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[54] **METHOD OF REDUCING SULPHUR DIOXIDE EMISSIONS FROM COAL**

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[51] **Int. Cl.** **F23b**
[58] **Field of Search**..... 110/1 J, 1 K, 106; 44/1 R, 44/4; 201/17

[56] **References Cited**

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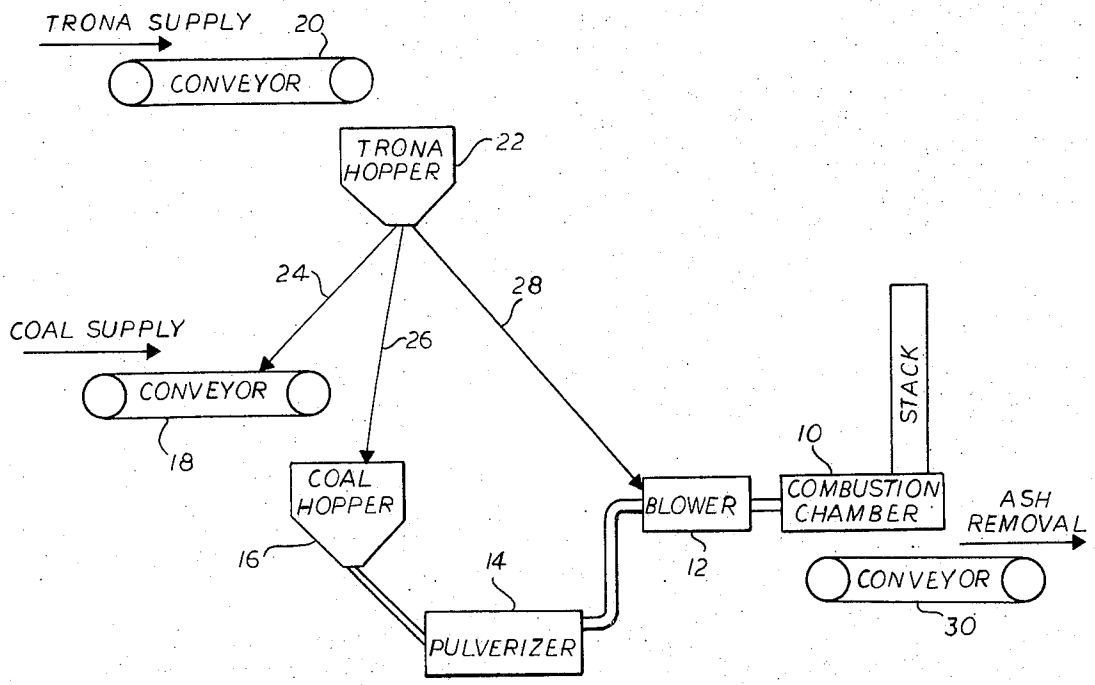
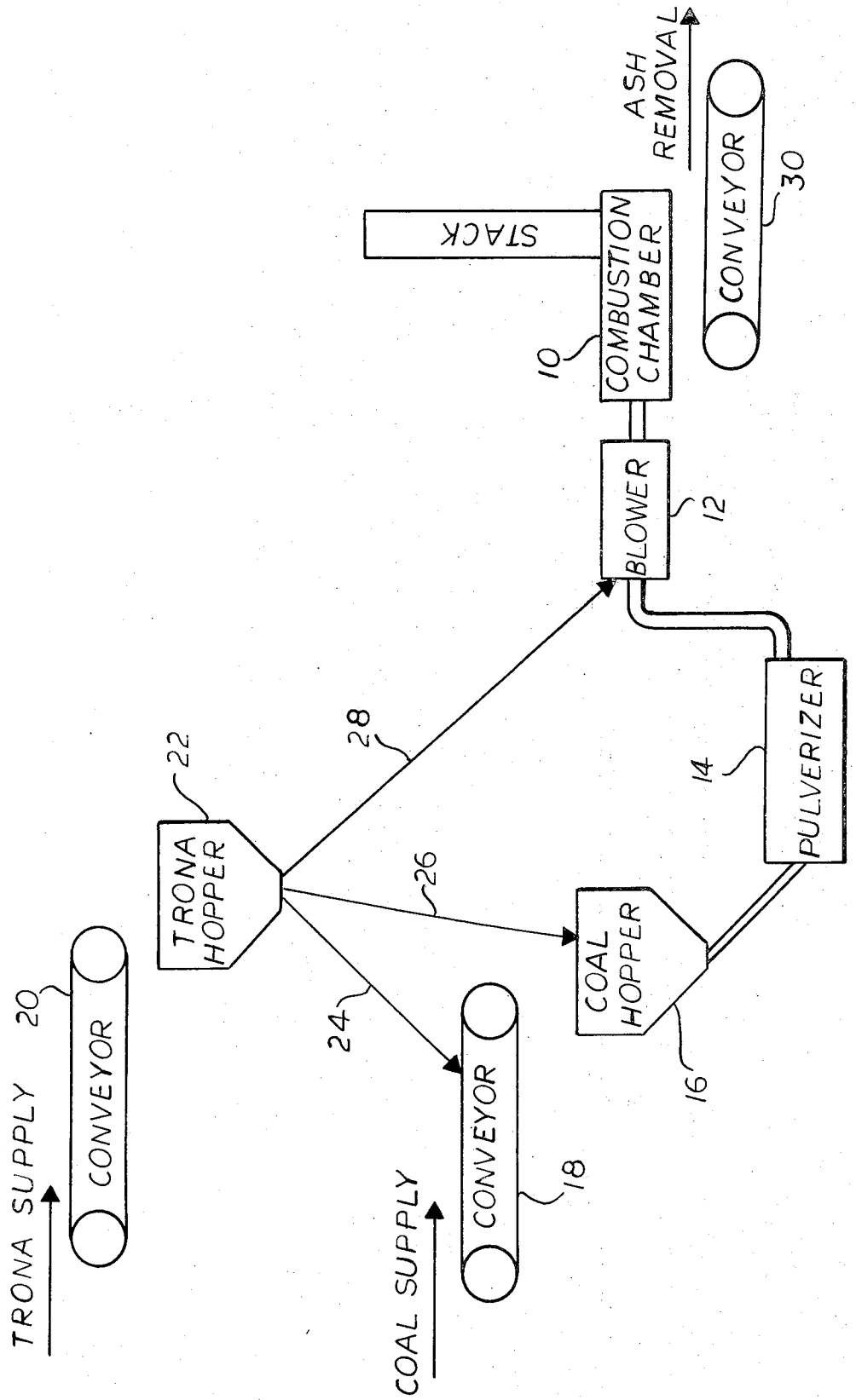
[57] **ABSTRACT**

A method of reducing sulphur dioxide emissions from coal by adding an effective amount of Wyoming Trona to the coal for combining with sulphur in the coal to form a relatively heavy ash which is collected with other heavier ash for removal in the usual way.

8 Claims, 1 Drawing Figure




TRONA SUPPLY
20
CONVEYOR
TRONA HOPPER
22
24
COAL SUPPLY
CONVEYOR
18
26
28
COAL HOPPER
16
PULVERIZER
14
BLOWER
12
10
COMBUSTION CHAMBER
STACK
ASH REMOVAL
CONVEYOR
30

METHOD OF REDUCING SULPHUR DIOXIDE EMISSIONS FROM COAL

The present invention relates to a novel process of eliminating or substantially reducing to acceptable levels sulphur dioxide emissions which normally result from the burning of sulphur containing coal.

It has long been recognized that one serious contributor to the problem of air pollution is the emission of sulphur dioxide from burning coal used in furnaces or boilers such as in power plants and the like. The amount of such emissions varies with the sulphur content of the coal being used. The sulphur content varies widely in accordance with the type and source of the coal and may, for example, range from about 0.5 percent to 5 percent or 6 percent by weight. In general, much of the more economical and readily available coal, particularly in the midwest, is a relatively soft coal having a rather high sulphur content.

Numerous attempts have been made to eliminate or reduce to acceptable levels the sulphur dioxide emissions such as by pre-treating the coal or by mixing an additive with the coal. For environmental purposes, it is usually desired to keep sulphur dioxide emissions at a level of about one percent or less of the gaseous emissions resulting from oxidation or combustion of the coal. Prior attempts to achieve this goal, particularly with high sulphur coal, have not been generally successful since they have either been too costly or have resulted in unacceptable side effects. For example, attempts have been made to use limestone as an additive with coal, but this results in the formation of an unacceptable coating on the interior of the furnace or boiler.

SUMMARY OF THE INVENTION

It is an important object of the present invention to provide a novel process of eliminating or reducing to an acceptable level sulphur dioxide emissions when burning sulphur containing coal in a manner which is relatively economical and which has no unacceptable side effects.

A more specific object of the present invention is to provide a novel process for eliminating or reducing to an acceptable level sulphur dioxide emissions by introducing an additive at an effective point in the combustion of the coal so as to cause the sulphur in the coal to combine with the additive in a manner which facilitates subsequent removal and which does not result in an unacceptable side effect such as coating or corrosion of the interior of the furnace or boiler.

In order to accomplish the objects of this invention, dry Wyoming Trona in powder or granular form is applied to or mixed with the coal. Preferably the Trona is mixed intimately with the coal prior to initiation of combustion. An amount of Trona is used which is effective to reduce the sulphur dioxide emissions to or below the desired level of 1 percent. The amount of Trona required to be so effective will vary in accordance with the amount of sulphur in the coal. In addition the amount of Trona required will vary in accordance with the moisture content of the coal. In general, the amount of Trona which is effective to reduce the sulphur dioxide emissions to a given level increases with the sulphur content of the coal and also increases with the moisture content of the coal. For example, relatively high sulphur (about 4 to 5 percent by weight) and high moisture coal from Kentucky requires the addition of about 15 percent by weight of Trona to reduce sulphur dioxide emissions to 1 percent or less while relatively dry coal having lower sulphur contents (about 2 to 3 percent sulphur) usually requires the addition of only about 10 percent by weight of Trona to reduce the sulphur dioxide emissions to 1 percent or less.

The Trona used in the present invention is a mineral mined from known deposits in the State of Wyoming and has an average composition as follows:

INGREDIENTS	% BY WEIGHT
Silicates	0.21
Aluminum	0.24
Iron Oxide	0.045
Magnesium Oxide	0.23
Potassium	0.03
Chloride	0.02
Soda Ash (Na_2CO_3)	57.65
Inerts	41.575

The chemical reaction which takes place is not fully known, but it is known that the Trona binds with and neutralizes the sulphur and forms a relatively heavy ash which is readily collected with other ash material and does not pass up the stack with the gaseous combustion products. The ash is then removed from the furnace or boiler in the usual manner.

Other objects and advantages of the invention will become apparent from the following description and accompanying drawings. Wherein

FIG. 1 is a schematic view of an installation which may be used in carrying out the process in the present invention.

While it is to be understood that the process of the present invention may be utilized in known types of coal burning equipment, FIG. 1 schematically shows one typical installation. In this installation a furnace or boiler is provided with the usual combustion chamber into which pulverized or powdered coal is injected by a blower **12.** The coal is delivered to the blower from a pulverizer **14** which serves to reduce the coal particles or lumps to the desired pulverized or powdered condition. The pulverizer in turn is fed from hopper **16** which received the fuel from a conveyer **18** extending from a suitable source of supply.

In accordance with the present invention Trona in dry powdered or granulated or sand-like form is added to the coal, preferably prior to the introduction to the combustion chamber. For example, the Trona may be delivered from a suitable source of supply by conveyer means **20** into a hopper **22** from which it may be directed to the coal at any one of a number of locations as indicated by the arrows **24, 26** and **28.** In other words, the Trona may be introduced into the coal at any desired location such as the conveyer **18,** the coal hopper **16** or even the blower **12.** Preferably the Trona is introduced so that it is intimately mixed throughout the coal for the best results, but if the apparatus is such that such intimate mixture cannot be obtained or the coal is burned on a grate rather than in pulverized form, adequate results can be obtained by introducing the Trona as a layer on top of the coal. The Trona combines with the sulphur in the coal to form an ash which falls to the bottom of the combustion chamber along with other ash materials and may be removed by any suitable means such as a conveyer **30.**

In investigating the effect of the addition of Trona on sulphur dioxide emission during the combustion of high sulphur content coals, the following test was conducted. An amount of untreated coal was oxidized as a control reference followed by oxidation of a like amount of coal to which was added the Trona. The same conditions for all experiments were maintained and in these experiments the term oxidation is used to signify the chemical reaction and at no time were the samples observed to be burning with an open flame. The Trona used was acquired from a Texas Gulf Sulphur Company mine in Wyoming.

The untreated coal was first pulverized and sieved to be in the size range of 0.033 inch and 0.066 inch and was dried at 115°C for 1 hour to remove moisture. Two 2.000-gram samples of pulverized coal were weighed. Both were spread uniformly over the bottom of alundum combustion boats 3½ inches long ½ inch wide and 5/16 inch deep. One was oxidized as is. To the second, 0.400 grams of Trona was either spread on top of the coal or mixed with it.

The samples were placed in a horizontal tube furnace with a Vycor combustion tube which contained alundum crucible during a two-hour heating cycle. A thermocouple at the crucible indicated the temperature in the oxidation zone. Each run began with the furnace at ambient temperature. It required about 1 hour to reach 700°C with a final temperature of about 740° C. Air flowing at 1 liter per minute was introduced at one end of the Vycor tube, flowed over the sample and swept the effluent gases into an absorbing tray. Three iced absorbers in a series were used to make certain that all gases were trapped. Each absorber contained 50 ml of H_2O_2. The results of several runs are shown in table 1. From this table it is concluded that the sulphur dioxide emissions were reduced about 10-fold by the use of Trona additive. The manner in which the additive was applied to the coal affected the oxidation characteristics with mixing producing more complete oxidation compared to the layering method.

TABLE 1

SUMMARY — SO_2 EMISSIONS FROM COAL

Oxidation Time, 2 Hrs.
Max Temp., 740°C (1364°F)
Air Flow, 1 liter/min.

Coal Sample	Weight grams	Additive Weight	Position of Additive	SO_2 Weight Grams	SO_2 of Control	%
Southern Illinois	2	None	—	0.0173	—	
Southern Illinois	2	0.40	on top	0.0016	9.3	
East Kentucky	2	none	—	0.0148	—	
East Kentucky	2	0.40	on top	0.0019	12.8	
East Kentucky	2	0.40	mined	0.0013	8.8	

The process of the present invention has been carried out in actual furnace installations and has been found effective to reduce sulphur dioxide emissions without providing any adverse side effects. The Wyoming Trona is preferably used in the condition received from the mine and without refinement. However, it is contemplated that some or substantially all of the inert material may be removed from the Wyoming Trona. While the Trona thus refined will function in the process of the present invention, such refinement increases the cost of the material and thus the process.

As previously indicated, the amount of Trona added during the process should be sufficient to reduce the sulphur dioxide emissions to one percent or less by weight of the flue gases. The quantity of the Trona additive necessary to accomplish this result will vary in accordance with the sulphur and moisture content of the coal. In general, the amount of Trona required increases with the amounts of sulphur and moisture in the coal so that for relatively high sulphur coals of about five percent sulphur, about 15 percent by weight of Trona should be added. On the other hand for relatively dry lower sulphur coals having the sulphur content of about two to three percent by weight, and an amount of Trona equal to about ten percent by weight of the coal should be added to reduce the sulphur dioxide emissions to the desired acceptable level of 1 percent or less.

While the preferred embodiment of the present invention has been shown and described herein, it is obvious that many changes may be made without departing from the spirit of the scope of the appended claims.

The invention is claimed as follows:

1. A process of reducing sulphur dioxide emissions substantially to or beneath a predetermined level when oxidizing coal containing sulphur in a furnace, comprising adding an effective amount of Wyoming Trona to said coal, and causing the Trona to be combined with at least a portion of the sulphur in said coal to provide an ash.

2. A process as defined in claim **1,** comprising the step of adding the Trona in a particulate form to coal particles and mixing the Trona throughout the coal particles.

3. A process as defined in claim **1,** comprising adding the Trona in a particulate form as a layer generally on top of a bed of coal particles.

4. A process of reducing sulphur dioxide emissions to or below a predetermined level when burning coal containing in excess of one percent by weight of sulphur in a furnace, comprising adding an effective amount of Wyoming Trona to particles of said coal to be burned, subjecting the coal and Trona to heat and causing the Trona to combine with at least a portion of the sulphur to form as ash readily separable from gaseous products

of combustion.

5. A process as defined in claim **4,** wherein the coal contains up to about 6 percent by weight of sulphur and Trona is added in amounts up to about 20 percent by weights of the coal.

6. A process, as defined in claim **5** wherein the Trona comprises:

INGREDIENTS	% BY WEIGHT
Silicates	0.21
Aluminum	0.24
Iron Oxide	0.045
Magnesium Oxide	0.23
Potassium	0.03
Chloride	0.02
Soda Ash (Na_2CO_3)	57.65
Inerts	41.575

7. A process, as defined in claim **6,** wherein the Wyoming Trona is at least partially refined prior to being added to the coal by the removal of part or substantially all of the inerts.

8. A process, according to claim **5,** wherein the effective amount of Trona added is sufficient for reducing sulphur dioxide emissions in combustion gases to about 1 percent or less by weight.

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