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METHOD OF BURNING GRANULAR LOW VOLATILE FUELS

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This invention relates to a method of burning fuel and particularly to the method of efficiently burning in a furnace a granular fuel of such coarseness and having such a low volatile content that it is incapable of self-sustaining ignition when suspension firing is employed.

Such a fuel may be the resultant product of certain fluidized processes as for example, the char produced by the fluidized process for low temperature carbonization of coal or the coke produced by the oil cracking process which uses fluidized coke beds. These granular fuels are in general of such a fineness or coarseness that about 60% or less of the fuel will pass through a 50 mesh sieve with the 40% that will not pass through the 50 mesh sieve being passable through a 20 mesh sieve. The char has about 10% volatile matter while the coke has about 4.5% volatile matter with the major constituent of each of these fuels being carbon. Because of the combination of the relatively large size of these granules together with the relatively low volatile matter in these carbonaceous fuels they are incapable of self-sustaining ignition when suspension firing is employed, i. e., when the fuel is injected into the furnace in streams of air and is burned in suspension. It is, however, extremely desirable to be able to efficiently burn these fuels to recover the B. t. u. value thereof by employment of the suspension method of firing which of course gives rise to numerous operating difficulties. The present invention is directed to the accomplishment of this result and circumvention of these difficulties.

The method of this invention, in general, involves simultaneously injecting into a furnace the granular low volatile fuel and a fuel capable of self-sustaining ignition when suspension firing is employed and burning these fuels together in suspension in the furnace with the furnace preferably being of the slagging bottom type and the firing preferably being of the tangential method. Sufficient heat is then extracted from the burning fuel and the combustion gases thus generated so that the temperature of the unburned low volatile fuel portions entrained in the combustion gases are sufficiently low to permit their being passed through a mechanical pulverizer. These unburned fuel portions are separated from the entraining combustion gases and conveyed through a mechanical pulverizer where they are pulverized and reintroduced into the furnace.

It is an object of this invention to provide an improved method for efficiently burning in a furnace a granular fuel of such coarseness and having such a low volatile content that it is incapable of self-sustaining ignition when suspension firing is employed.

The invention will be understood from the following description when considered in combination with the accompanying drawing forming a part thereof and which depicts in diagrammatic form an organization for carrying out the improved method.

In the drawing there is disclosed a steam generator having a furnace 10 of the slagging bottom type and which has its walls lined with steam generating tubes 12.

The furnace is, so called, suspension fired through burners 16, 18 and 20 with these burners projecting the fuel and air into the furnace tangent to an imaginary circle vertically disposed centrally of the furnace and in a manner known in the art as tangential or turbulent tangential firing such as explained in U. S. Patent 2,216,117 to Krug or 2,243,909 to Kruger. The fuel is burned in suspension and the combustion gases generated by this burning fuel pass from the upper end of the furnace through horizontal gas pass 22 and then downward through vertical gas pass 24 from which they pass through outlet 26 into dust collector 28, which may be of any suitable type, with the gases passing upwardly and outwardly of the dust collector to a suitable stack. Molten ash collects in the bottom of the furnace and is continually drawn off through opening 13.

In traversing gas passes 22 and 24 the combustion gases serially pass over superheater 30, economizer 32 and air heater 34, which are interconnected in the system of the steam generator in the usual manner. In traversing these heat exchange devices the temperature of the gases is substantially lowered so that upon passing through outlet 26 and entering dust collector 28 they are approximately 300 to 600° F.

Each of the burners is supplied with combustion supporting air through duct 14 with this air having first been heated by passage through air heater 34. Together with this air, a granular carbonaceous fuel (as the previously mentioned char or coke) which is of such a coarseness and has such a low volatile content that it is incapable of self-sustaining combustion with suspension firing is fired through the burners 18 while a gaseous fuel or other fuel capable of self-sustaining ignition with suspension firing is simultaneously fired through burners 16. The latter fuel burns completely and assists in burning the granular low volatile fuel but because of the coarseness and low volatile content of the granular fuel a relatively high percentage of this fuel, possibly as much as 25%, passes from the furnace unburned and entrained in the combustion gases. A portion of this unburned fuel is collected in hopper 36 at the lower end of gas pass 24 with a vast majority of the remainder being separated from the entraining gases upon their passage through dust collector 28 with the separated fuel being collected in hopper 38 of the dust collector and the combustion gases passing out through the upper end of the dust collector.

If this unburned fuel were reintroduced into the furnace in the condition it is in when it is separated from the entraining gases a very small percentage of it would burn on its second passage through the furnace. The reason for this is that these fuel portions are the very coarse portions of the granular fuel and are therefore the most difficult to burn and moreover after having been passed through the furnace once they have an even lower volatile content than when originally injected into the furnace because of the intense heat within the furnace and are accordingly much more difficult to ignite. Thus, if the material collected in hoppers 36 and 38 were reintroduced directly into the furnace without further processing the result would be a progressive building up of the amount of material thus recirculated resulting in deleteriously eroding the heat exchange surfaces of the steam generator and eventually overloading the system with this recirculated material.

To obviate these difficulties the unburned fuel portions collected in hoppers 36 and 38 are conveyed through conduit 40 to pulverizing mill 42 which may be of any suitable type such as a ball mill, and which receives its carrier gas through duct work 41 with valves 43 controlling the proportion of air and combustion gases that make up this carrier gas with a majority if not all of

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this gas generally being inert combustion gases so as to insure against fires starting in the mill. In passing through mill 42 the material is crushed or pulverized and then supplied through ducts 44 and fan 46 to burners 20 which introduce this crushed fuel into the furnace. By crushing or pulverizing these fuel portions substantially all of this reintroduced fuel will be burned upon its second passage through the furnace thereby eliminating the aforementioned difficulties of eroding the heat exchange surfaces and overloading the system.

When burning the coke produced by the aforementioned oil cracking process, by introducing this granular coke in its original form directly into the furnace and then passing through the pulverizer 42 only that percentage, which may be as much as 25%, which does not burn in its initial passage through the furnace and is collected in hoppers 36 and 38, it is necessary to pulverize only a very small percentage of this coke and since this material is very difficult to pulverize a considerable saving is effected.

When the char produced by the previously mentioned process for the low temperature carbonization of coal is fired into furnace 10, it is desirable since this char has a temperature of approximately 900°, to convey the same directly into the furnace 10 and not through a pulverizer, since a pulverizer could not withstand such a high temperature and it would therefore be necessary to substantially reduce the temperature of this char before it could be passed through a pulverizer. However, with the method of this invention the unburned portions of the char collected in hoppers 38 and 36 have a much lower temperature than that of the originally introduced char because of the heat absorbed by the various heat exchange surfaces of the steam generator and therefore not only is it necessary to pulverize only a small percentage of the char but the sensible heat contained in the originally introduced char is recovered and it is unnecessary to have special means for reducing the temperature of this char in order to pulverize it.

By tangentially firing furnace 10 and employing a slagging bottom type of furnace the temperatures within the furnace are higher than would be the case if a less turbulent firing method were used or if a dry bottom type of construction were used with this additional temperature being of substantial aid in effecting combustion of the rather coarse low volatile fuel.

It is thus apparent that with the method of this invention a high operating efficiency is achieved in the burning in suspension of a relatively coarse granular fuel of low volatile content in a most expeditious and practical manner.

What I claim is:

1. The method of burning in suspension in a furnace a granular carbonaceous fuel that is of such coarseness and has such a low percentage of volatile matter that it is incapable of self-sustaining ignition when suspension firing is employed, comprising injecting and burning in suspension in said furnace a fuel capable of self-sustaining ignition, simultaneously injecting the low volatile fuel into the furnace in such intimate relation to said burning fuel as to cause ignition and burning in suspension of a portion of the same therewithin, collecting the unburned low volatile fuel portions that pass from the furnace entrained in the combustion gases, pulverizing the fuel portions thus collected and reintroducing the thus pulverized fuel into the furnace generally at the location of the burning fuel and burning the same in suspension therewithin.

2. The method of burning in suspension in a furnace a granular carbonaceous fuel that is of such coarseness and has such a low percentage of volatile matter that it is incapable of self-sustaining ignition when suspension firing is employed, comprising firing said furnace in the turbulent tangential manner simultaneously using said

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low volatile fuel and a fuel capable of self-sustaining ignition with such firing with these fuels being in intimate relation with each other in the furnace, completely burning the latter fuel but burning only a portion of the low volatile fuel, collecting the unburned low volatile fuel portions that pass from the furnace entrained in combustion gases, pulverizing the fuel portions thus collected and reintroducing the thus pulverized fuel into the furnace generally at the location of the burning fuel and burning the same in suspension therewithin.

3. The method of burning in suspension in a slagging bottom furnace a granular carbonaceous fuel that is of such coarseness and has such a low percentage of volatile matter that it is incapable of self-sustaining ignition when suspension firing is employed, comprising firing said furnace in the turbulent tangential manner simultaneously using said low volatile fuel and a fuel capable of self-sustaining ignition with such firing with these fuels being in intimate relation with each other in the furnace, completely burning the latter fuel but burning only a portion of the low volatile fuel, collecting the unburned low volatile fuel portions that pass from the furnace entrained in the combustion gases, pulverizing the fuel portions thus collected, and reintroducing the thus pulverized fuel into the furnace generally at the location of the burning fuel and burning the same in suspension therewithin.

4. The method of burning in suspension in a slagging bottom furnace a granular carbonaceous fuel that is of such coarseness and has such a low percentage of volatile matter that it is incapable of self-sustaining ignition when suspension firing is employed, comprising injecting a fuel capable of self-sustaining ignition and air into said furnace tangent to an imaginary centrally disposed longitudinally extending cylinder and burning this fuel within the furnace, simultaneously injecting said low volatile fuel into the furnace tangentially of said cylinder and in such intimate relation to said burning fuel as to cause ignition and burning of a portion of the same therewithin, collecting the unburned low volatile fuel portions that pass from the furnace entrained in combustion gases, pulverizing the fuel portions thus collected, and reintroducing the thus pulverized fuel into the furnace generally at the location of the burning fuel and burning the same in suspension therewithin.

5. The method of burning in suspension in a furnace a granular carbonaceous fuel that is of such coarseness and has such a low percentage of volatile matter that it is incapable of self-sustaining ignition when suspension firing is employed, comprising injecting and burning in said furnace a fuel capable of self-sustaining ignition, simultaneously injecting the low volatile fuel into the furnace in such intimate relation to said burning fuel as to cause ignition and burning in suspension of a portion of the same therewithin, extracting sufficient heat from the burning fuel and the combustion gases thus generated so that the temperature of the unburned low volatile fuel portion entrained in the combustion gases are sufficiently low to permit their being passed through a mechanical pulverizer thereafter separating said unburned low volatile fuel portions from said entraining gas, conveying said separated portions through a mechanical pulverizer and pulverizing the same therein, and introducing the thus crushed fuel into the furnace generally at the location of the burning fuel and burning the same in suspension therewithin.

6. The method of burning in suspension in a furnace a granular carbonaceous fuel that is of such coarseness and has such a low percentage of volatile matter that it is incapable of self-sustaining ignition when suspension firing is employed, comprising injecting and burning in suspension in said furnace a fuel capable of self-sustaining ignition, simultaneously injecting the low volatile fuel into the furnace in such intimate relation to said burning fuel as to cause ignition and burning in suspen-

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sion of a portion of the same therewithin, reducing the temperature of the unburned low volatile fuel portions that pass from the furnace entrained in the combustion gases to below 700° F., thereafter collecting the unburned low volatile fuel portions that pass from the furnace entrained in the combustion gases, crushing the fuel portions thus collected and reintroducing the thus crushed fuel into the furnace generally at the location of the burning fuel and burning the same in suspension therewithin.

7. The method of burning in suspension in a furnace a granular carbonaceous fuel that is of such coarseness and has such a low percentage of volatile matter that it is incapable of self-sustaining ignition when suspension firing is employed comprising tangentially firing said furnace with a fuel capable of self-sustaining combustion and burning said fuel therewithin, simultaneously tangentially firing said furnace with the low volatile fuel in such intimate relation with said burning fuel as to cause ignition and burning of a portion of the same therewithin, utilizing a sufficient amount of the heat evolved by burning the fuel to generate and heat steam so as to reduce the temperature of the unburned low volatile fuel portions entrained in the combustion gases to a point to permit their being passed through a mechanical pulverizer, separating said unburned fuel portions from the combustion gases, conveying said separated portions through a mechanical pulverizer and pulverizing the same therein, and introducing the thus pulverized fuel into the furnace generally at the location of the burning fuel and burning the same in suspension therewithin.

8. The method of burning in suspension in a slagging bottom furnace a granular carbonaceous fuel that is of such coarseness and has such a low percentage of volatile matter that it is incapable of self-sustaining ignition when suspension firing is employed comprising tangentially firing said furnace with a fuel capable of self-sustaining combustion and burning said fuel therewithin, simultaneously tangentially firing said furnace with the low volatile fuel in such intimate relation with said burning fuel as to cause ignition and burning of a portion of the same therewithin, utilizing a sufficient amount of the heat evolved by burning the fuel to generate and heat steam so as to reduce the temperature of the unburned low volatile fuel portions entrained in the combustion gases to a point to permit their being passed through a mechani-

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cal pulverizer and pulverizing the same therein, and introducing the thus pulverized fuel into the furnace generally at the location of the burning fuel and burning the same in suspension therewithin.

9. The method of burning in suspension a granular fuel of a particle size such that about 60% will pass through a 50 mesh sieve with the 40% that will not pass through the 50 mesh sieve being passable through a 20 mesh sieve and being not more than about 10% volatile matter with the major portion of the fuel being carbon and with this fuel being incapable of self-sustaining combustion when suspension firing is employed, comprising injecting a fuel capable of self-sustaining ignition with suspension firing together with air into a slagging bottom furnace and tangent to an imaginary centrally disposed longitudinally extending cylinder and burning this fuel in suspension within the furnace, simultaneously injecting said granular fuel into the furnace tangentially of said cylinder and in such intimate relation to said burning fuel as to cause ignition and burning in suspension of a portion of the same with the remainder, comprising a substantial portion, passing from the furnace entrained in the combustion gases and unburned, flowing these gases over heat absorbing surface and imparting heat thereto to reduce the temperature of the gases and the material entrained therein to a sufficiently low temperature to permit the material to be introduced into a mechanical pulverizer, thereafter separating said entrained unburned fuel portions from said gases, conveying said separated portions through a mechanical pulverizer and pulverizing the same therein, and introducing the thus pulverized fuel into the furnace generally at the location of the burning fuel and burning the same in suspension therewithin.

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