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[54] PROCESS FOR CONTROLLING THE BURNING OF SULFUR

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[58] **Field of Search** .....23/177, 179, 232, 254, 254 E, 23/1 B; 236/15 E

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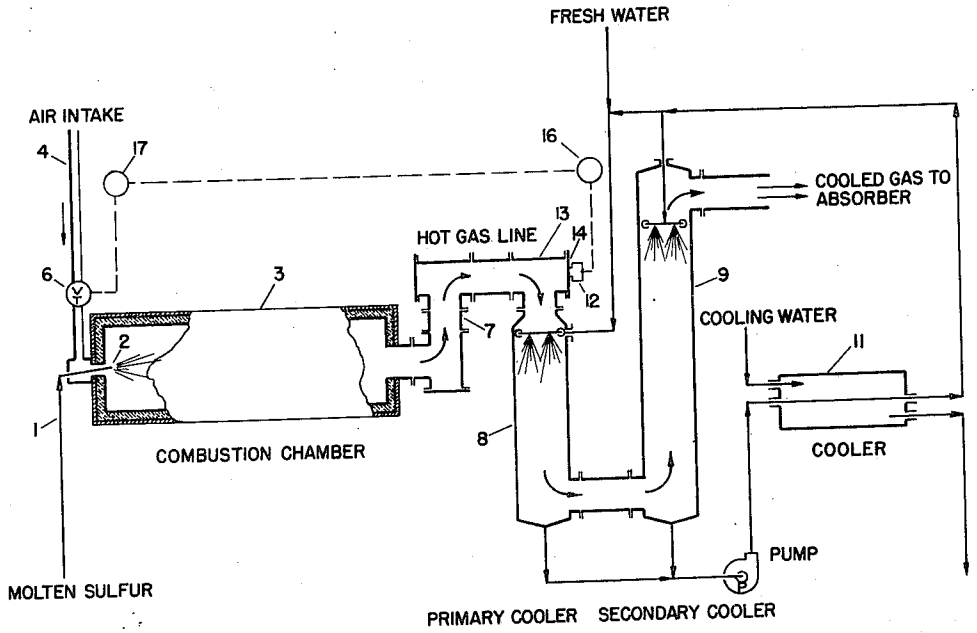
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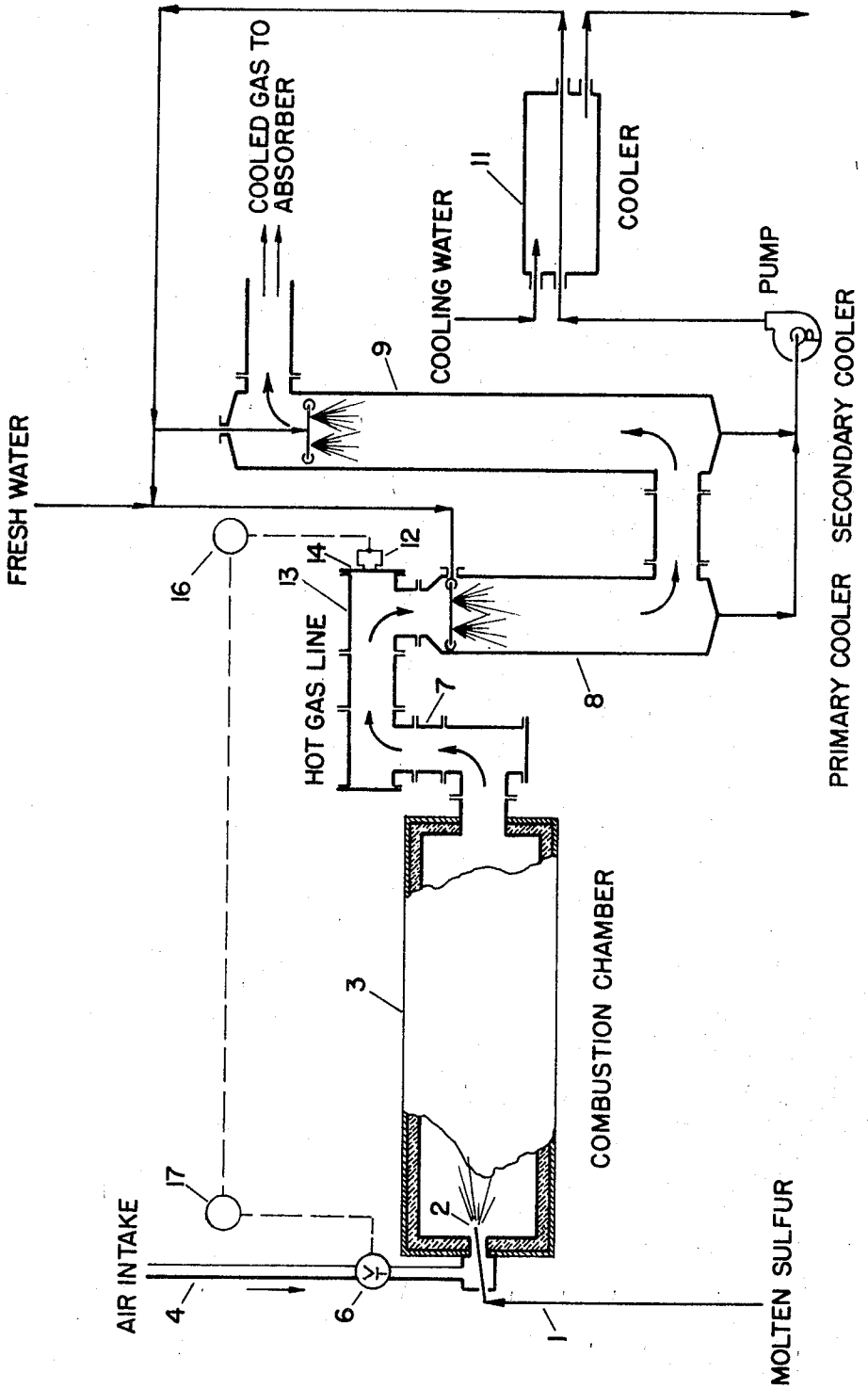
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[57] **ABSTRACT**

A method for controlling the burning of sulfur to obtain sulfur dioxide by determining the ultraviolet radiation of the combustion gases discharged from the combustion chamber and adjusting the ratio of air to sulfur being used to obtain a flame of a predetermined magnitude in the combustion gases discharged from the combustion chamber.

8 Claims, 1 Drawing Figure





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PROCESS FOR CONTROLLING THE BURNING OF SULFUR

This invention pertains to a method for controlling the burning of sulfur. More particularly, it pertains to controlling the combustion of sulfur to obtain sulfur dioxide under conditions to oxidize all of the sulfur with a minimum of excess air.

Sulfur dioxide is one of the basic chemicals used in the preparation of sulfur acids and other sulfur compounds. In most chemical processes requiring sulfur dioxide gas or sulfurous acid, sulfur dioxide is prepared by burning of sulfur in air. In many of these applications, for example in the sulfite pulping process, it is desirable to obtain the sulfur dioxide in a high concentration substantially free of sulfur trioxide and unoxidized sulfur. This requires closely controlling the conditions of the combustion or burning of the sulfur. One of the methods commonly used for controlling the oxidation is based upon the determination of the sulfur dioxide content of the combustion gases. The determination is generally made on the combustion gases after cooling. While this method of control may be satisfactory for many situations, there is a considerable time lag. As a result, the close control that is necessary is difficult to obtain under normal varying process conditions.

Therefore, it is an object of this invention to provide a process for controlling the burning or oxidation of sulfur which would be readily responsive to variations in the oxidizing conditions. A further object is to provide a process for controlling the burning or oxidizing the sulfur wherein the sulfur may be substantially completely oxidized with the employment of the minimum amount of oxygen or air. A still further object is to provide a sulfur burner assembly equipped with an ultraviolet sensor to control the oxidizing conditions of the sulfur combustion.

The above and other objects are obtained by this invention by controlling the oxidation of the sulfur to obtain a predetermined amount of flame or burning of sulfur in the combustion gases discharged from the combustion chamber of the sulfur burning assembly. The flame is detected and its magnitude determined by the ultraviolet radiation of the flame. The control is accomplished by determining the ultraviolet radiation and controlling the combustion conditions to obtain a given amount of ultraviolet radiation in the combustion gases at a particular control point. By controlling the sulfur oxidation by the magnitude of the flame obtained in the combustion gases, any changes in the oxidizing conditions can be readily detected and the ratio of sulfur to oxygen or air being passed to the burner and combustion chamber can be quickly adjusted to obtain the desired degree of oxidation or burning.

An embodiment of the invention is illustratively shown in the attached figure. As shown in the figure, molten sulfur is pumped through line **1** to spray nozzle **2** where it is sprayed into combustion chamber **3**. Air through line **4** is introduced into the combustion chamber to provide the oxygen for the oxidation of the molten sulfur sprayed into the chamber. The amount of air introduced into the combustion chamber is controlled through Valve **6** to provide a sufficient amount of air to completely oxidize the sulfur. The combustion gases from the combustion chamber are discharged through hot gas line **7** to primary cooler **8** where they are contacted with a water spray to rapidly cool the gases to a temperature below 500° C. Temperatures in the range of from about 900° to 500° C. are favorable for trioxide formation. The partially cooled gases are then passed to the secondary cooling tower **9** where they are contacted with further quantities of water to be cooled to a temperature in the range of 80° to 90° C. The cooled gas is then passed to the absorbers (not shown) for the recovery of SO_2 by absorption. The water used for the cooling is recycled to coolers **8** and **9** after being cooled in heat exchanger **11**.

While most of the sulfur is burned or oxidized in the combustion chamber, completion of the combustion is generally effected in the hot gas line between the combustion chamber and the cooler. As a rule, at least one and sometimes as many as seven or eight changes in direction of gas flow are made in the line to obtain adequate mixing of the gases to complete the combustion. To utilize the hot gas line most efficiently, it is

desirable to control the oxidation in the combustion chamber such that the oxidation of the sulfur is continued in the gas line and completed just prior to the entry of the combustion gases into the primary cooler. In this way, the hot gas line is not only serving as a conduit for transferring the gas but as an extension of the combustion chamber to complete the oxidation of the sulfur.

It is generally desirable to have the instrumentation or the point of control for the determination of the ultraviolet radiation located in the portion of the gas line near the primary cooler. As shown in the drawing, the oxidation of the sulfur is controlled by having the ultraviolet sensor cell **12** positioned at one end of tee **13**, which provides the final change of direction for the gas before it enters primary cooler **8**. The ultraviolet sensor cell is positioned at flange **14** of tee **13** so that it is facing or viewing the approaching gases coming from the combustion chamber. The ultraviolet radiation picked up by cell **12** is transmitted by an ultraviolet transmitter **16** to an ultraviolet recorder and controller **17**, which is set to control the opening and closing of valve **6** to adjust the amount of air being introduced into the combustion chamber to obtain a given ultraviolet radiation.

The amount of ultraviolet radiation picked up by cell **12** is set at a predetermined amount to obtain a flame of burning sulfur in the combustion gases. Since the ultraviolet radiation is related to the magnitude of the flame or the amount of burning sulfur, the ultraviolet radiation is adjusted to a level such that the combustion of the sulfur would be completed in the combustion gases prior to the gases' entry into the primary cooler. The determination of the amount of ultraviolet radiation needed to obtain the desired flame or level of burning can be made by calibration of the cell after the installation. This can easily be done by varying the amount of air being introduced into the combustion chamber and determining the extent of combustion or oxidation being obtained. The determination can be made by sulfur dioxide and oxygen analyses, or other various known means used. A convenient way to determine the maximum radiation desirable for any particular installation is to decrease the amount of air being introduced into the combustion chamber to a point just before unoxidized sulfur is detected in primary cooler **8**. Upon quenching of the combustion gases, the unoxidized sulfur will be carried down in the quench water giving a milky color to the water, which can be readily noted. Thus, in operation of the unit, the combustion is controlled to obtain the largest flame or the highest ultraviolet radiation reading at the control or determination point and still have all of the sulfur oxidized by the time the combustion gases reach the cooler.

The actual value of ultraviolet radiation obtained to maintain the desired level of combustion in the gas line will depend upon the installation and location along the gas line selected for point of control. The location of the ultraviolet sensor cell in the gas line closer to the cooler or points of lower flame or combustion levels will result in more sensitive control. However, the cell can be placed such that the ultraviolet determination is made of the gases at the exit from the combustion chamber. At this point the extent of combustion would be considerably greater and the ultraviolet radiation at considerably higher levels, resulting in a decrease in sensitivity. The variations in radiation obtained at these higher levels would not be as significant as at the lower levels of radiation which are obtained closer to the primary cooler.

It is also convenient to locate the ultraviolet sensor cell at a point where the line makes a change in direction of flow. Since the gases are at a high temperature, the installation is usually made by locating the cell outside of the gas line with the cell sighting into the line. The cell could be installed in the line. However, provisions would have to be made to cool the cell, which would be elaborate, to provide the necessary protection. It is generally desirable to have the cell located such that sufficient area of the combustion gases is exposed to the cell to obtain a meaningful reading. Placing the cell to view the approaching gases in line with the flow of the gases is thus ad-

vantageous. Even though the line in view of the cell may be of considerable length, the ultraviolet radiation which will be detected by the cell will be that occurring in the portion of the line near the cell. Ultraviolet radiation is absorbed by sulfur dioxide so that radiation emitted by burning sulfur or the flame located at a considerable distance from the cell will be absorbed to some extent by the SO_2, minimizing its effect on the detection or reading obtained.

In the attached drawing, the method of control shown is that the amount of air being introduced into the combustion chamber is regulated to obtain the desired combustion. In this method of operation, the amount of molten sulfur introduced is adjusted to a particular rate and the amount of air used to control or regulate the combustion. It is not necessary to control the conditions of oxidation by regulating the amount of air introduced. If desired, the amount of molten sulfur being sprayed into the combustion chamber or burner can be controlled to obtain the desired oxidizing conditions.

Also, as shown in the attached drawing, the sulfur burner used is a spray type where molten sulfur is sprayed directly into the combustion chamber. However, other types of burners can be used. Most burners other than the spray type are considerably larger in size and are separate and distinct from the combustion chamber. In these burners, sufficient amount of sulfur is burned to maintain high temperatures and to vaporize the desired amount of sulfur needed for the combustion. For example, a commonly used type of burner is a rotary burner where the sulfur is burned by passage of air through a rotating drum. A molten pool of sulfur is maintained in the drum. By rotation of the drum, the inner surface of the drum becomes coated with the molten sulfur, increasing the surface area of the molten sulfur exposed to oxidation and vaporization. The gases from the burner, mixed with additional or secondary air, are then passed into the combustion chamber where the major portion of the vaporized or sublimed sulfur is burned. When such a burner is used, the oxidation conditions in the combustion chamber can be most conveniently controlled by controlling the secondary air or the air being introduced into the combustion chamber.

The ultraviolet detector or sensor used may be of the various types which are commercially available. The ultraviolet sensors such as used for flame detection may be modified and used.

The combustion or burning of sulfur in a sulfur dioxide plant was controlled by the method of this invention. The unit operated was similar to that shown in the attached drawing except that the air was drawn into the combustion chamber by use of a blower located after the cooler. By operating under slightly less than atmospheric pressure, the atmosphere around the unit was maintained free of combustion gases or SO_2. The discharge line from the combustion chamber to the primary cooler had five 90° changes in direction. The cell was installed at the fourth change of direction, which was a tee in the discharge line. The ultraviolet sensor unit was installed on the outside of this tee, positioned to view the approaching combustion gases in the line through a hole which was drilled in the flange of the tee. The ultraviolet sensor unit used was an ultraviolet flame detector modified to record the output from the ultraviolet sensor. After the installation was made, the unit was calibrated. The calibration was made by operating the burner at a fixed sulfur feed rate and decreasing the amount of air being drawn into the combustion chamber by closing the discharge valve from the blower. This increased the level of combustion or flame obtained within the discharge line, resulting in increased ultraviolet radiation reading. The air intake was thus decreased to a point until unoxidized sulfur was detected in the primary cooler. When this point was reached, the amount of air being used was increased, lowering the ultraviolet radiation and the level of oxidation within the discharge line to a point where the system was operating with all the sulfur being oxidized by the time the combustion gases reached the cooler.

Prior to equipping the unit with the ultraviolet radiation control, the oxidation or combustion of sulfur was controlled by use of the sulfur dioxide analyzer. The analysis for sulfur dioxide was made after the primary cooler. Considerable time lag in control of the unit was experienced. In operating the plant to obtain the desired high concentration of sulfur dioxide, periodically appreciable amounts of vaporized sulfur would be carried into the primary cooler due to variations in operating conditions. This difficulty was not experienced when the unit was controlled by the method of this invention. Variations in the operating conditions were quickly detected by changes in the ultraviolet reading obtained and the necessary adjustments made.

What is claimed is:

1. In a process for the preparation of sulfur dioxide wherein sulfur is burned in the presence of oxygen in a combustion chamber to oxidize the sulfur to sulfur dioxide and the combustion gases discharged from the combustion chamber to a cooler, the improvement for controlling the oxidation of the sulfur which comprises the determination of the ultraviolet radiation of the combustion gases discharged from the combustion chamber and adjusting the ratio of the sulfur to oxygen being used in the combustion chamber to obtain a predetermined amount of ultraviolet radiation in the combustion gases indicating the presence of a flame of burning sulfur, said flame being of a magnitude at the point of determination such that all of the sulfur is oxidized prior to the passage of the combustion gases into the cooler.

2. In a process for the preparation of sulfur dioxide wherein sulfur is burned in the presence of oxygen in a combustion chamber to oxidize the sulfur to sulfur dioxide and the combustion gases discharged from the combustion chamber through a discharge line to a cooler, improvement of controlling the oxidation of the sulfur which comprises the determination of the ultraviolet radiation of the combustion gases at a point between the discharge from the combustion chamber and the inlet to the cooler, and adjusting the ratio of the sulfur to air being used in the combustion chamber to obtain a predetermined amount of ultraviolet radiation in the combustion gases at the point of determination indicating the presence of a flame of burning sulfur, said flame being of a magnitude such that the combustion is completed prior to passage of the combustion gases into the cooler.

3. A process according to claim 2 wherein the ultraviolet radiation is determined in the portion of the discharge line more distant from the combustion chamber.

4. A process according to claim 3 wherein the discharge line has at least one change in direction.

5. A process according to claim 4 wherein the ultraviolet radiation determination is made at the point of change of direction in the discharge line to obtain the ultraviolet radiation of the combustion gases approaching the change of direction in the line.

6. A process according to claim 5 wherein the ultraviolet radiation determination is made of the combustion gases at the last change in direction of discharge line prior to the line's attachment to the cooler.

7. An apparatus for burning of sulfur in the preparation of sulfur dioxide, comprising a sulfur burner, a combustion chamber having an air control means for controlling the flow of air into said chamber, a gas cooler connected to the combustion chamber by a discharge line, an ultraviolet radiation sensing device positioned to determine the ultraviolet radiation inside of said discharge line, and means to actuate said air flow control means in relation to the level of ultraviolet radiation detected by said sensing device.

8. An apparatus according to claim 7 where the discharge line has at least one change in direction and the ultraviolet sensing device is positioned outside of the discharge line in a portion of the line more distant from the combustion chamber.

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