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OXIDIZER FOR BLACK LIQUOR

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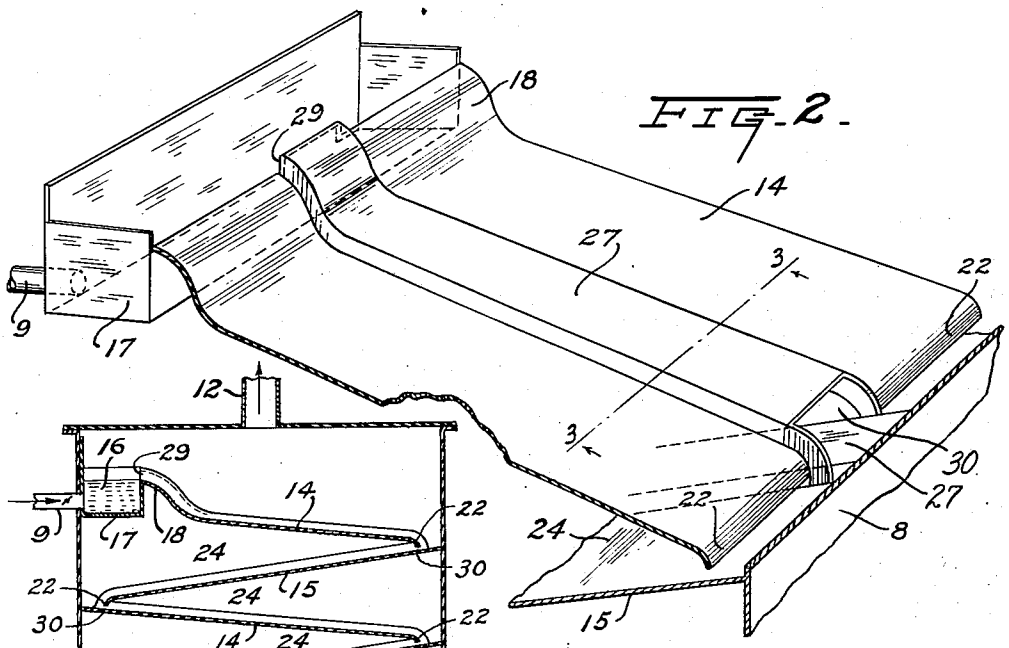


FIG. 2.

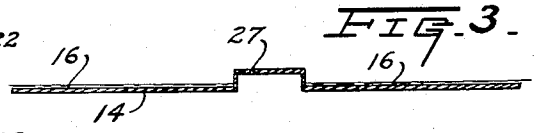


FIG. 3.

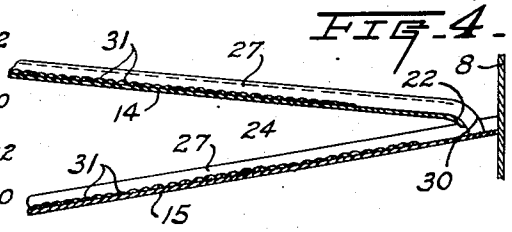


FIG. 4.

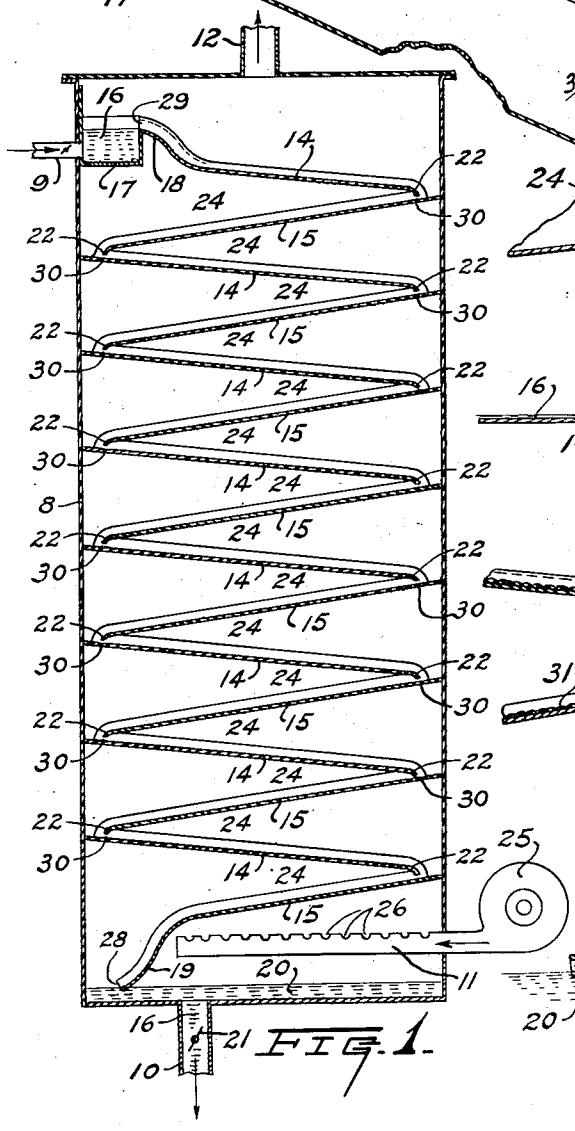


FIG. 1.

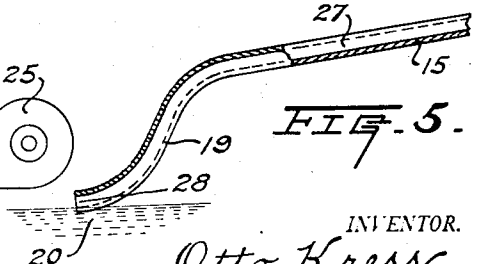


FIG. 5.

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OXIDIZER FOR BLACK LIQUOR

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3 Claims. (Cl. 23—283)

1

The present invention relates generally to improvements pertaining to the art of pulp production, and relates more specifically to improvements in the mode of handling black liquor such as is recovered in kraft pulping.

The primary object of my present invention is to provide improved apparatus for treating chemical solutions such as black liquor, in order to increase their sulfidity and to avoid escape of hydrogen sulfide.

When manufacturing pulp by the kraft process, at the end of the cooking procedure most of the caustic soda has been consumed but about one-half of the original sodium sulphide originally present in the cooking liquor remains. The resulting liquor which is separated from the pulp by suitable washing is known as black liquor, and this black liquor is now evaporated with well known equipment to produce a concentrated liquor of approximately sixty per cent concentration. This concentrated liquor is burned in a furnace for the recovery of sodium compounds and steam is produced by the combustion of the organic portion of the black liquor. During such concentration of the weak black liquor to the strong black liquor and which is accomplished in multiple effect evaporators, considerable hydrogen sulphide is produced and lost, this being objectionable not only from the standpoint of loss of sulphur, but also due to the contamination of air and condensed water delivered from the multiple effect evaporators.

While diverse methods, and equipment for oxidizing the sulphur present in the black liquor in order to save sulphur have heretofore been proposed, most of them based upon the provision of extensive surface contact areas between the liquor and air before the liquor was delivered to the concentrators, these prior systems involved too much agitation of the liquid which would result in excessive and objectionable foaming especially when resinous woods had been cooked, and the prior oxidizing equipment would also tend to become clogged with deposits thereby making it impossible to effectively expose the liquor to the air and also making it more difficult to propel the oxidizing air through the oxidizing tower. Even the most efficient prior oxidizing units also failed to effect sufficient recovery of sulphur to prevent the production of enough hydrogen sulphide to contaminate the water and air in proximity to the mills, and this contamination has heretofore been a constant source of annoyance from the standpoint of both air and stream pollution.

2

It is therefore a more specific object of the present invention to provide an improved mode of subjecting black liquor to a flow of air in a manner whereby objectionable production and escape of hydrogen sulphide is eliminated, and maximum available sulphur is recovered.

Another specific object of this invention is to provide simple and highly effective apparatus for treating black liquor for the recovery of sulphur and for the elimination of offensive odors during the recovery procedure.

A further specific object of my invention is to provide an improved system of oxidizing black liquor automatically and most efficiently, and in a manner whereby escape of obnoxious odors and loss of valuable chemical is avoided.

Still another specific object of the invention is to provide an improved black liquor oxidation tower for kraft process pulp mills, which may be installed and operated at moderate cost while possessing vast capacity, and which is also exceedingly reliable in operation without requiring undue attention.

These and other objects and advantages of the invention will be apparent from the following detailed description.

A clear conception of the procedure involved in carrying on my improved system, and of the construction and operation of a typical oxidizing tower which may be utilized to exploit the present invention, may be had by referring to the drawing accompanying and forming a part of this specification wherein like reference characters designate the same or similar parts in the various views.

Fig. 1 is a somewhat diagrammatic vertical section through a typical black liquor oxidizing tower embodying the invention;

Fig. 2 is an enlarged perspective view of a fragment of the upper interior of the oxidizing tower shown in Fig. 1;

Fig. 3 is a similarly enlarged transverse section through a fragment of one of the plates or shelves of the unit, taken along the line 3—3 of Fig. 2;

Fig. 4 is a likewise enlarged vertical section through the cooperating ends of two of the successive superimposed plates, also showing riffles applicable to the upper surfaces thereof in order to gently augment exposure of all portions of the liquid to the air; and

Fig. 5 is a similarly enlarged fragmentary vertical section through the liquid delivery end of the lowermost shelf.

While the invention has been shown and described herein by way of illustration as being

especially advantageous for the treatment of black liquor, it is not my desire to unnecessarily limit the utility thereof by virtue of this particular use; and it is also contemplated that specific descriptive terms employed herein be given the broadest possible interpretation consistent with the disclosure.

In accordance with my invention, I expose the black liquor promptly after it is blown or delivered from the cooker in a kraft process pulp mill, in the form of an extensive and relatively thin and uninterrupted film, and for a prolonged period of time, to an abundance of gradually advancing oxidizing air. Violent agitation of the film is constantly avoided, and the oxidizing air is uniformly distributed throughout the entire exposed area of the film while this air is being conducted through the film producing zones with minimum obstruction to the air flow. I also provide simple instrumentalities for permitting rapid and effective dissipation of foam which may result from the previous treatment by the black liquor of resinous woods, and the various steps of the improved procedure may be performed automatically with the aid of simple equipment one embodiment of which is shown in the drawing.

Referring to the drawing, the typical black liquor oxidizing tower or unit shown therein comprises in general a vertically elongated receptacle or tank 8 having a fresh black liquor inlet 9 near its upper end and a treated liquid outlet 10 at its lower extremity, and also having an abundant fresh air inlet pipe 11 near its lower end and a spent air outlet pipe 12 at its upper extremity; and a series of superimposed oppositely inclined shelves or plates 14, 15 confined and mounted within the tank 8. The tank 8 may be of any suitable size, shape and height, and the number of plates 14, 15 may be varied as desired, in order to produce an oxidizing unit of any predetermined capacity; and the inclined shelves 14, 15 may be either permanently or detachably secured to the tank interior in any convenient manner. This tower or unit is adapted to be interposed between the cooker and the multiple effect evaporator for concentrating the black liquor prior to burning for final soda recovery.

The upper end of the uppermost inclined shelf or plate 14 of the oxidizing tower is adapted to receive fresh black liquor 16 from the cooker through the inlet 9 and a distribution launder or trough 17 extending transversely throughout the entire tank width, and over a dam 18 formed integral with the adjacent shelf and having a smoothly curved liquid cascading surface for conducting the entering liquid in the form of a thin continuous film onto the upper surface of the top plate 14, see Figs. 1 and 2. The lower end of the lowermost inclined shelf or plate 15 is adapted to deliver the oxidized film of black liquor 16 from its lower extremity over a smoothly reversely curved apron 19 formed integral with the adjacent shelf 15 and likewise having a liquid cascading surface for conducting the treated liquid into a receiving basin 20 formed in the bottom of the tank 8 and communicating with the outlet 10 which may be provided with a control valve 21 for regulating the depth of liquid within the basin 20, see Figs. 1 and 5. The outlet 10 in turn communicates with the usual multiple effect evaporator of the mill.

The successive superimposed shelves or plates 14, 15 are located closely adjacent to each other and are oppositely inclined only sufficiently to produce a relatively slow and sluggish flow of the liquid films downwardly therealong, and the plates 14 are all disposed approximately parallel to each other while the plates 15 are likewise disposed with respect to each other. The lowermost end of each shelf 14, 15 except the lowest, is provided with a depending smoothly curved lip 22 which is directed downwardly toward but is spaced from the uppermost end of the adjacent succeeding lower shelf, sufficiently to provide a horizontal gap between each pair of shelves 14, 15 and to produce an extensive continuous zigzag film of the descending liquid or liquor 17 from the crest of the dam 18 to the basin 20; and the relative inclination and spacing of the plates 14, 15 also creates a foam dissipating chamber 24 of gradually enlarging magnitude extending along each plate in the direction of advancement of the film therealong, as illustrated in Fig. 1.

The oxidizing air admitted to the lower portion of a tank 8 through the inlet or supply pipe 11 may be injected by a blower 25 through a series of openings 26 formed in the pipe 11, and the air outlet or exhaust pipe 12 may be connected to a suitable vacuum or reduced pressure zone such as an exhaust fan or a stack. In order to permit the oxidizing air to flow freely and with least obstruction through the successive superimposed chambers 24 of the evaporator, without interrupting the continuity of the liquid film flowing along the shelves or plates 14, 15, each of the latter is provided with a raised central inverted trough-like duct portion 27 which may extend throughout the entire length thereof. These raised portions 27 while being relatively narrow as compared to the overall width of their shelf plates, should have sufficient area to permit free flow therethrough of all of the air admitted to the unit; and the lower end of the lowermost duct portion 27 should provide an abundant air supply opening 28 directly above the basin 20 as shown in Fig. 5, while the upper end of the uppermost trough portion 27 may be closed at its end 29 above the crest of the dam 18 as indicated in Fig. 1, and the lower end of each of the other raised portions 27 should likewise provide an unobstructed air escape passage or flow opening 30 as depicted in Figs. 2 and 4.

While it is desirable to maintain continuity of the film flowing along the plates 14, 15, it may also be desirable in some instances, to slightly but gently disturb or agitate the film as it proceeds along the shelves beneath the expanding chambers, in order to insure most effective contact of all portions of the liquor 16 with the advancing oxidizing air. Such mild agitation of the liquid film may be effected by applying transverse riffles or rounded projections 31 to the upper surfaces of the shelves 14, 15 as illustrated in Fig. 4, but these riffles 31 are preferably omitted at the zone of transfer of the film from one plate to the next succeeding plate. The riffles 31 are so formed that they will turn over or roll the successive increments of the continuous film without necessarily interrupting the continuity thereof and without violently agitating the liquid to the extent of producing excessive foaming, but sufficiently to insure thorough contact between the exposed film surfaces and the oxidizing air which spreads out away from the openings 28, 30 and fills the chambers 24.

While the normal operation of the improved oxidizing tower should be quite apparent from the foregoing description of the construction of the apparatus, a résumé of operation will be

given. Normally fresh and weak black liquor 16 will be delivered in regulated quantities through the inlet 9 into the distribution trough 17 from whence it flows over the dam 18 in the form of a thin film. As shown in Fig. 3, this film of liquor 16 advances slowly along the upper surfaces of the successive shelves 14, 15 on opposite sides of the central raised portions 27, and as it leaves the lower lip 22 of each plate and drops or cascades over the open gap upon the next lower plate, its continuity is preserved, thus causing the continuity of the film to be constantly maintained from the time of its formation at the upper dam 18 until delivery thereof into the lower basin 20. During this constant flow of the uninterrupted thin film downwardly through the unit, it may be mildly agitated with the aid of riffles 31, and as fresh oxidizing air is injected through the supply pipe 11, it passes through the lower opening 28 and successively through the upper chambers 24 and through the openings 30, being thus brought into intimate direct contact with all portions of the exposed film surfaces and effectively oxidizing the sodium sulphide to produce sodium salts which may be subsequently readily reduced and recovered in the furnaces.

The flow of oxidizing air upwardly through the tank 8 and chambers 24 is unimpeded, and the continuity of the film is not disrupted, due to the fact that the air flows from one chamber 24 to another through the central openings 30 afforded by the raised plate portions 27 and does not pass directly through any portion of the film at any point. If foaming of the liquid occurs at the lips 22 or at any other localities, when handling resinous liquor 16, the foam bubbles will be dissipated within the elongated tapered or expanding chambers 24, and the film of liquid effectively retains the sulphur and prevents formation and escape of hydrogen sulphide with the oxidizing air which is eventually withdrawn from the upper outlet 12. The tapered chambers 24 also serve to spread the ascending air stream throughout the entire upper surfaces of the successive liquid film sections; and the sulfidity of the black liquor 16 is thus automatically increased without the loss of hydrogen sulphide and the resultant odors and contamination caused by escape of this chemical.

From the foregoing detailed description of my improved procedure apparatus, it should be apparent that the invention provides a simple yet effective system of treating black liquid or the like for the recovery of sulphur while avoiding production of hydrogen sulphide and resultant loss of valuable chemical. The successive steps of the procedure can obviously be carried on automatically with no attention after initial setting of the control valves, and with the aid of oxidizing air under relatively low pressure. The improved apparatus is also simple and comparatively compact in construction considering its capacity, and is devoid of filth accumulating pockets so that it may be conveniently cleaned by flushing with fresh liquid when necessary. The use of a series of superimposed slightly inclined shelves or plates 14, 15 disposed closely adjacent to each other in zig-zag formation, makes it possible to provide a tower or unit of large capacity which occupies minimum space and wherein most efficient oxidation is automaticaly effected. The installation and operation of these units may also be effected at relatively low cost, and the use of my improved system effectively eliminates both contamination of streams by discharging waste

chemicals therein, and the spreading of offensive odors over surrounding territory.

It should be understood that it is not desired to limit this invention to the exact steps of procedure or to the precise details of construction and operation of the oxidizing unit, herein shown and described, for various modifications within the scope of the appended claims may occur to persons skilled in the art.

I claim:

1. An oxidizer for black liquor comprising, a vertically elongated tubular casing provided with superimposed oppositely inclined shelves the lower end of each of which has a depending lip spaced from but closely approaching the upper end surface of the next successive downwardly inclined shelf to provide a narrow open gap between each succeeding pair of said shelves, means for delivering liquor to the uppermost of said shelves for gravity flow downwardly along said shelves and across said gaps in succession to produce a continuous and uninterrupted downwardly advancing thin film, means for injecting air into said casing beneath the lowermost of said shelves, and an air duct mounted on and extending downwardly along each shelf and being provided with a cut-out portion adjacent to the open gap at the lower end of the shelf, said ducts providing passages for air to rise successively through said cut-out portions and over the surfaces of the adjacent shelves and dividing the continuous liquor film into segregated downwardly flowing stream sections.

2. An oxidizer for black liquor comprising, a vertically elongated tubular casing provided with superimposed oppositely inclined shelves the lower end of each of which has a depending lip spaced from but closely approaching the upper end surface of the next successive downwardly inclined shelf to provide a narrow open gap between each succeeding pair of said shelves, means for delivering liquor to the uppermost of said shelves for gravity flow downwardly along said shelves and across said gaps in succession to produce a continuous and uninterrupted downwardly advancing thin film, means for injecting air into said casing beneath the lowermost of said shelves, and an air duct mounted on and extending downwardly along each shelf and being provided with a cut-out portion adjacent to the open gap at the lower end of the shelf, said ducts providing passages for air to rise successively through said cut-out portions and along the upper surfaces of the adjacent shelves and dividing the continuous liquor film into segregated downwardly flowing stream sections and said upper shelf surfaces being provided with transverse riffles for gently agitating said stream sections.

3. An oxidizer for black liquor comprising, a vertically elongated tubular casing provided with superimposed oppositely inclined shelves the lower end of each of which has a depending lip spaced from but closely approaching the upper end surface of the next successive downwardly inclined shelf to provide a narrow open gap between each succeeding pair of said shelves, means for delivering liquor to the uppermost of said shelves for gravity flow downwardly along said shelves and across said gaps in succession to produce a continuous and uninterrupted downwardly advancing thin film, means for injecting air into said casing beneath the lowermost of said shelves, and an air duct above and extending downwardly

along the mid-portion of each shelf and being provided with an opening adjacent to the open gap at the lower end of the shelf, said ducts providing passages for air to rise from said injecting means successively through said openings and along the upper surfaces of the adjacent shelves and dividing the continuous liquor films into segregated downwardly flowing stream sections disposed on opposite sides of the ducts.

OTTO KRESS.

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