rates are constant until the operator manually alters the pump speed, and therefore the flow rate. In some cases, changes in flow rate will be made during upset conditions and left at the changed flow rate for an extended (i.e., excessive) period of time.

[0006] Another control method that is commonly utilized in brown stock washing processes is simple “pounds per ton” control, i.e., pounds of wash aid dosed per ton of dry pulp. For “pounds per ton” processes, the brown stock washing process control system calculates a pounds-of-wash-aid-per-ton-of-dry-pulp setpoint and then controls washing aid dosage based on the setpoint. “Pounds per ton” control does not base its wash aid dosage control on changes in either measured entrained air concentration data or changes in fiber characteristics that may impact drainage.

BRIEF SUMMARY

[0007] According to a first aspect of the present invention, there is provided a method of treating brown stock in a brown stock washing process. The method includes measuring a refractive index of a brown stock;

measuring a conductivity of the brown stock;

determining total dissolved solids from the refractive index of the brown stock;

determining a total black liquor carryover comprising an organic fraction and an inorganic fraction in the brown stock based on the refractive index of the brown stock and the conductivity of the brown stock;

determining the organic fraction and the inorganic fraction based on the refractive index of the brown stock and the total dissolved solids of the brown stock; and

dosing an additive to the brown stock according to at least the refractive index and the conductivity of the brown stock.

[0008]

[0009]

[0010]

[0011] In some examples, the total black liquor carryover comprises an organic fraction and an inorganic fraction.

[0012] In some examples, the organic fraction is determined using a formula that is a function of the conductivity of the brown stock and total dissolved solids in the brown stock.

[0013] In some examples, the additive comprises a drainage aid.

[0014] In some examples, the drainage aid comprises a surfactant, a defoamer, a solvent, or combinations thereof.

[0015] In some examples, the additive comprises a defoamer.

[0016] In some examples, the defoamer comprises a hydrocarbon, an oil, a fatty alcohol, a fatty ester, a fatty acid, a poly(alkylene oxide), an organic phosphate, hydrophobic silica, a silicone-containing compound, and combinations thereof.

[0017] In some examples, the defoamer comprises a silicone-containing compound.

[0018] In some examples, the silicone-containing compound is a polydimethylsiloxane-containing compound.

[0019] In some examples, the method includes determining a chlorine dioxide dosage in a bleaching stage of a papermaking process based on the total black liquor carryover.

[0020] In some examples, the brown stock washing process comprises a plurality of washers arranged in series.

[0021] In some examples, the method includes measuring the conductivity and the refractive index of the brown stock being fed to a first washer in the plurality of washers and measuring the conductivity and the refractive index of washed pulp leaving a last washer in the plurality of washers.

[0022] According to a second aspect of the present invention, there is provided a system for controlling dosing of an additive to a brown stock washing process. The system includes a refractive index measurement device; a conductivity measurement device; a controller configured to receive data provided by the refractive index measurement device and the conductivity measurement device, and transform the data into additive addition output instructions, wherein the controller is configured to determine a total black liquor carryover in the brown stock based on a refractive index of the brown stock and a conductivity of the brown stock; and an additive delivery unit configured to receive and execute the additive addition output instructions from the controller after receiving data from the refractive index measurement device and the conductivity measurement device.

[0023] In some examples, the system further comprises at least one of a vat level detector, a shower flow measurement device, a shower conductivity measurement device, a drum thickener electrical current relay, an entrained air and bubble size detector, and combinations thereof, in communication with the controller.

[0024] In some examples, the system includes a conductivity measurement device configured to measure conductivity of the brown stock.

[0025] In some examples, the controller is configured to determine a total black liquor carryover in the brown stock based on at least two variables: a refractive index of the brown stock and a conductivity of the brown stock.

[0026] In some examples, the additive delivery unit comprises a pump.

[0027] In some examples, the controller stores a formula that is a function of conductivity of the brown stock and total dissolved solids in the brown stock.

[0027a] According to a third aspect of the present invention, there is provided a method of treating brown stock in a brown stock washing process, comprising:

measuring a refractive index of a brown stock;

measuring a conductivity of the brown stock;

determining an inorganic fraction and an organic fraction based on the refractive index of the brown stock and the conductivity of the brown stock, wherein a total black liquor carryover comprises the organic fraction and the inorganic fraction; and

dosing an additive to the brown stock after measuring the refractive index and the conductivity of the brown stock.

[0028] The foregoing has outlined rather broadly the features and technical advantages of the present disclosure in order that the detailed description that follows may be better understood. Additional features and advantages of the disclosure will be described hereinafter that form the subject of the claims of this application. It should be appreciated by those skilled in the art that the conception and the specific embodiments disclosed may be readily utilized as a basis for modifying or designing other embodiments for carrying out the same purposes of the present disclosure. It should also be realized by those skilled in the art that such equivalent embodiments do not depart from the spirit and scope of the disclosure as set forth in the appended claims.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0029] A detailed description of the invention is hereafter described with specific reference being made to the drawings in which:

[0030] FIG. 1 shows a schematic for an embodiment of a system for treating and washing brown stock;

[0031] FIG. 2 shows conceptual schematic of using the refractive index to determine the total dissolved solids in the wash liquor;

[0032] FIG. 3 shows the predicted organic loading multiple regression model for the online measurements utilizing the total dissolved solids and conductivity measurements;

[0033] FIG. 4 shows a comparison of the predicted organic fraction to the lab result using gravimetric analysis;

CLAIMS

What is claimed is:

1. A method of treating brown stock in a brown stock washing process, comprising:

measuring a refractive index of a brown stock;

measuring a conductivity of the brown stock;

determining total dissolved solids from the refractive index of the brown stock;

determining a total black liquor carryover comprising an organic fraction and an inorganic fraction in the brown stock based on the refractive index of the brown stock and the conductivity of the brown stock;

determining the organic fraction and the inorganic fraction based on the refractive index of the brown stock and the total dissolved solids of the brown stock; and

dosing an additive to the brown stock according to at least the refractive index and the conductivity of the brown stock.

2. The method of claim 1, wherein the conductivity of the brown stock is measured by implementing a conductivity sensor.

3. The method of claim 1, wherein the inorganic fraction is determined based on formula (I): Inorganic (% wt.) = Constant + B*Conductivity (mS/cm) + A*TDS (% wt.) (I), where A and B are parameters determined from a fit of the data to gravimetric measurements of the brown stock and where TDS is a total dissolved solids measurement based on the refractive index of the brown stock.

4. The method of claim 1, wherein the organic fraction is determined using a formula that is a function of the conductivity of the brown stock and the total dissolved solids in the brown stock.

5. The method of claim 1, wherein the additive comprises a drainage aid.

6. The method of claim 1, wherein the additive comprises a defoamer.

7. The method of claim 6, wherein the defoamer comprises a hydrocarbon, an oil, a fatty alcohol, a fatty ester, a fatty acid, a poly(alkylene oxide), an organic phosphate, hydrophobic silica, a silicone-containing compound, and combinations thereof.

8. The method of claim 7, wherein the silicone-containing compound is a polydimethylsiloxane-containing compound.

9. The method of claim 1, further comprising determining a chlorine dioxide dosage in a bleaching stage of a papermaking process based on the total black liquor carryover.

10. The method of claim 1, wherein the brown stock washing process comprises a plurality of washers arranged in series.

11. The method of claim 10, further comprising measuring the conductivity and the refractive index of the brown stock being fed to a first washer in the plurality of washers and measuring the conductivity and the refractive index of washed pulp leaving a last washer in the plurality of washers.

12. A system for controlling dosing of an additive to a brown stock washing process, comprising:

a refractive index measurement device;

a conductivity measurement device;

a controller configured to receive data provided by the refractive index measurement device and the conductivity measurement device, and transform the data into additive addition output instructions, wherein the controller is configured to determine a total black liquor carryover in the brown stock based on a refractive index of the brown stock and a conductivity of the brown stock; and

an additive delivery unit configured to receive and execute the additive addition output instructions from the controller after receiving data from the refractive index measurement device and the conductivity measurement device.

13. The system of claim 12, wherein the system further comprises at least one of a vat level detector, a shower flow measurement device, a shower conductivity measurement device, a drum thickener electrical current relay, an entrained air and bubble size detector, and combinations thereof, in communication with the controller.

14. The system of claim 12, wherein the refractive index of the brown stock and the conductivity of the brown stock can be used in a feedforward control strategy, and/or the refractive index of the brown stock and the conductivity of the brown stock can be used in a feedback control strategy.

15. A method of treating brown stock in a brown stock washing process, comprising:

measuring a refractive index of a brown stock;

measuring a conductivity of the brown stock;

determining an inorganic fraction and an organic fraction based on the refractive index of the brown stock and the conductivity of the brown stock, wherein a total black liquor carryover comprises the organic fraction and the inorganic fraction; and

dosing an additive to the brown stock after measuring the refractive index and the conductivity of the brown stock.

16. The method of claim 21, further comprising determining the total black liquor carryover in the brown stock based on at least the refractive index of the brown stock and the conductivity of the brown stock.

17. The method of claim 15, further comprising determining total dissolved solids from the refractive index of the brown stock.

18. The method of claim 15, wherein the inorganic fraction is determined based on formula (I):

Inorganic (% wt.) = Constant + B*Conductivity (mS/cm) + A*TDS (% wt.) (I),

where A and B are parameters determined from a fit of the data to gravimetric measurements of the brown stock and where TDS is a total dissolved solids measurement based on the refractive index of the brown stock, and

wherein the organic fraction is determined based on formula (II):

Organic (% wt.) = TDS (% wt.) - Inorganic (% wt.) (II).

19. The method of claim 1, further comprising monitoring a brown stock washer drum speed, a brown stock washer stock flow, or a combination thereof.

20. The method of claim 19, wherein the brown stock washer drum speed is from about 1 rpm to about 5 rpm, and wherein the brown stock washer stock flow is maintained to provide a brown stock consistency of from about 1 % to about 4%.