS

**[0016]** Figure 1 illustrates a digester in accordance with an embodiment of the present invention.

**[0017]** Figure 2 illustrates a digester in accordance with another embodiment of the present invention.

#### DETAILED DESCRIPTION OF THE INVENTION

**[0018]** Figure 1 shows a portion of a semi-chemical pulping system 100 that includes a digester 110. The inputs to the digester 110 include a conduit 102, which generally contains at least green liquor and uncooked pulp comprising lignocellulosic material. Conduit 102 (or another conduit) may supply other chemicals, such as, for example, NaOH, Na<sub>2</sub>CO<sub>3</sub>, Na<sub>2</sub>SO<sub>3</sub>, and/or white liquor, to the digester 110. The inputs to the digester 110 also include conduit 108, which supplies white liquor, NaOH (and/or other bases), and/or other agents that may increase the solubility of lignin and/or decrease the likelihood of extraction screen clogging.

**[0019]** The pulp is cooked in digester 110, which contains various extraction screens. Though digester 110 may contain various extraction screens at different elevations, extraction screen 112 illustrates where the spent or used liquor (i.e., black liquor) is removed or extracted from the digester 110. Black liquor is extracted via conduit 114, which splits into conduit 116 and conduit 106. The flow content of conduit 116 is mixed with the flow content of conduit 108 (e.g., white liquor and/or NaOH) and recycled back into digester 110 via conduit 118. This recycle loop may facilitate the efficient extraction of lignin in the black liquor while perhaps reducing the amount of white liquor and/or NaOH required.

**[0020]** The end of conduit 118 is positioned at or near the extraction screen 112. The end of conduit 118 may deliver the contents of conduit 118 in a concentrated location at or near extraction screen 112 or may deliver

the contents at or near substantially the entire surface of extraction screen 112 within the digester. Alternatively, the end of conduit 118 may be incorporated into the extraction screen 112. The distance from the addition point to the extraction screen may be such that the pH is increased across substantially the entire surface of the extraction screen so as to inhibit the adherence of lignin to the extraction screen.

**[0021]** FIGURE 2 shows a portion of another semi-chemical pulping system 200 that includes a digester 210. The inputs to the digester 210 include conduit 202, which generally contains at least green liquor and uncooked pulp. The conduit 202 may also supply other chemicals, such as, for example, NaOH, Na<sub>2</sub>CO<sub>3</sub>, Na<sub>2</sub>SO<sub>3</sub>, and/or white liquor. The inputs to the digester 210 also include liquor such as white liquor, NaOH (and/or other bases), and/or other agents through the conduit 208 that may increase the solubility of lignin and/or decrease the likelihood of extraction screen clogging.

**[0022]** The pulp is cooked in digester 210, which contains various extraction screens. Though digester 210 may contain various extraction screens at different elevations, the extraction screen 212 illustrates where the spent or used liquor (i.e., black liquor) is removed or extracted from the digester 210. In the illustrated embodiment, black liquor is extracted via conduit 206.

**[0023]** The liquor supply conduit 208 feeds into and/or through (as illustrated) a center pipe 220 of the digester. The end of liquor supply conduit 208 and/or center pipe 220 is positioned at or near extraction screen 212. The end of liquor supply conduit 208 and/or center pipe 220 may deliver the contents of the liquor supply conduit 208 and/or center pipe 220 in a concentrated location at or near extraction screen 212 or may deliver the contents at or near substantially the entire surface of extraction screen 212. Alternatively, the end of liquor supply conduit 208 and/or center pipe 220 may be incorporated into extraction screen 212. The distance from the addition point to the extraction screen may be such that the pH is increased across substantially the entire surface of the extraction screen so as to inhibit the adherence of lignin to the extraction screen.

**[0024]** In certain embodiments, furthermore, it may be possible to combine the recycle loop and center pipe in a single method or vessel.

**[0025]** 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 scope of the appended claims.

#### Claims

1. A method for inhibiting fouling of a black liquor ex-

traction screen (112; 212) in a cooking vessel (110; 210) for semi-chemical pulping, the method comprising the steps of:

- feeding lignocellulosic material and green liquor to the cooking vessel (110; 210) for semi-chemical pulping;
  - cooking the lignocellulosic material in the cooking vessel (110; 210) for semi-chemical pulping such that some or all lignin is separated from the lignocellulosic material, and wherein lignin is dissolved into a cooking liquor;
  - extracting via an extraction screen (112; 212) black liquor comprising dissolved lignin, wherein the black liquor is formed during the semi-chemical pulping process from the cooking vessel (110; 210); and
  - adding at least one of white liquor and a base to the cooking vessel (110; 210) at or near the extraction screen (112; 212), such that a pH at or near the extraction screen (112; 212) is elevated and inhibits lignin from adhering to the extraction screen (112; 212).
2. The method of claim 1, wherein the base comprises NaOH.
  3. The method of claim 1 or 2, wherein the step of feeding lignocellulosic material to the cooking vessel (110; 210) further comprises feeding at least one of NaOH, Na<sub>2</sub>CO<sub>3</sub>, Na<sub>2</sub>SO<sub>3</sub> and white liquor to the cooking vessel (110; 210).
  4. The method of any one of the preceding claims, wherein the step of adding white liquor and/or the base to the cooking vessel (110; 210) at or near the extraction screen (112; 212) occurs near the end of a cook when most lignin has been extracted from the lignocellulosic material.
  5. The method of any one of the preceding claims, wherein the step of adding white liquor and/or the base to the cooking vessel (210) at or near the extraction screen (212) occurs using a central pipe (220) running through the center of the cooking vessel (210).
  6. The method of any one of the preceding claims, wherein the step of adding white liquor and/or the base to the cooking vessel (110) at or near the extraction screen (112) occurs using a circulation loop (114, 116, 118) comprising a mixture of white liquor and/or NaOH and black liquor comprising dissolved lignin.
  7. The method of any one of the preceding claims, wherein the step of adding white liquor and/or the base to the cooking vessel (110; 210) at or near the extraction screen (112; 212) creates a localized elevated pH at or near the extraction screen (112; 212) higher than the pH of the cooking liquor above the extraction screen (112; 212).
  8. The method of any one of the preceding claims, wherein a pH of the cooking liquor at the end of the cook is 10 or higher, preferably between 10 and 13, and more preferably between 10 and 12.
  9. A cooking vessel (110; 210) for a process of semi-chemical pulping of lignocellulosic material that inhibits fouling of a black liquor extraction screen (112; 212) in the cooking vessel (110; 210), the cooking vessel (110; 210) comprising:
    - a first input conduit to the cooking vessel (110; 210) that carries green liquor;
    - a second input conduit to the cooking vessel (110; 210) that carries lignocellulosic material;
    - a cavity in which lignin is separated from the lignocellulosic material and dissolved into a cooking liquor;
    - an extraction screen (112; 212) connected to an extraction conduit (114; 206) that extracts black liquor comprising dissolved lignin, wherein the black liquor is formed during the semi-chemical pulping process from the cooking vessel (110; 210); and
    - a third input conduit (108; 208) for delivering at least one of white liquor and a base to the cooking vessel (110; 210) at or near the extraction screen (112; 212), such that a pH at or near the extraction screen (112; 212) is elevated and inhibits lignin from adhering to the extraction screen (112; 212).
  10. The cooking vessel (110; 210) of claim 9, wherein the base comprises NaOH.
  11. The cooking vessel (110; 210) of claim 9 or 10, wherein the first and second input conduits comprise a single input conduit (102; 202).
  12. The cooking vessel (110; 210) of any one of claims 9 to 11, further comprising a fourth input conduit (102; 202) for feeding at least one of NaOH, Na<sub>2</sub>CO<sub>3</sub>, Na<sub>2</sub>SO<sub>3</sub> and white liquor to the cooking.
  13. The cooking vessel (110; 210) of any one of claims 9 to 12, wherein the extraction screen (112; 212) is located near the end of a cook where most lignin has been extracted from the lignocellulosic material.
  14. The cooking vessel (210) of any one of claims 9 to 13, wherein the third input conduit (208) comprises a central pipe (220) running through the center of the cooking vessel (210).

15. The cooking vessel (110) of any one of claims 9 to 14, wherein the third input conduit (108) comprises a circulation loop (114, 116, 118) for recirculating a portion of the black liquor with a mixture of white liquor and/or the base.

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16. The cooking vessel (110; 210) of any one of claims 9 to 15, wherein the third input conduit (108; 208) is located at or near the extraction screen (112; 212) so as to create a localized elevated pH at or near the extraction screen (112; 212) higher than the pH of the cooking liquor above the extraction screen (112; 212).

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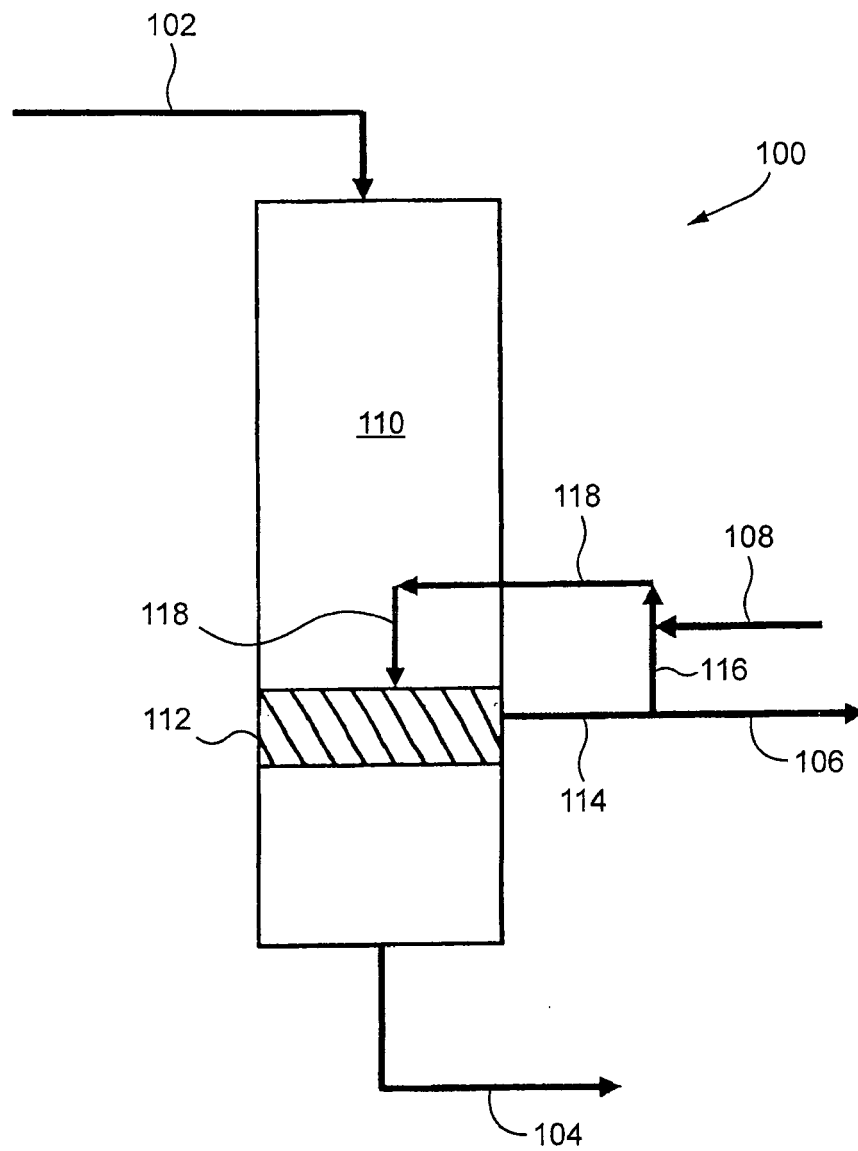


Fig. 1

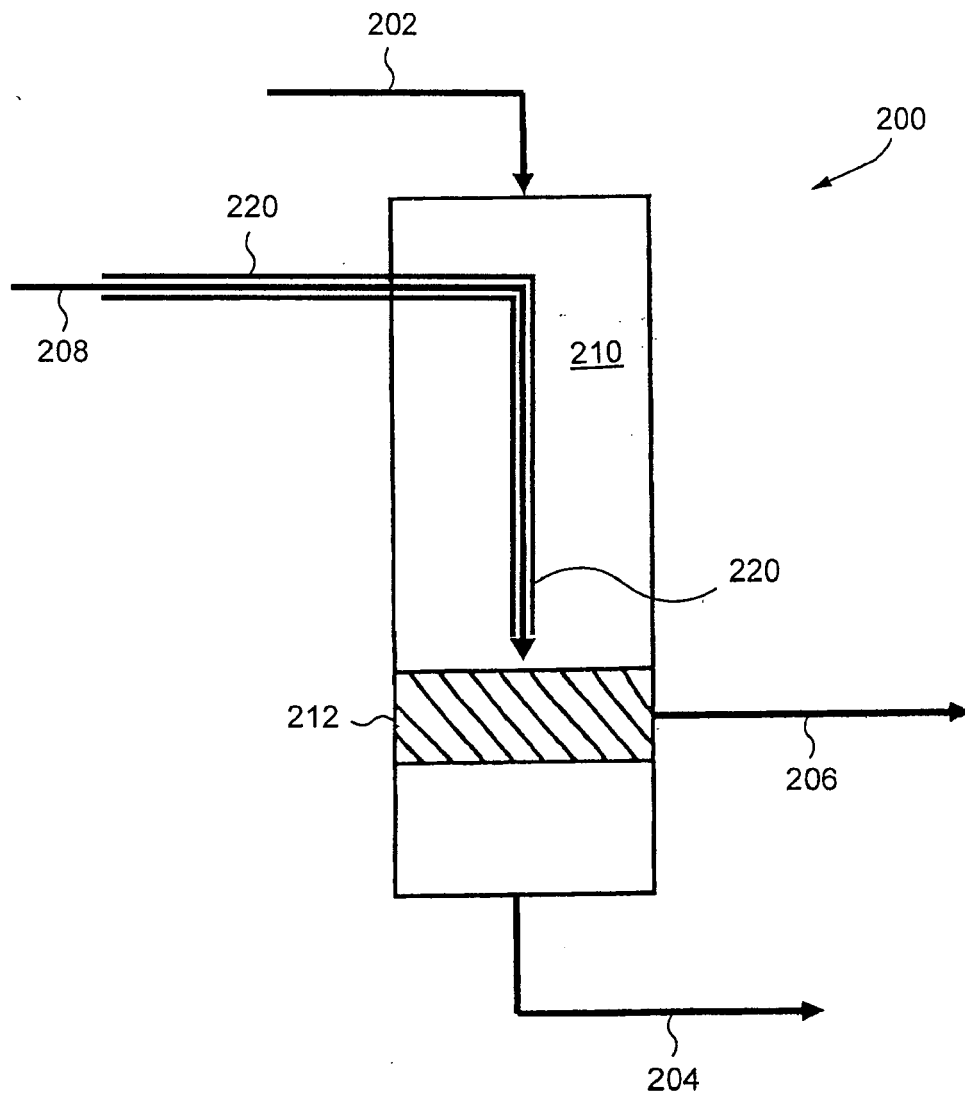


Fig. 2



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Application Number  
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