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APPARATUS FOR RECOVERING BLACK LIQUORS

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11 Claims. (Cl. 23—277)

This invention relates to improvements in apparatus for regenerating black liquors such as are obtained in the manufacture of sulfate or soda pulp.

5 More particularly this invention relates to improvements in smelting furnaces used in processes employed in the regeneration of spent black liquors including the recovery of their alkali metal constituents and the utilization of the calorific
10 value obtainable from the combustion of their organic contents.

This application is a division of my prior application Serial No. 553,041, filed July 25, 1931.

15 In the manufacture of pulp by the sulfate process wood is treated in closed vessels under pressure with steam and with cooking liquors. Sulfate cooking liquor is composed principally of sodium hydroxide, sodium sulfide, and sodium carbonate. When this treatment is completed
20 the contents of the closed vessels are blown into diffusers or wash tanks where the spent cooking liquor is separated from the pulp by drainage and washing. This spent liquor is known as "black liquor" and is generally recovered by concentration in vacuum or direct heat evaporators
25 producing a heavy syrup-like, black liquor high in organic content and containing nearly all of the sodium compounds used in the cooking process.

30 The final steps in the recovery of the concentrated black liquor are effected by various methods. In some cases the concentrated black liquor is fed into a rotary incinerator where it is dried and burned to form what is commonly
35 called "black ash". In other cases the heavy black liquor is sprayed directly into a smelting furnace where it is burned and the sodium compounds fused off and recovered. In the processes described in my Patents, Numbers 1,779,535;
40 1,779,536; 1,779,537 and 1,779,768 dated October 28, 1930, concentrated black liquor is first converted into a moisture-free powder and this powder is treated under controlled reducing conditions to reduce the sulfate to sulfide and to
45 recover the fused sodium compounds while at the same time utilizing the heat of combustion to dehydrate the black liquor. In all the recovery processes, however, the final step consisted of burning the organic matter and of fusing
50 the sodium compounds in the smelting furnace.

My present invention relates particularly to improvements in apparatus for burning the black liquor in the form of a liquid spray or in the
55 form of a dried black liquor powder or in the

burning of both sprayed black liquor and dried black liquor powder in combination.

I have found that in the operation of the above mentioned processes according to my prior patents, it is advantageous to control the zone of combustion of both the sprayed black liquor and the black liquor powder. The high temperatures obtaining in the smelting furnace result in the volatilization of the combustible material at or very near the point of entrance of the sprayed
60 black liquor or powder. If this volatilization takes place under oxidizing condition, it is accompanied almost immediately by combustion. This immediate combustion is not conducive to best results, as it reduces the overall efficiency of the
65 reduction of the sulfate to sulfide.

I have now found that it is possible to control the combustion by introducing an inert gas into the smelting furnace at or near the point of entrance of the sprayed black liquor or dried black
70 liquor powder. This inert gas has the effect of retarding the combustion of the organic constituents and permits the sprayed concentrated liquor or the dried black liquor powder to be projected into the smelting furnace for some distance
75 before combustion of its organic content occurs.

A preferred embodiment of my novel control feature resides in the supplying of heated inert gas which, in the case of spraying the black liquor directly into the smelting furnace, has the additional advantage of acting as a drying and evaporating agent to expel moisture from the sprayed
80 black liquor prior to combustion of its organic contents.

It is therefore an object of this invention to provide apparatus for the regeneration of black liquor to recover valuable alkaline substances therefrom and utilize the heat of combustion of the organic constituents in the black liquor.

A further object of this invention is to provide apparatus for controlling the smelting furnace operation in the regeneration of black liquor whereby the combustion of organic constituents in the black liquor is retarded to obtain a distinct and localized reduction zone and thereby produce
85 a more efficient and economical operation.

Other and further important objects of this invention will be apparent from the disclosures in the specification and accompanying drawing.

As shown on the drawing:

105 The reference numeral 1 indicates a spray drier into which concentrated black liquor is fed from spray devices 2. Evaporation in the spray drier 1 is effected by hot flue gases. The dried black liquor collects in the bottom of the spray drier 1,
110

is removed therefrom by a spiral conveyor 30 or by other suitable means and is blown, together with the flue gases, through a duct or pipe 3 by means of a blower 4 suitably driven by any power means such as a motor 5. The dried black liquor and flue gases from the duct 3 are led into a cyclone powder collector 6 wherein the dried black liquor powder may be freed from the flue gases. The cyclone powder collector may, if desired, be operated so that a part of the flue gases remain admixed with the dried black liquor by closing the damper 7 in the gas outlet stack 8.

The dried black liquor is in the form of a fine powder and is fed from the cyclone collector by means of a spiral conveyor 9 or other suitable means into a smelting furnace 10. The conveyor 9 is driven by any suitable means such as by a belt 11 connected to a motor (not shown). Air is introduced into a smelting furnace 10 through a tuyère or blow pipe 12 located near the bottom thereof. The organic matter in the dried black liquor fed to the smelting furnace is partially burned and the hot gases of this partial combustion are directed into a steam boiler or generator 13 where additional air is introduced through secondary air nozzles or openings 23 in the boiler setting. The additional air supplied through openings 23 allows complete combustion and supplies sufficient air for complete combustion of the gases of the smelting furnace. Part of the calorific value of these gases is expended in supplying steam which may be used to run the evaporators or concentrate the weak black liquor sufficiently that it may be fed into the spray drier and into the smelting furnace as shown. The flue gases after passing through the boiler 13 still contain a valuable heat content which heretofore was allowed to go either up the stack 14 or, in accordance with my previous inventions, to the spray drier 1.

According to my present invention, however, a fan or blower 16 is provided for propelling a part of the flue gases leaving the steam boiler through a duct 15. These gases are blown into the smelting furnace 10, as at 27. Another part of the flue gases is allowed to pass through the spray drier 1, where their calorific content is utilized in dehydrating the concentrated black liquor. A damper arrangement is provided at 17 to automatically release the flue gases to the stack 14 when the flue to the drier is closed and vice versa to automatically close the passage to the stack 14 when the drier 1 is in operation. A further damper arrangement 18 may be provided in the duct 15 to regulate the amount of gases passing through the duct. Ordinarily this is not necessary since such regulation is possible by the fan 16 which is preferably provided with variable speed controls.

When the smelting furnace is fed both with dried black liquor and with concentrated black liquor, a spray device 19 is located near the top of the smelting furnace in the path of the incoming flue gases from the fan 16 through the pipe line or duct 20. The hot flue gases cause a partial dehydration of the concentrated black liquor without combustion of their organic content. The partially dehydrated black liquor then drops into the lower part of the smelting furnace where the organic products are volatilized and the volatile matter partially burned. Likewise the burning of the dried black liquor from the feed 9 is retarded by the flue gases from the fan 16 as well as from the flue gases from the cyclone separator with which it may be admixed.

When the dried black liquor from the feed 9 as well as the partially dehydrated black liquor from the spray 19 reach the lower part of the smelting furnace 10 the organic material is burned off and the gaseous products of combustion pass into the steam boiler 13 and from thence partly through the duct 15 and partly through the spray drier 1.

In ordinary practice the flue gases of the steam boiler are discharged at temperatures of around 500 to 600° F. Therefore, part of these flue gases were allowed to be drawn up the stack 14 and their heat value was thereby wasted. By means of my improved apparatus it is possible to completely shut off the stack 14 by closing the damper 17 to the stack and thus use practically all of the calorific value of the flue gases from the steam boiler in the process of recovering the black liquor. The relatively cool gases may then finally be discharged from the apparatus through the exit 8 of the cyclone collector and thence through a scrubber (not shown).

If desired, flue gases may be taken by fan 16 from the boiler region at a point where the temperature of these gases reaches 1,000° F. or even higher so that the difference in temperature may be expended in the evaporation of the concentrated black liquor rather than in the formation of steam in the boilers.

The cyclone separator is ordinarily operated under a back pressure in order to furnish a current of flue gases to the feed conveyor 9. In this operation the inert flue gases have no available calorific content but merely serve to assist in regulating the delivery of the dried black liquor powder to the furnace and in retarding its combustion upon its introduction into the smelting furnace.

The retarding of combustion of the organic materials present in the black liquor permits the substantially dehydrated black liquor to be deposited near the bottom of the smelting furnace before substantial or complete combustion occurs. This causes a building up of a bed of burning dried black liquor and fused metallic values which flow from the bottom of the smelting furnace in a molten state. Being out of the turbulent area of the smelting furnace created by the flaming gases higher up in the furnace the alkali metal values are smoothly fused off without being volatilized. This causes an increased efficiency in the recovery of the alkalis since their volatilization is reduced to a minimum.

The building up of a bed of fused and burning materials near the bottom of the smelting furnace also increases the reduction of sulfate bodies to sulfide bodies in the event of regenerating black liquor from sulfate pulp.

I am aware that many changes may be made and numerous details of construction may be varied through a wide range without departing from the principles of this invention, and I therefore do not purpose limiting the patent granted hereon otherwise than necessitated by the prior art.

I claim as my invention:

1. An apparatus for the regeneration of black liquor comprising a furnace for burning dried black liquor, steam generating means operated by the gaseous products of combustion from said furnace, black liquor spray drying means heated by the exit gases from said steam generator means and means for feeding dehydrated black liquor from said drying means to said furnace

in admixture with the gaseous drying medium employed.

2. Apparatus for the regeneration of black liquor comprising, in combination, a smelting furnace, a steam generator, a spray drier, means for conveying the gaseous products of combustion from said smelting furnace into said steam generator, means for conveying a part of the exit gases from said steam generator into said spray drier to dehydrate black liquors sprayed therein, means for directing another part of the exit gases from said steam generator back into said smelting furnace in contact with black liquor fed thereinto and means for conveying said dehydrated black liquor admixed with the drying gases from said spray drier to said smelting furnace.

3. Apparatus for regeneration of black liquor comprising a smelting furnace provided with a tuyère for supplying air thereto, a spray device located near the top of said smelting furnace, means for enveloping the black liquor discharged from said spray device with inert gases, and means for feeding dry black liquor powder admixed with inert gas into said smelting furnace at a point below said spray device.

4. Apparatus for the recovery of alkaline values and utilization of heat contents of black liquor comprising a vertical retort having walls defining a deep container for a bed of black liquor solid residues, a blow pipe in said container near the bottom thereof for supplying a limited amount of air to the bed, a conveyor for black liquor solids entering the furnace on top of said bed, air nozzles in said retort above said black liquor feed for supplying additional air to the rising gases from the bed for their thorough combustion, a steam generator for receiving the hot gases of combustion, means for returning hot flue gases from the steam generator region back to the smelting furnace, and means for spraying concentrated black liquor into said retort in the path of said returned flue gases.

5. Apparatus for the regeneration of black liquor which comprises, in combination, a smelting furnace having a relatively deep container for a bed of black liquor solids, means for supplying a limited amount of air to said container, means for supplying black liquor solids to said bed, a combustion zone in said furnace above said bed, air nozzles opening into said combustion zone for supplying sufficient air for thorough combustion of the rising gases from the fuel bed, a steam generator for receiving the hot gases of combustion, means for transmitting part of the inert gases from the steam generator back to the smelting furnace, a spray device in the path of incoming inert gases in said smelting furnace, a spray drying cabinet for the evaporation of black liquor and means for transmitting flue gases from the steam generator to said spray drying cabinet.

6. Apparatus for the regeneration of black liquor which comprises, in combination, a smelting furnace, a container in said smelting furnace for receiving a bed of black liquor solids, means for supplying a limited amount of air to said container, a steam generator, means for conveying hot gases of combustion from the bed of said smelting furnace to said steam generator, air nozzles in the path of hot gases from the bed of the smelting furnace to the steam generator for supplying sufficient air to said gases for their thorough combustion, means for transmitting part of the inert gases from the steam generator

to the smelting furnace to prevent entrainment of solids from the bed in the rising gases, a spray drier for dehydration of black liquor and means for conveying flue gases from the steam generator to said spray drier.

7. Apparatus for the regeneration of black liquor which comprises a vertical retort, a container for a bed of black liquor solids in said vertical retort, a blow pipe in said container near the bottom thereof for supplying a limited amount of air to the bed, a tap hole in said container for allowing the removal of molten alkaline values from the bed, means for supplying black liquor solids to said fuel bed, a steam generator for receiving hot gases of combustion from the vertical retort, air nozzles in the path of the hot gases ahead of the steam generator for supplying a sufficient amount of air for thorough combustion of the gases, a duct for transmitting flue gases from the steam generator region back to the vertical retort, a fan for propelling said gases, a duct for transmitting the remaining portion of flue gases from the steam boiler to a spray drier for the dehydration of black liquor and means for conveying dried black liquor from the spray drier to said black liquor solids supply means.

8. In an apparatus for the regeneration of black liquor including a smelting furnace, a steam generator and a spray drier, means associated with said spray drier for receiving dried black liquor solids and inert gases therefrom and means for conducting said solids together with a portion of the inert gases to the smelting furnace.

9. In an apparatus for the regeneration of black liquor including a smelting furnace, a steam generator and a spray drier, a powder and gas separating device associated with said spray drier for receiving dried black liquor powder and inert gases from the spray drier, controlled means for releasing a part of the gases in the separator to the atmosphere, and a conveyor for conducting said powder admixed with some of the inert gases to the smelting furnace.

10. In an apparatus for the regeneration of black liquor including a steam generator and a furnace provided with a smelter bed for black liquor substance, means for supplying a limited amount of air to said bed for partial combustion under reducing conditions of the black liquor substance therein, means for re-circulating part of the inert gases from the steam generator region back to the furnace, and a spray device for black liquor in the path of the recirculated inert gases for depositing black liquor residues on said bed.

11. An apparatus for regeneration of black liquor including a steam generator and a smelting furnace, means for transmitting heat from the furnace to said steam generator, a relatively deep bed in the bottom of said furnace for black liquor substance, means for supplying a limited amount of air to said bed for partial combustion, under reducing conditions, of the combustible black liquor material therein, means for removing fused sodium compounds from the bottom of said bed, means for re-circulating part of the inert gases from the steam generator region back to the smelting furnace, a spray device for black liquor in the path of the re-circulated gases for depositing black liquor substance on the bed and means for supplying additional air to complete combustion of gases rising from the bed before said gases reach the steam generator.

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