July 13, 1965 S. M. NEUVILLE 3,194,638

COMBINED SLAKER-CAUSTICIZER APPARATUS

Filed Nov. 21, 1962 2 Sheets-Sheet 1

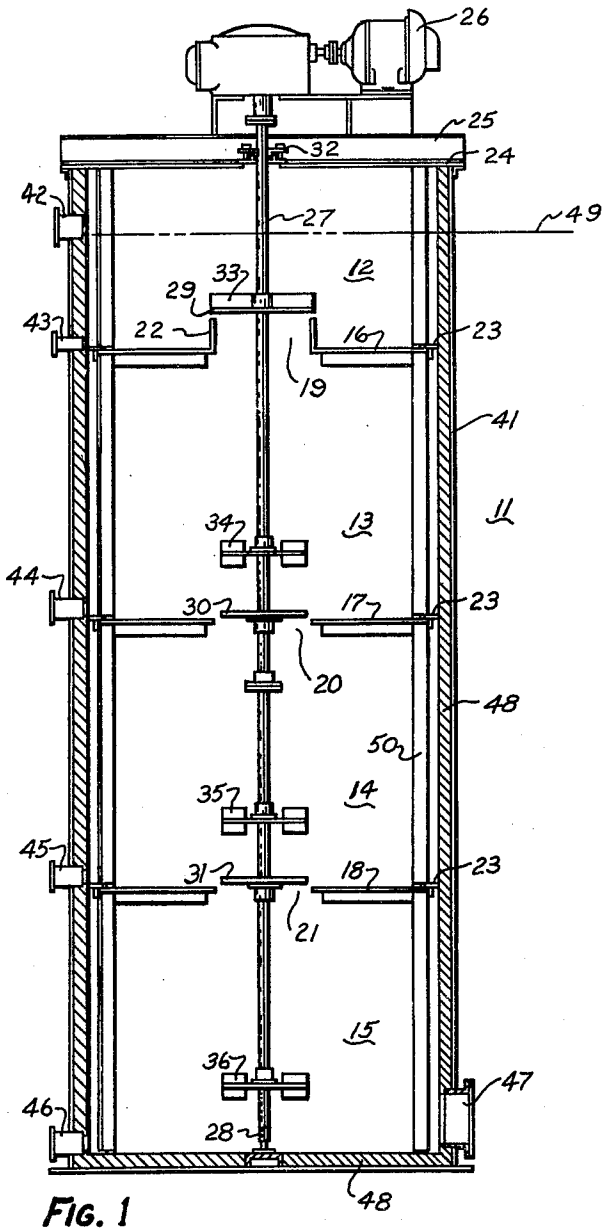


FIG. 1

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COMBINED SLAKER-CAUSTICIZER APPARATUS

Filed Nov. 21, 1962 2 Sheets-Sheet 2

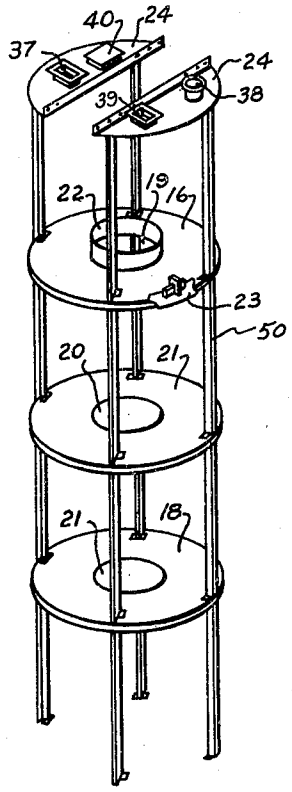


FIG. 2

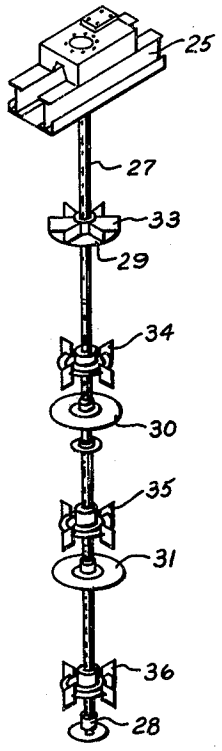


FIG. 3

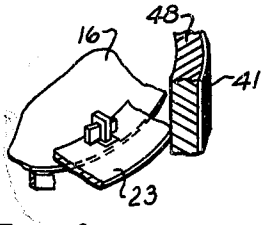


FIG. 4

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3,194,638

COMBINED SLAKER-CAUSTICIZER APPARATUS

Stewart M. Neuville, Harrison, Wis., assignor to Kimberly-Clark Corporation, Neenah, Wis., a corporation of Delaware

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2 Claims. (Cl. 23—283)

This application relates to an improved method and apparatus for the preparation of cooking liquor in the alkaline pulping of cellulosic materials. More specifically it relates to a combined lime slaker and causticizer and an improved more efficient method for preparing white liquor for use in alkaline pulping.

Economic operating of the alkaline pulping process requires the recovery and reuse of the chemicals employed in cooking the cellulosic source material. The first step in recovering these compounds is to first concentrate and then burn the spent cooking liquor. The smelt obtained is then dissolved to form what is known as green liquor. In the soda process, the green liquor is essentially a solution of sodium carbonate, while in the sulfate process, the green liquor also contains sodium sulphide. The next step in recovery is to causticize the green liquor by the addition of quicklime (CaO) to thereby convert the sodium carbonate to sodium hydroxide and produce white liquor suitable for reuse in the cooking process.

In conventional operations, slaking of the lime and subsequent causticization of the green liquor is done in separate units, each specially designed to carry out a single step of the process. Thus, strong green liquor is fed to a lime slaker-classifier unit where it is mixed with and slakes a measured flow of quicklime. The resultant milk of lime flows to a classifier section for removal of coarse grit and unreacted material by means of a conveyor or rake-like device moving up the inclined bottom of the classifier tank. The degritted slurry overflows from the claker-classifier into a level-controlled headbox and is pumped from there through a series of tanks in which it is agitated, and the causticizing reaction, already started in the slarker, is completed. The causticized slurry then passes to a clarifier where the precipitated lime mud is separated out and is usually pumped to a thickener for recovery. The strong white liquor removed from the clarifier is then ready for use in cooking.

A serious disadavantage of the conventional slaking-causticizing system is the tendency for portions of the reacting slurry to overflow from one stage to the next without being retained in a particular reaction zone for the full time intended. This short-circuiting or bypassing of relatively unreacted chemicals is relatively inefficient and does not utilize the available chemicals to the best advantage.

It is an object of this invention to combine the slaking and causticizing operation in a single unit thus providing savings in both equipment and space requirements.

A further object is to provide an improved and more efficient method for carrying out the slaking-causticizing operation, utilizing the improved apparatus to insure against short-circuiting or bypassing of relatively unreacted chemicals.

Additional objects and advantages of the invention will become apparent from the following detailed description of certain preferred embodiments together with the accompanying drawing.

In the drawings,

FIG. 1 is a sectional elevational one embodiment of a combined slaker-causticizer constructed in accordance with this invention and employed in carrying out the improved process.

FIG. 2 is a perspective view showing in more detail the vertical and horizontal baffle structure in the apparatus.

FIG. 3 is a perspective view showing the details of a preferred structure for the agitator mechanism in the apparatus.

FIG. 4 is a perspective view showing in more detail annular seal plates comprising a part of the apparatus structure.

In accordance with the invention, the primary object is attained by arranging slaking and causticizing units in a single vertical tower. As shown in the drawings, a preferred embodiment of the combined slaker-causticizer tower comprises a closed vertical cylindrical vessel 11 divided into a top slaking compartment 12, and three causticizing compartments 13, 14 and 15, by flat horizontal floor elements in the form of annular stator baffles 16, 17 and 18 suitable supported and mounted therein and provided with annular seal plates 23 extending to the interior lining 48 of vessel 11. These annular baffles are imperforate except for large central circular apertures 19, 20 and 21. Aperture 19 in baffle 16, which separates slaking compartment 12 from the first causticizing compartment 13, is preferably flanged upwardly as at 22 to provide baffle 16 with an annular vertical portion. Apertures 20 and 21 do not have such auxiliary central flange. The annular baffles are rigidified and partially supported by vertical baffles 50 extending through each compartment for the full height of the vessel and spaced at 90° intervals. The vertical baffles 50 are normally spaced from the interior lining 48 of the vessel to avoid dead areas. It is also understood that more vertical baffles than the number shown in the drawing may be provided.

Top plate 24 of vessel 11 is provided with a diametrically extending mounting plate 25 carrying an electric motor 26 coupled to a central vertical shaft 27 extending vertically and axially of vessel 11. Shaft 27 is rotatably mounted in bearing 28 on the floor of the vessel, and is provided with a seal 32 where it enters the tower. Shaft 27 has fixed thereon a plurality of rotor baffles in the form of flat, circular imperforate discs 29, 30, 31 and agitators 33, 34, 35, and 36. Rotor baffle 29 and agitator 33 are shown in this embodiment to be of unitary construction, while the remaining agitators and rotor baffles are in spaced arrangement. Baffle 29 and agitator 33 may also be in spaced arrangement, if desired. The rotor baffles are suitably sapced from their respective stator baffles to restrict the passage therethrough of fluid being treated to prevent intermixing or short circuiting between compartments. A typical annular spacing is about 1", but it may be varied to suit particular conditions. Top plate 24 is provided with a lime feed aperture 37 and an inlet pipe 38 for green liquor. The top plate also is equipped with a vent 39 and an access manhole 40. Cylinder wall 41 in slaking compartment 12 is provided with a flanged overflow outlet 42 connected to the sewer or a suitable collecting vessel. A grit withdrawal outlet 43 is also provided in cylinder wall 41 near the base of slaking compartment 12. The cylinder wall in each of the causticizing compartments is provided with flanged discharge or clean-out outlets 44, 45 and 46 near the base of each compartment with the latter outlet 46 also serving as the conduit for discharging fully causticized white liquor. An inspection manhole 47 may also be provided in the lowermost caustisizing compartment 15. Those parts of structure which come into contact with the chemical slurry are preferably made of stainless steel or other erosion or corrosion-resistant material. For example, the walls and bottom of cylinder 11 may be suitable lined with alkali-resistant brick 48, as shown, if the more expensive

stainless steel is not employed for the cylinder wall structure.

In operation, strong green liquor is introduced through inlet 38, and a measured flow of quicklime, either reclaimed lime sludge or fresh lime, is introduced through lime feed aperture 37, while rotor shaft 27, agitator 33 and rotor baffle 29 are turned at a speed sufficient to provide circulation and intimate intermixing of the chemical slurry to assist in the initial slaking reaction while maintaining undissolved materials in uniform suspension. Rotor baffle 29 is closely spaced from annular flange or dam 22 of stator baffle 16 to restrict flow from the slaking compartment 12 into the first causticizing compartment 13 thus preventing undesirable short-circuiting. The annular flange 22 further serves to retain in slaking compartment 12 large grit particles and unreacted material which settles out for subsequent removal through grit withdrawal outlet 43 suitably equipped with a gate valve or the like. Centrifugal action of the agitator 33 and rotor baffle 29 also tends to direct the undesirable coarse particles of grits and unreacted material in the slurry to the periphery of stator baffle 16 from where the particles are removed by continuously or intermittently withdrawing a portion of the slurry through outlet 43 by means of a suitable exterior pump, not shown. The withdrawn portion of the liquor containing the grits is subsequently screened, the grits discarded, and the degritted liquor returned to the slaking compartment. The degritted liquor may be returned through vent 39 thereby serving as a wash for fumes and dust being vented therethrough. The reacted liquor in the slaking compartment flows into the first causticizing compartment through the restricted annular aperture formed by closely spaced rotor baffle 29 and dam 22. Such spacing may be adjusted as desired, but a spacing of about 1" was found to work satisfactorily. The flow continues to each of the causticizing compartments in sequence through the restricted annular apertures shown, and substantially fully reacted and causticized white liquor is removed continuously through discharge conduit 46. After clarification to remove lime mud, the clarified causticized liquor is ready for use in the pulping operation. The lime mud removed in the clarifying step is washed, thickened and reburnt to convert it to CaO, for subsequent reuse in the slaking-causticizing operation.

The size of the vessel and each compartment is such that total retention time of the liquor is sufficient to obtain optimum reaction for each stage of the process. For example, about 15 minutes in the slaking compartment, and a total of about 2 hours in the causticizing section is sufficient to bring the reaction to substantial completeness. The causticizing section is compartmented and connected by restricted openings as shown, to prevent short-circuiting between reaction zones, and insures against intermixing of less reacted material with more completely reacted material. The number and size of the individual causticizing compartments may be varied to suit particular conditions, depending on total capacity designed into equipment, rate of flow, and the like.

In startup operation, the vessel is first filled with green liquor to operating level 49 before lime is introduced. A major portion of the green liquor used in initial filling is substantially unreacted and may be shunted back to the green liquor feed until acceptable full strength white liquor is obtained at the discharge end.

While this specific example relates to reconstituting green liquor derived from spent alkaline cooking liquor, the process and apparatus is equally applicable to the preparation of fresh cooking liquor from unslaked lime and fresh sodium carbonate solution.

The chemical reaction involved in the slaking-causticizing operation is well known and proceeds in two stages. In the first, or slaking, stage, calcium oxide (CaO) of the lime first reacts with the water in the green liquor to form calcium hydroxide ($Ca(OH)_2$) with the evolution of considerable heat. This reaction may be written as follows.

$$CaO+H_2O\rightarrow Ca(OH)_2+Heat$$

The resultant calcium hydroxide then reacts with the sodium carbonate in the green liquor to form sodium hydroxide and calcium carbonate precipitate. This causticizing reaction may be written:

$$Ca(OH)_2+Na_2CO_3\rightleftarrows 2NaOH+CaCO_3\downarrow$$

Although written in two stages, the reactions actually overlap, and part of the causticizing occurs almost simultaneously with the slaking. The reaction is reversible to some extent, and all the sodium carbonate cannot be converted to sodium hydroxide no mater how much lime is used. However, the use of hot fresh lime, high temperature, and intimate mixing all aid in improving efficiency. It is understood that means may be provided for regulating temperature of the reaction at its optimum level.

The apparatus and method described in this invention make possible more complete mixing, better temperature control, a simpler flow pattern, all combining to produce a more uniform liquor than was hitherto possible and at substantial savings in cost.

When the slaking-causticizing operation is carried out in the apparatus shown and by the method described, several advantages result. The unitary construction is more economical, utilization of gravity flow requires less complicated and expensive auxiliary equipment, and retention time is more easily controlled thus permitting more complete causticizing and better overall efficiency.

It will be understood that various changes in the process details and arrangements of parts herein described and illustrated for the purpose of explaining the invention may be made by those skilled in the art within the principles and scope of the invention as defined in the appended claims.

What is claimed is:

1. A combined slaker-causticizer apparatus comprising a vertical cylindrical vessel, a plurality of spaced stationary horizontal imperforate baffles dividing said vessel into superposed compartments, said baffles having central apertures therein for communication between said compartments, an upstanding flange disposed around the circumference of the central aperture in the uppermost compartment, a shaft rotatably mounted axially of said vessel and extending through said compartments, horizontal rotating imperforate baffles mounted on said shaft adjacent to and closely spaced from each of said apertures, agitating means located in each compartment and mounted on said shaft, means for admitting both dry and liquid reaction chemicals into the uppermost of said compartments for mixture therein, outlet means near the floor of said uppermost compartment and communicating with an exterior of the vessel for withdrawing from the uppermost compartment a portion of the reaction mixture containing coarse particles, and outlet means at the base of the lowermost compartment of said vessel for removing fully reacted chemicals.

2. A combined slaker-causticizer apparatus comprising a vertical cylindrical vessel, a plurality of horizontal annular stator imperforate baffles axially spaced in said vessel to divide said vessel into a plurality of superposed reaction chambers, said baffles having centrally disposed circular apertures therein defining communication channels between said chambers, an upwardly extending flange coextensive with the circular aperture in the floor of the uppermost chamber, a plurality of annularly spaced stationary vertical baffles extending radially inward from the outer periphery of said horizontal baffles, a rotatably mounted shaft extending axially of said vessel, a plurality of flat horizontal circular rotor imperforate baffles mounted on said shaft and closely spaced above each of said apertures to partially restrict

communication between said chambers, agitator means mounted on said shaft for rotation in each of said chambers, inlet means above the uppermost chamber for admitting a reactive fluid chemical therein, a second inlet means above said uppermost chamber for admitting a reactive solid chemical therein, outlet means near the floor of said uppermost chamber and communicating with the exterior of the vessel for withdrawing a portion of the reaction mixture containing coarse particles from said chamber, and outlet means near the floor of the lowermost chamber for withdrawing fully reacted chemicals.

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MORRIS O. WOLK, *Primary Examiner.*

WILLIAM B. KNIGHT, *Examiner.*