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F. W. HOCHMUTH
BLACK LIQUOR CHEMICAL RECOVERY UNIT
UTILIZING GAS RECIRCULATION

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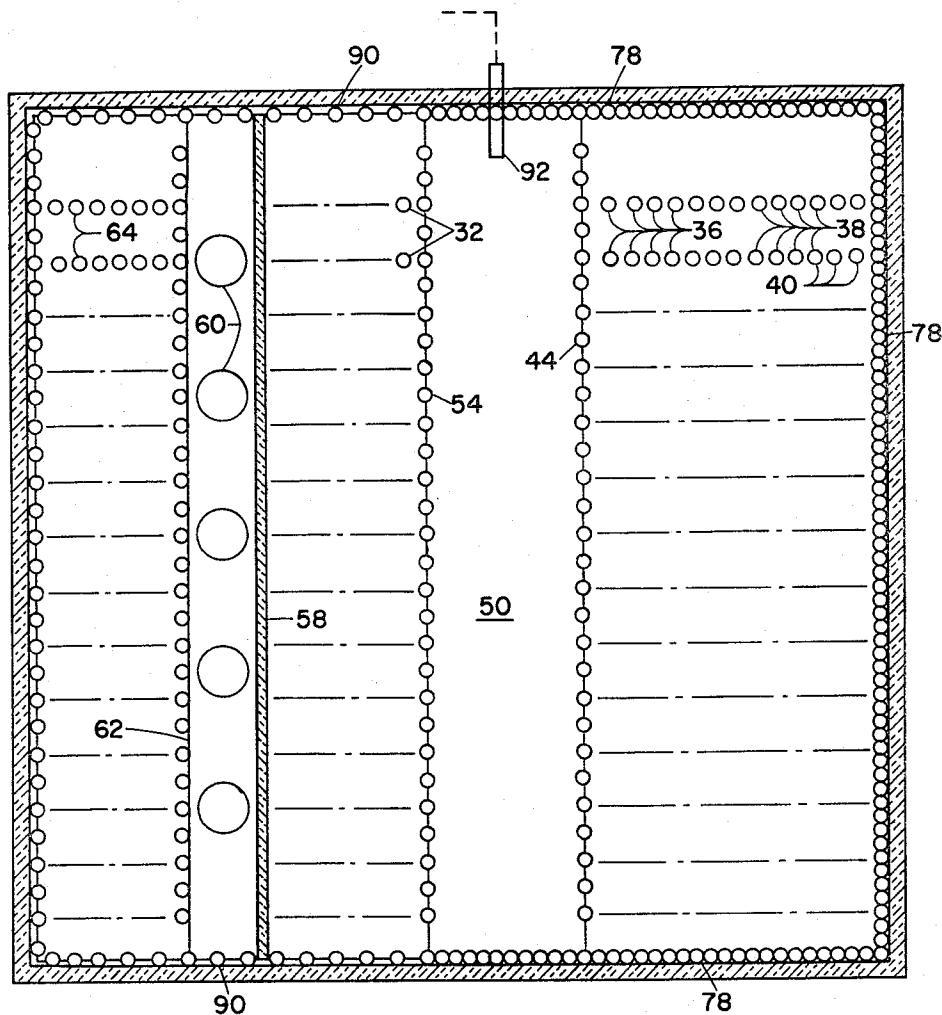


FIG. 2

INVENTOR.
FRANK W. HOCHMUTH

BY

Robert L. Olson, Atty.

1

2

3,170,442

**BLACK LIQUOR CHEMICAL RECOVERY UNIT
UTILIZING GAS RECIRCULATION**

Frank W. Hochmuth, West Simsbury, Conn., assignor to
Combustion Engineering, Inc., Windsor, Conn., a cor-
poration of Delaware

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This invention relates to chemical recovery boilers, and in particular to the construction thereof which will permit the attainment of higher superheat temperatures.

In the sodium base process of paper pulp manufacture, wood chips are cooked in digesters, and the resulting pulp is taken from the digesters, washed and prepared for further use. The so-called black liquor separated from the removed pulp is thereafter passed through evaporators for greater concentration and is then burned in a special furnace to oxidize the organic matter, and to recover the inorganic chemicals. The heat liberated from the burning of the black liquor is utilized by generating and superheating steam.

Problems are encountered in the boiler section of these units because of the large amount of chemical ash particles which is contained in the hot combustion gases exhausted from the furnace. When the temperature of the chemical ash particles carried by the combustion gases is above the softening or melting temperature, these sticky particles tend to collect on the steam generating and superheating tubes in such a manner that they are rather difficult to thereafter remove. For this reason, from the standpoint of clean boiler operation, it is desirable to maintain the temperature of the combustion gases and the ash particles carried thereby below the softening or melting point of the ash before these gases encounter any steam generating surface. In recent years, in order to increase the over-all efficiency of these chemical recovery boilers, higher superheat temperatures are being asked for. It is not uncommon for a chemical recovery boiler today to produce superheated steam of 900° F. and above. In order to obtain these higher temperatures, it obviously is necessary to also increase the temperature of the combustion gases in the superheater. New metals which are corrosion resistant and capable of withstanding exposure to high temperatures are available which make possible the higher operating temperatures of the chemical recovery superheater. However, when the temperature of the combustion gases leaving the superheater becomes excessive, the chemical ash particles carried by the combustion gases becomes molten or semi-molten in form. These sticky ash particles when contacting heat exchange surface adhere thereto, causing slagging and plugging of these heat exchangers.

It is an object of this invention to construct a chemical recovery unit which will be capable of producing high superheat temperatures while still avoiding slagging and plugging in the steam generating section of the boiler because of higher combustion gas temperature.

Additional objects and advantages of the invention will appear from the following description of a preferred embodiment thereof when considered in conjunction with the accompanying drawings wherein:

FIG. 1 is a vertical elevation (partly in cross section) of a black liquor recovery system employing the principles of the invention;

FIG. 2 is a top view of the unit when taken on line 2-2 of FIG. 1.

Referring to FIG. 1, 10 denotes a recovery furnace having a hearth, or smelting zone 12. Black liquor, evaporated to the desired density, is introduced into the furnace by nozzles 18. The air for combustion is supplied by means of duct 16 and air nozzles 14. The black liquor

supplied to the furnace is evaporated, so as to increase its solids content to a desired percentage, in cascade evaporator 20. The black liquor is introduced into the evaporator by means of inlet 22 and leaves therefrom through outlet pipe 26. Contained within the evaporator is a rotating drum 23 driven by means of motor 24. This drum in rotating picks up black liquor from the pool contained in the lower portion of the housing, thus exposing it to the hot combustion gases flowing through the upper portion of the housing.

The hot combustion gases generated by the burning of black liquor within the furnace pass into the upper portion of the furnace, flowing first over steam generating tubes 32. Also positioned within the upper portion of the furnace above tubes 32 is final superheater section 34, and primary superheater tubes 36, 38 and 40.

The combustion gases, after passing over these heating surfaces, leave the upper portion of the furnace through opening 42. The tubes extending through the opening 42 are offset with respect to one another so as to allow free passage of gases therethrough. Below the opening 42, the tubes 44 are formed into a single plane, and are finned as shown in FIG. 2, so as to form a solid baffle between the upper furnace and the open gas pass 50. After flowing through this open gas pass 50, the gases make a reverse turn at the bottom thereof, and enter the upwardly extending steam generating portion of the gas pass through opening 52. An ash hopper 53 is positioned beneath the opening 52, so as to permit removal of any ash particles that might settle out at this point as the gases make a turn in direction.

The second portion of the gas pass contains extensions of steam generating tubes 32. Finned tubes 54 form an imperforate baffle between the first and second portions of the gas pass. The tubes 54 passing through the opening 52 are offset and contain no fins, just as the tubes in the opening 42 are constructed. Also, some of the tubes 54 are bent out of the panel and form a part of the tube screen extending into the upper portion of the furnace. The gases leaving the steam generating section of the gas pass flow through opening 56 into the last portion, which contains the economizer tubes 64. A baffle 58 separates these two portions of the gas pass.

Also positioned between these two passages are downcomers 60 which extend through baffle plates 62. Since it is desired to maintain the water flowing through downcomers 60 relatively cool with respect to the flow of fluid through the steam generating or riser tubes 32, the baffle plates 62 assist in that respect and also prevent the gases from bypassing the economizer tubes 64. If desired, the downcomers could be positioned outside of the gas pass altogether.

The combustion gases flow by means of duct 65 into the evaporator 20, and are then exhausted to the atmosphere through stack 82. Fan 80 maintains a steady flow of these gases to the atmosphere. Duct 84, the inlet end of which is connected to the stack 82 downstream of fan 80, and the outlet end of which is connected to nozzles 86, can be used for recirculating gases back to the open gas pass 50 when desired. Thermocouple 92 is positioned within the open pass 50, and measures the temperature of the combustion gases at this point. Signals from thermocouple 92 are received by control 94, which regulates the positions of both sets of dampers 96 and 98. In this manner the temperature of the combustion gases leaving the open gas pass 50 is maintained below a predetermined maximum.

Water enters the economizer tubes 64 by means of inlet header 66, and flows by way of outlet header 68 into the steam and water drum 70. Downcomers 60 supply water to header 74, and also to header 76. The water flows

3

from header 76 into tubes 78 which line all four of the walls of the furnace 10.

As seen in FIG. 2, tangent tubes 78 and finned tubes 90 completely line the outer walls of the furnace and the adjacent gas pass.

The operation of the invention will now be explained. When black liquor is being burned in large quantities in the furnace 10, the volume and temperatures of the combustion gases thereby created will be greater than during the periods when only a small amount of black liquor is being burned. For this reason, the amount of recirculated gas introduced into the open pass 50 will vary with the load of the unit. In other words, when black liquor is being burned at maximum capacity, or at full load, a large amount of cool gas is recirculated in order to prevent the temperature of the gases leaving open pass 50 from exceeding a predetermined maximum. The recirculated gas is at a temperature substantially below that of the gases flowing from the superheater section, since it has given up heat in the steam generating section, the economizer, and the evaporator. These recirculated gases will be 1000° to 1200° F. cooler than the gases coming from the superheater zone. As less black liquor is burned, the need for cooled recirculated gases also becomes less. Thus it can be seen that as the temperature sensed by thermocouple 92 increases, control 94 will move the dampers 98 in a closing direction, while simultaneously moving dampers 96 in an opening direction. Conversely, as the temperature sensed by thermocouple 92 decreases, dampers 98 are moved in an opening direction while dampers 96 are simultaneously moved in a closing direction. The hot combustion gases laden with chemical dust particles, leaving the upper portion of the furnace, will enter open gas pass 50 by means of opening 42. During their downward flow through the open gas pass 50, the dust particles, which are generally 100° F. or more above the temperature of the combustion gases, cool down by giving up heat to the combustion gases. Heat is also transferred from the combustion gases to the tubes lining the walls of this pass 50. When the unit is operating at maximum capacity, the temperature of the gases flowing through the open pass 50 is also substantially reduced by discharging a large amount of relatively cool recirculated gases through nozzles 86. During periods when less black liquor is burned, and thus the temperatures sensed by thermocouple 92 decreases, less gas will be recirculated.

From the above it will be seen that higher combustion gas temperatures can be allowed in the superheater sections, while still preventing excessive combustion gas temperatures and/or semi-molten chemical dust particles from entering the steam generating section of the boiler. For example, by utilizing gas recirculation introduced into open gas pass 50, it might be possible to allow the hot combustion gases to leave the superheater section and enter the open gas pass 50 at a temperature of 1500° F. or higher when firing the unit at maximum capacity. The temperature of the chemical dust particles carried thereby will then be somewhat higher. In passing through the open gas pass 50, the temperature of both the combustion gases and the dust particles will be reduced by means of the recirculated gas, and also because of the heat transfer to the tubes lining the walls of this pass.

The combustion gases entering the steam generating section of the gas pass should be reduced in temperature to approximately 1100° F. in order to insure the solidification of the dust particles prior to their contact with the steam generating tubes. Above this temperature, the particles will become molten or semi-molten and sticky in form. These sticky particles when coming into contact with heat exchange surface, attach themselves thereto, solidifying thereon. Such ash particles are extremely

4

difficult to thereafter remove by means of sootblowing or other conventional ash deposit removal equipment, whereas if the dust particles are in the solid state they do not attach themselves to the heat exchanger as readily and also can be easily removed therefrom.

While the preferred embodiment of the invention has been shown and described, it will be understood that minor changes in construction may be made without departing from the spirit and scope of the invention as claimed.

What I claim is:

1. In a system for recovering chemicals and generating and superheating steam from the combustion of black liquor, the combination of a smelter furnace defined by generally vertical walls, means for supplying black liquor into the furnace interior and for burning the same in the lower portion thereof for producing combustion gases laden with chemical ash particles, a super heater heat exchanger positioned within the upper portion of the furnace, a gas pass connected to the upper portion of the furnace, said gas pass comprised of walls forming a tortuous gas passage made up of a plurality of upwardly and downwardly extending interconnected passages, the walls of the gas passage being lined with fluid cooled tubes, a first portion of the gas passage being connected to the upper portion of the furnace, said first portion being an open gas pass free of any heat exchange members other than the fluid cooled tubes lining the walls thereof, a second portion of the gas passage being downstream of the first portion and in series flow relationship therewith, a plurality of steam generating tubes positioned within the second portion of the gas passage, a stack open to atmosphere at one end and connected to the second portion of the gas passage at the other end, a fan positioned within the stack, first damper means positioned within the stack downstream of the fan, a duct having an inlet end and an outlet end, the inlet end being connected to the stack upstream of the first damper means but downstream of the fan, with the outlet end of the duct connected to the first portion of the gas passage, second damper means positioned in said duct, temperature sensing means positioned in said first portion of the gas passage, said temperature sensing means being operatively connected to the first and second damper means so as to move the first damper means in a closing direction when an increase in temperature is sensed while moving the second damper means in an opening direction, and moving the first damper means in an opening direction when a decrease in temperature is sensed while moving the second damper means in a closing direction, to thereby allow the attainment of higher superheat temperature while still preventing undue slagging of the steam generating tubes positioned within the second portion of the gas passage.

2. The system set forth in claim 1, including a black liquor evaporator positioned intermediate the stack and the second portion of the gas passage, through which the combustion gases pass.

References Cited in the file of this patent

UNITED STATES PATENTS

1,794,006	Falla	Feb. 24, 1931
2,869,521	Hardgrove	Jan. 20, 1959
2,953,124	Marquez	Sept. 20, 1960
2,985,153	Dickey	May 23, 1961

FOREIGN PATENTS

143,725	Sweden	Jan. 19, 1954
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OTHER REFERENCES

"Steam, Its Generation and Use," published by the Babcock and Wilcox Co., New York, 27th ed., 3rd printing, 1955 (page 20-10 relied on).