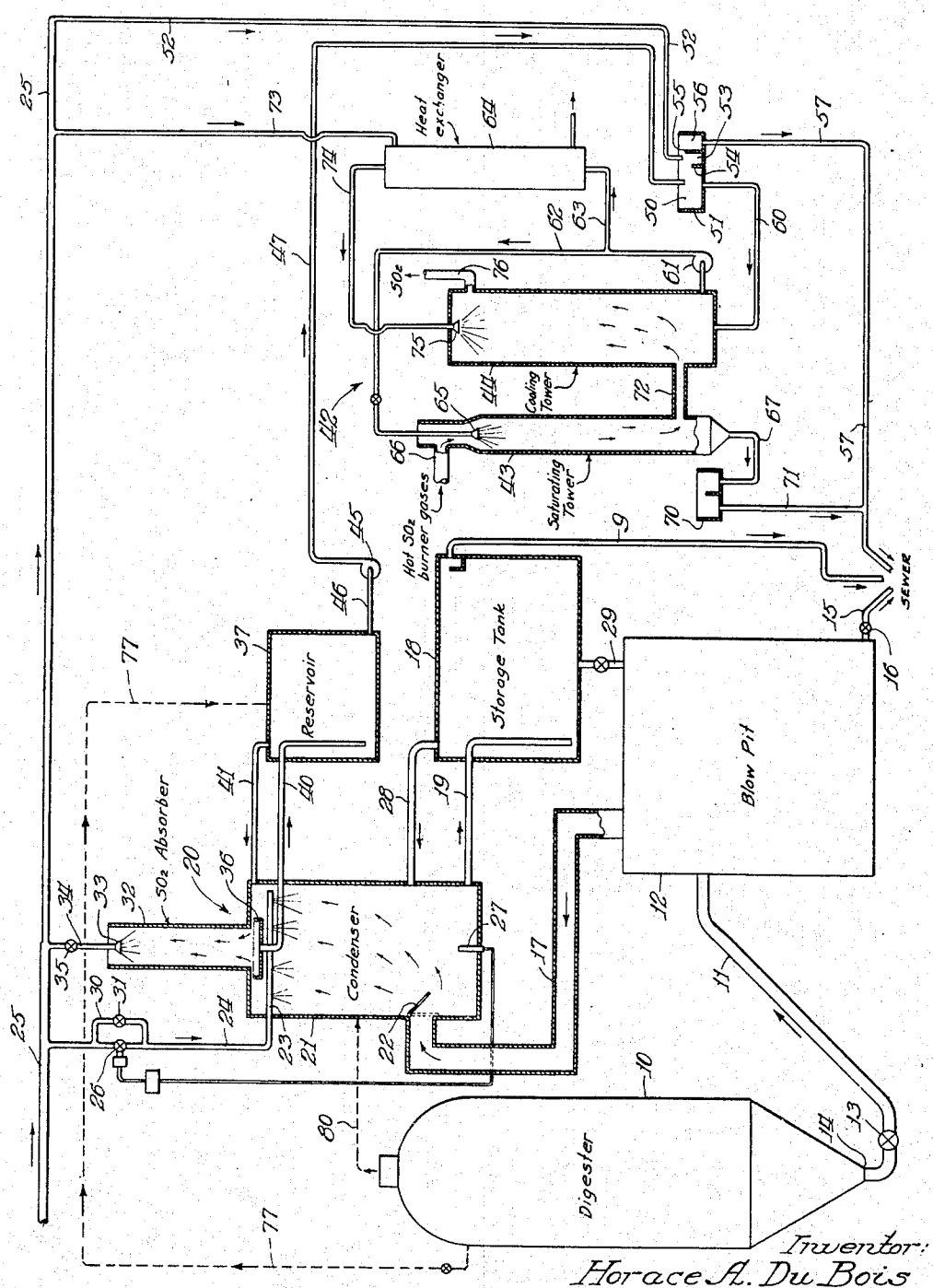
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RECOVERY OF SO_2 FROM DIGESTER BLOW-OFF GASES

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RECOVERY OF SO_2 FROM DIGESTER BLOWOFF GASES

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1

My invention relates, generally, to sulphite pulp plants, and it has particular relation to a method and means for recovering and utilizing SO_2 from waste gases periodically discharged in connection therewith.

In general, a sulphite pulp plant includes a digester operated in an intermittent manner, and a sulphur burner and liquor making system which operate in a continuous manner. Depending upon the size of the plant, there may be one or a battery of several digesters operated in connection with the sulphur burner and acid liquor system. At the start of each digester batch, or cook, a digester is loaded with wood chips and filled with acid liquor containing an excess of SO_2. After charging, the digester is closed and the contents are steam heated to cooking temperature. After an initial cooking period, during which the digester pressure remains substantially uniform, the digester is blown down preparatory to blowing the finished sulphite pulp from the digester into a blow pit.

The main purpose of the blow-down portion of the cook or batch is to recover as much SO_2 gas as possible before emptying the digester contents into the blow pit, since the cost of SO_2 is a very important factor or item in the production of sulphite pulp. And, normally, if the SO_2 is not recovered during the blow-down period it is wasted to the atmosphere as part of the blow pit ventilator gases. The recovery of SO_2 is considered sufficiently important even though the blow-down period may take from one-third to one-half of the total cooking time, and in spite of the fact that in many cases the conditions established or prevalent in the digester during the blow-down period have a positive detrimental effect upon pulp yield and the quality thereof.

The principal object of my invention is to provide an inexpensive method and means of recovering the SO_2 periodically discharged as a component of the blow pit ventilator gases. It will be seen that SO_2 intermittently discharged from certain other parts of the digester system may also be similarly recovered. The invention permits a shorter blow-down period, thereby increasing a pulp plant's output and permitting a better quality of pulp to be produced. If increased pulp production is not essential, my invention permits the maintenance of regular production rates at lowered cooking temperatures, thereby reducing the steam cost factor, and increasing the pulp yield per unit of wood. And, the invention permits a greater overall SO_2 recovery thereby reducing chemical cost and allowing a corresponding reduction in pulp cost.

2

A very important feature of my invention is that it involves inexpensive equipment and material of simple construction which may be conveniently added to a conventional sulphite plant installation. The additional equipment required in connection with my invention is dependable and operates in a continuous manner so that its adoption does not increase operating costs.

It will be understood that although, conceivably, certain prior art stripping equipment and methods are available which could after a fashion handle these high intermittent discharges of SO_2, such equipment and methods as were known would require high initial first cost and entail excessive operating costs.

According to my invention, the water vapor is first condensed from the blow pit ventilator gases, or other periodically discharged SO_2 enriched gases in connection with the digester system. This water vapor or flash steam condensation is preferably carried out in a packed tower with a water spray or shower at the top thereof, the condensing water being automatically supplied at such a rate that the waste water formed is at a temperature slightly under its boiling point or 212° F. In this way substantially all of the water vapor or steam is condensed from the SO_2 enriched gases but only very little SO_2 will be dissolved and carried away in the hot waste water.

The condensation step may also be carried out by means of sprays provided in the blow pit 12. In this event the condensing water supply would be controlled automatically by the temperature of the gases leaving the blow pit.

After condensation of the steam, the SO_2 is next absorbed from the SO_2 enriched gases to form an aqueous SO_2 solution. The absorption of the SO_2 is also preferably carried out by a water shower in a packed absorbing tower, the water being supplied at such a temperature and in such an amount that substantially all of the SO_2 is absorbed.

The aqueous SO_2 solution is then collected and drained into a reservoir from which it may be drawn and pumped into the continuously operating cooling system for the hot burner gases, forming a part of the plants' acid liquor making system. Here the SO_2 is stripped from the aqueous SO_2 solution by the hot burner gases. The reservoir for the aqueous SO_2 solution has a storage capacity sufficient to accommodate the relatively high intermittent influx of the solution

and to also permit it to be continuously pumped away into the burner gas cooling system at a uniform rate.

For a more complete understanding of the nature and scope of my invention, reference may be had to the following detailed description, taken in connection with the accompanying drawing wherein the single figure is a flow sheet diagrammatically illustrating my invention.

Referring now to the drawing, a sulphite pulp plant is shown having a digester 10, of any suitable conventional construction, with its bottom outlet connected through a discharge pipe 11 into a blow pit 12. The discharge pipe 11 is provided with a valve 13 adjacent to the outlet 14 of the digester 10 for shutting off the discharge pipe 11 except when the digester contents are being discharged into the blow pit 12. A drain pipe 15 is provided at the lower right hand side of the blow pit 12 leading into a sewer, as shown. The drain 15 is provided with a suitable valve 16.

When the digester contents are blown into the blow pit 12 through the discharge pipe 11 at the end of each cook or batch, the reduction in pressure allows certain gases to be given off in the blow pit 12. These gases are generally referred to as blow pit ventilator gases and contain water vapor or flash steam, sulphur dioxide, and inert gases, largely nitrogen. These blow pit ventilator gases are taken off from the top of the blow pit 12 and conducted through a ventilator pipe 17 and led to a two-stage tower system indicated generally at 20. The ventilator pipe 17 is connected to the bottom or lower part of a condenser tower 21 which forms one stage of the two-stage tower system 20. The opening of the ventilator pipe 17 into the tower 21 is provided with a flap valve 22 which prevents the gaseous contents of the condenser tower 21 from backing up into the ventilator pipes 17 of other blow pits in the system. The condenser tower 21 is packed with suitable material of a non-fouling nature.

In order to condense the water vapor or flash steam from the ventilator gases rising up through the condenser tower 21, a water spray or shower 23 is provided which is connected by a pipe 24 to a supply water main 25. In order to prevent absorption of SO_2 in the condenser tower 21, the condensing or spray water supply to the shower 23 should be regulated in such amount that the waste water formed when it condenses the flash steam from the ventilator gases will be at a temperature only slightly below the boiling point or 212° F. At this temperature only an insignificant amount of SO_2 can be dissolved in or absorbed by the hot waste water. In order to provide for such controlled regulation of the condensing water, a regulating valve 26 is provided in the pipe line 24 which is automatically controlled by a thermo-responsive element or thermostat 27 provided in the base of the condensing tower 21, at which point the waste water collects.

This condensing water control system may be of any one of several conventional throttling types. For example, the thermo-element 27 may be of the vapor pressure type whereby changes in temperature thereof produce corresponding changes in pressure. The pressures in turn may control the pressure of an external supply of compressed air from a separate system. The compressed air may operate an air operated diaphragm motor valve which controls the flow of condensing water. As an alternative, the thermo-element 27 may be of an electrical type, such as a resistance thermometer. In this case, electrical means in circuit relationship with the element 27 automatically restore the system to electrical balance and also operate through a system of relays to open or close the condensing water control valve by means of currents supplied to a small reversing valve motor. A by-pass pipe 30 with a valve 31 is provided in the pipe line 24 around the automatically controlled valve 26.

The hot waste water collected in the bottom of the condenser tower 21 may be drained into a waste storage tank 18 through a drain pipe 19. The top of the storage tank 18 is vented into the condenser tower 21 through a vent pipe 28. The hot waste water may be drained from the waste storage tank 18 into the blow pit 12 through a suitable pipe 29 where it may be used for washing the cooked pulp in the blow pit to free it from cooking liquor. It will also be seen that hot waste water may be utilized for any other suitable purpose in the sulphite plant. The waste storage tank 18 is provided with an overflow pipe 9 through which any excess of waste water may be discharged into the sewer, as shown.

In operation the ventilator gases flow upwardly through the condenser tower 21 and are broken up into a multitude of fine turbulent streams by the packing in the tower to give the effect of large area of contact with the water. The spray water from the shower 23 flows downwardly through the packing and condenses the water vapor from the rising ventilator gases. The ventilator gases leave the top of the condenser tower 21 and pass upwardly into an SO_2 absorbing tower 32 which forms the second stage of the two-stage tower system 20. The absorbing tower 32 is likewise packed with suitable packing material of an inert nature similar to the packing material in the condenser tower 21. A spray or shower 33 is provided in the top of the absorbing tower 32 which is connected by a pipe 34 to the water supply main 25. The pipe line 34 is provided with a control valve 35. The cool water from the shower or spray 33 passes downwardly through the packed tower 32 and absorbs the sulphur dioxide from the streamlets of ventilator gases rising upwardly therethrough, to form an aqueous SO_2 solution. The aqueous SO_2 solution is collected in a shallow collector pan 36 in the base of the absorbing tower 32 as it is formed, and drains into a surge tank or reservoir 37 through a drain pipe 40. The gases leaving the top of the absorption tower 32 will be largely inert, such as nitrogen and carbon dioxide and may be discharged to atmosphere. The surge tank or reservoir 37 may be vented into the top of the condensing tower 21 by a vent pipe 41.

As the blow pit ventilator gases are periodically discharged from the top of the blow pit 12 at the end of each cook or batch when the pulp is blown into the blow pit 12, it will be seen that the two stage condensing and absorbing system 20 will operate in an intermittent manner. That is, the hot waste water and the aqueous SO_2 solution will not be formed at a uniform rate. Accordingly, the waste water storage tank 18 and the reservoir 37 should have relatively large storage capacities in order to take care of the intermittent flow of liquids thereto.

The sulphite plant also includes a sulphur burner gas cooling system indicated generally at 42. The cooling system 42 shown is of the spray

type and includes a first saturating and cooling spray tower 43 and a second larger spray cooling tower 44. The sulphur burner, the acid tower proper (not shown) and the hot burner gas cooling system 42 operate in a continuous manner as part of the acid liquor making system in contrast to the intermittently operated digestion system. The acid liquor output of this system is discharged into an acid liquor storage tank (not shown) from which it may be withdrawn as necessary to fill the digester at the start of each cook or batch.

Cooling liquor is continuously circulated through the burner gas cooling system 42. Make-up water must be continuously introduced into the circulating system in order to make up for a loss in this circulating cooling water. The aqueous SO_2 solution is utilized in the burner gas cooling system 42 at a uniform rate in connection with this cooling water make-up arrangement as will appear below.

A pump 45 is provided with its inlet or suction side connected to the base of the reservoir 37 through a suitable inlet pipe 46, while the outlet or pressure side of the pipe 45 is connected to a discharge line 47. The discharge line or pipe 47 opens into a compartment 50 of a make-up water supply tank 51, as shown. Any required make-up water in addition to the aqueous SO_2 solution supplied by the pump 45 may be added through a pipe line 52 connected with the water supply main 25. Water from the pipe line 52 discharges into a compartment 53 and overflows into the compartment 50 over a weir 54 to form make-up liquor with the aqueous SO_2 solution therein. Any excess liquor in the tank 51 overflows over another weir 55 into a compartment 56 from which it may be withdrawn through a pipe line 57 into the sewer, as shown. A pipe 60 connects the bottom of the compartment 50 with the bottom of the large spray cooling tower 44.

The make-up liquor is withdrawn from the base of the tower 44 by a continuously operating pump 61. The discharge of the pump 61 is divided so that a small part of the liquor flows through a pipe line 62 to the top of the first cooling tower 43 while the larger part of the cooling liquor passes through a pipe 63 into a heat exchanger 64.

The volume of hot liquor discharged through the line 62 is equal to the aqueous SO_2 solution input from the reservoir 37, plus a small circulating load. This liquor is sprayed from a shower 65 in the top of the cooling tower 43. Hot SO_2 burner gases are introduced into the top of the cooling tower 43 above the shower 45 as indicated at 66. These hot burner gases flow downwardly through the tower 43 co-current with the finely divided spray liquor from the shower 65 and serve to remove or strip the SO_2 content from the spray liquor. The hot burner gases may have a temperature drop from 2000° F. to 160° F. in the tower 43. The waste liquor from which the SO_2 has been stripped collects in the bottom of the tower 43 and is drawn off through a line 67 into an outlet weir tank 70. The overflow compartment of the tank 70 may be connected through a drain pipe 71 to the sewer drain 57, as shown. The partially cooled burner gases leave the bottom of the cooling tower 43 and are conducted into the bottom of the larger spray cooling tower 44 through a connecting conduit 72.

The larger portion of the liquor discharge from the pump 61 is cooled in the heat exchanger 64 by cooling water supplied to the heat exchanger through a pipe line 73 connected to the supply main 25. The cooled liquor leaves the top of the heat exchanger through a line 74 through which it is pumped to a shower 75 in the top of the tower 44. The cooling liquor from the shower 75 flows downwardly through the tower 44 countercurrent to the uprising burner gases and serves to cool these gases as much as 70° to 80° F. The cool SO_2 enriched gas leaves the top of the spray cooling tower 44 through the outlet 76 from which it may be conducted to the acid liquor making system (not shown). Substantially all of the SO_2 is stripped from the spray liquor in the spray cooling tower 43 by the hot burner gases flowing downwardly therethrough. This stripped SO_2 recovered in the spray cooling tower 43 represents the SO_2 dissolved from the blow pit ventilator gases in the SO_2 absorbing tower 32.

In older burner gas cooling installations wherein the coolers are of the surface cooling type, these coolers may be retained to serve the cooling function of the cooling tower 44, while the SO_2 stripping may be effected in a spray type cooling tower, such as tower 43, placed in series with and ahead of such surface type coolers. The condensate from the surface cooler in such an arrangement would be pumped as a circulating load to the stripping tower together with the make-up aqueous SO_2 solution from the reservoir 37.

In certain instances it may be desired to recover SO_2 intermittently discharged from the digester system other than from the blow pit 12. For example, appreciable amounts of SO_2 are lost when the so-called "side-relief" liquors from the digester 10 are sent directly to waste. This "side-relief" liquor comprising hot water and SO_2 is shown in the drawing as originating at the left hand side of the digester 10 and conducted into the reservoir 37 through the pipe line 77, shown in broken line in the drawing, or it may be flashed or conducted into the condenser tower 21 through a line 80, also shown in broken line.

It will be seen that since my invention provides for the recovery and utilization of sulphur dioxide from blow gases, the sulphur dioxide content of the digester contents blown into the blow pit 12 may be substantially higher than that in the normal practice. This reduces the amount of sulphur dioxide that it is normally necessary to recover during the blow down period of a digester cook, and thereby shortens the blow-down period. This advantage is of particular importance where modern means for forced circulation are employed, in that the active relief during the latter stages of the cooking cycle greatly impairs the rate of circulation at a phase of the process where active and positive circulation is to be desired. Accordingly, each digester may be operated to give increased pulp output for production without a sacrifice in economy due to waste of SO_2. Or, as stated above, if it is not essential or desirable to increase the pulp production, a lower cooking temperature may be used since the effective cooking period of each batch may be extended a period of time corresponding to the shortening or reduction of the blow-down period.

Since certain changes may be made in my foregoing method and means for the recovery and utilization of intermittently discharged sulphur dioxide and different embodiments of the invention may be made without departing from the spirit and scope thereof, it is intended that all matter described hereinbefore or shown in the

accompanying drawing shall be interpreted as illustrative and not in a limiting sense, and that the appended claims be given the broadest possible construction consistent with the state of the prior art.

I claim:

1. In the operation of a sulphite pulp plant including an intermittently operated digester system and a continuously operated sulphur burner and burner gas cooling system, the method of recovering and utilizing intermittently discharged SO_2 which comprises, absorbing the SO_2 as it is discharged to form an aqueous solution thereof, conducting said aqueous SO_2 solution as it is formed to a storage tank therefor, delivering the aqueous SO_2 solution at a relatively uniform rate from said storage tank to said burner gas cooling system, and stripping absorbed SO_2 from said aqueous SO_2 solution by contacting the solution with hot burner gases from said sulphur burner.

2. In the manufacture of sulphite pulp, the method of recovering and utilizing SO_2 intermittently discharged as one of the blow pit ventilator gases which comprises, condensing the steam from said blow pit ventilator gases to form hot waste water, maintaining the temperature of said waste water slightly below 212° F. to thereby substantially prevent absorption of SO_2 therein, absorbing the SO_2 from said blow pit ventilator gases by cool water to form an aqueous solution thereof, conducting said aqueous SO_2 solution as it is formed to a reservoir therefor, delivering the aqueous SO_2 solution at a substantially uniform rate from said reservoir to a cooling system for cooling sulphur burner gases, and stripping the absorbed SO_2 from said aqueous SO_2 solution by contacting the solution with hot burner gases from a sulphur burner, said burner gas cooler system and said sulphur burner being operated in a continuous manner in connection with the manufacture of sulphite pulp.

3. In the operation of a sulphite pulp plant which includes at least one digester, a blow pit into which the digester contents are periodically discharged, a sulphur burner, and a burner gas cooling system comprising at least a first saturating spray tower, said sulphur and said burner gas cooler being operated in a continuous manner, the method of recovering and utilizing SO_2 intermittently discharged in the blow pit ventilator gas from said blow pit which comprises, conducting blow pit ventilator gas to condenser means, spraying water into said condenser means to condense the water vapor component from said blow pit ventilator gas and form hot waste water, thermostatically regulating the quantity of water sprayed into said condenser so as to maintain said hot waste water only slightly below 212° F. to thereby substantially prevent absorption of SO_2 therein, conducting the blow pit ventilator gas leaving said condenser means to SO_2 absorption means, spraying cool water into said SO_2 absorption means to remove the SO_2 from said blow pit ventilator gas and to form an aqueous solution thereof, passing said aqueous SO_2 solution into a reservoir therefor, delivering the aqueous SO_2 solution at a relatively uniform rate from said reservoir to make-up water storage means for said burner gas cooling system to form make-up liquor with make-up water therewithin, pumping said make-up liquor at a rate substantially equal to the rate at which it is delivered from said reservoir plus a small additional circulating load to said first saturating spray tower of said burner gas cooling system, spraying said make-up liquor thus pumped within first spray tower, and stripping absorbed SO_2 from said liquor spray by means of hot burner gases.

4. In the operation of a sulphite pulp plant which includes at least one digester, a blow pit into which the digester contents are periodically discharged, a sulphur burner, and a spray type burner gas cooling system comprising a series of at least first and second spray towers, said sulphur burner and said spray type burner gas cooler being operated in a continuous manner, the method of recovering and utilizing SO_2 intermittently discharged in the blow pit ventilator gas from said blow pit which comprises, conducting blow pit ventilator gas to condenser means, spraying water into said condenser means counter-current to the flow of blow pit ventilator gas therein to condense the water vapor therefrom and to form hot waste water, thermostatically regulating the rate at which said condenser water is sprayed so as to form said hot waste water at slightly below 212° F. to thereby substantially prevent absorption of SO_2 therein, conducting the blow pit ventilator gas leaving said condenser means into SO_2 absorption means, spraying cool water into said SO_2 absorption means counter-current to the flow of the blow pit ventilator gas therein to remove SO_2 therefrom and form an aqueous SO_2 solution, collecting said aqueous SO_2 solution, passing said aqueous SO_2 solution into a reservoir therefor, delivering the aqueous SO_2 solution at a relatively uniform rate from said reservoir to make-up water storage means for said burner gas cooling system to form make-up liquor with make-up water supplied thereto, conducting said make-up liquor to the last tower in said series of spray towers of said burner gas cooling system, pumping a part of said make-up liquor at a rate substantially equal to the rate at which it is delivered from said reservoir plus a small additional circulating load to the top of said first spray tower of said burner gas cooling system, spraying said make-up liquor thus pumped into said first spray tower, passing hot burner gas into said first spray tower co-current with said make-up liquor spray to thereby strip the SO_2 from this spray, passing the SO_2 enriched burner gas into the next in said series of spray towers, removing the stripped make-up liquor from said first spray tower, cooling a relatively large part of the liquor from the second cooler by circulating it through a heat exchanger, and spraying the cooled mixture of make-up and circulating liquors into the top of said last spray tower to thereby cool the SO_2 enriched burner gas.

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