METHOD AND DEVICE FOR PRESSURE SPRAYING AND BURNING A COAL DUST-WATER MIXTURE

ABSTRACT: Method of pressure spraying and burning a coal dust-water mixture includes heating the coal dust and the water contained in the mixture, prior to discharging the same from a nozzle at a pressure of several atmospheres excess pressure, to a temperature that is just below the water-vaporizing temperature corresponding to the pressure produced upstream of the nozzle so that the water is pressure-relieved and vaporizes directly after passing through the nozzle; and device for carrying out the method.
METHOD AND DEVICE FOR PRESSURE SPRAYING AND BURNING A COAL DUST-WATER MIXTURE

Our invention relates to method and device for pressure spraying and burning a coal dust-water mixture. To increase the efficiency of coal mining and the utilization or exploration of coal, experiments are being carried out in numerous lands for directly burning mixtures of coal dust and water in power plants. The mixture generally contains 60 percent coal dust and 40 percent water. It is possible to mine coal containing inclined seams directly by the use of water. In addition, the coal dust accumulating with the washing of the coal from the seams can be still further used; finally, with such a mixture, the direct transport of coal dust through pipelines is possible.

The construction of the burner for such a mixture presents great difficulty, however. Herefore, tests have been conducted with high-pressure rotary sprayers or spray nozzles, such as are conventional for oil burners. Such burners exhibit considerable wear and tear, however, so that the operational life thereof is very short. Moreover, adequate spraying of the mixture, which is critical for proper combustion, cannot be achieved with the tested burners.

It is accordingly an object of our invention to provide method and device for pressure spraying and burning coal dust-water mixtures which avoids the aforementioned disadvantages of the heretofore known methods and devices of this general type and which moreover, assures the attainment of highly efficient dispersal or atomization of the mixture.

With the foregoing and other objects in view, we provide method of pressure spraying and burning a coal dust-water mixture which comprises heating the coal dust and the water contained in the mixture, prior to discharging the same from a nozzle at a pressure of several atmospheres excess pressure, to a temperature lying just below the water vaporizing temperature corresponding to the pressure produced upstream of the nozzle so that the water is pressure-relieved and vaporized directly after passing through the nozzle.

By this method of our invention, wherein no additional water is required for spraying the mixture, the mixture supplied under pressure is heated to a temperature at which the water actually does not vaporize. Only directly after the water leaves the nozzle is it abruptly pressure-relieved and vaporized. High turbulence is simultaneously achieved thereby.

In order to prevent premature vaporization of the water in the nozzle, the latter must be kept very short, because the coal dust would otherwise no longer be capable of flowing and the nozzle would become clogged.

The device for carrying out the method of our invention comprises a supply line for the coal dust-water mixture, means for heating the supply line, and orifice means having an axial bore located at the outlet end of the supply line.

In accordance with a further feature of the device of our invention, the nozzle proper is formed of a supply line for a coal dust-water mixture, and a plate closing the supply line at the outlet end thereof, a portion of the supply line adjacent the plate being formed with radial bores. The coal dust-water mixture is thereby blown radially out of the nozzle.

In accordance with an added feature of the device of our invention, we provide means built into the supply line upstream of the plate to retard thereof for producing a swirl in the flow of the coal dust-water mixture so as to increase the turbulence thereof.

Other features which are considered as characteristic for the invention are set forth in the appended claims.

Although the invention is illustrated and described herein as embodied in method and device for pressure spraying and burning a coal dust-water mixture, it is nevertheless not intended to be limited to the details shown, since various modifications and structural changes may be made therein without departing from the spirit of the invention and within the scope and range of equivalents of the claims.

The construction and method of operation of the invention, however, together with additional objects and advantages thereof will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

FIG. 1 is a schematic view of a novel system for carrying out the method of our invention;

FIGS. 2 and 3 are fragmentary schematic views of the system of FIG. 1 showing respective modifications therein;

FIG. 4 is a longitudinal sectional view of a burner nozzle with an axial bore forming part of the systems of FIGS. 1 to 3;

FIG. 5 is a view corresponding to that of FIG. 4 showing a modified burner nozzle with radial bores;

FIG. 6a, is another view corresponding to those of FIGS. 4 and 5 showing a flow twisting member received in the burner nozzle; and

FIG. 6b, is a cross sectional view of FIG. 6a, taken along the line VI-VI'B in the direction of the arrows.

Before describing the figures, it should be noted that generally the coal dust-water mixture is delivered directly from the mine or a central storage depot to the respective power plant.

Referring now to the drawings and first particularly to FIG. 1 thereof, there is shown a system in a power plant wherein the coal dust-water mixture 3 is accumulated in a funnel-shaped supply vessel 1 from which it is to be supplied to the burners of a power plant upon demand. The supply vessel 1 is advantageously provided with a stirring or agitating mechanism 2 by means of which the mixture is stirred either continuously or at specific time intervals in order to prevent settling of the coal dust. The coal dust-water mixture 3 is withdrawn from the lower end of the supply vessel 1, as shown in FIG. 1, through transport line 4. A pump 5 connected in the transport line 4 provides the mixture with the required transporting and injection pressure. Behind or down stream of pump 5 there is connected in the transport line 4 an adjustable valve 6 for additionally controlling the flow throughput or flow rate of the mixture. In order to be able to operate the pump 5 with constant rotary speed in the most suitable range of capacity, it is advantageous to connect to the transport line 4 between the pump 5 and the valve 6, a return line 7 leading back to the supply vessel 1, an adjustable valve 8 being connected in the return line 7. Excess coal dust-water mixture, which is not further conducted through the valve 6, can thereby be returned to the supply vessel 1.

After passing through the valve 6, the coal dust-water mixture 3 is then preheated in a heat exchanger 9 heated generally with superheated steam. Suitable inlet and outlet lines 10 and 11 are connected to the heat exchanger for circulating the required superheated steam therethrough. After leaving the heat exchanger 9, the coal dust-water mixture is then conducted to a fuel nozzle 12 properly wherein it is heated in the embodiment of FIG. 1 by superheated steam passing through a heating tube 13, to a temperature which is not quite as high as the evaporating temperature of the water of the mixture corresponding to the respective pressure thereof. An inlet 14 and outlet 15 are connected to the heating tube 13 for circulating the superheated steam therethrough. A manometer 14 is connected to the transport line 4 behind or down stream of the heating tube 13 for monitoring the pressure of the coal gas-water mixture heated in the heating tube 13. The heated mixture then flows through an opening at the end of the nozzle 12 into a combustion chamber defined by walls 17. After discharging from the nozzle 12, the water contained in the mixture abruptly expands due to the sudden reduction in pressure. The volume increase accompanying the partial vaporization of the water causes the discharging liquid jet to be broken apart and to be very finely atomized or comminuted.

In the fragmentary modified structure of the system of FIG. 1 shown in FIG. 2, the coal dust-water mixture downstream of the heat exchanger 9 is heated in a nozzle 12 by a suitable electric heating device surrounding the nozzle 12. A temperature sensing or measuring device 19 located downstream of the electric heater 18 controls a regulated voltage source 20 providing energy to the heater 18.
In the modification of FIG. 3, the final heating of the coal dust-water mixture is effected by superheated steam in a heating tube 13 as in the embodiment of FIG. 1. However, in the modification of FIG. 3, the preheating of the mixture is not carried out in a separate heat exchanger such as in the embodiment of FIGS. 1 and 2, but rather the transport line 4 is passed over a heating surface 21 disposed in the boiler or combustion chamber 28 so that the coal dust-water mixture is preheated directly by the flue gases. A special embodiment of the burner of the invention is shown in FIG. 4 similar to that of FIG. 2 wherein the nozzle 12 is heated by an electric heater 18. The coal dust-water mixture 3 is heated in the nozzle 12 of FIG. 4 to a temperature which is not quite as high as the evaporating temperature of the water of the mixture corresponding to the respective pressure of the mixture in the nozzle 12. A nozzle tube 12 is closed at its outlet end by a plate 22 having an axial bore 23 formed therein. After passing through this bore or orifice 23, the water entrained in the mixture expands due to the abrupt pressure release that the discharging liquid jet is torn apart and very finely comminuted.

It is essential that the coal dust-water mixture be pressure-relieved only after it has been discharged from the nozzle 12. Evaporation and consequent drying of the coal dust-water mixture in the bore or orifice 23 proper of the nozzle is thereby prevented. For this reason the length of the bore must be kept very short. Due to the high heat of vaporization which is produced, the coal dust particles are moreover warmer than the surrounding atmosphere after the mixture has been pressure-relieved and expanded so that any water droplets clinging to the surface of the respective coal dust particles are largely evaporated afterwards. Desirable prerequisites for the ignition of the coal dust is thereby imparted thereto.

In the embodiment of FIG. 5 the burner nozzle 12 is heated by superheated steam as in the embodiments of FIGS. 1 and 3. In general, the superheated steam is conducted in counterflow through an inlet line 14 into the heating tube 13 proper and is discharged therethrough from an outlet line 15. According to the embodiment of FIG. 5, the nozzle tube 12 is closed at the end thereof by a face plate 24. However, radial bores 25 are formed in the nozzle tube 12 adjacent the face plate 24 so that the coal dust-water mixture is blown laterally or transversely out of the nozzle 12. In FIGS. 6a and 6b there is shown a burner nozzle corresponding substantially to that of FIG. 5 wherein an additional device is received for imparting a twisting motion to the flow of coal dust-water mixture through the nozzle. The twisting device is spaced from the radial bores 25 and is formed of inclined guide vanes 26 extending from an axially oriented flow body 27 to the inner wall surface of the nozzle 12. By this twisting action, the coal dust-water mixture is set in rotation so that it can be discharged more readily from the radial nozzle openings 25.

By means of the method and the nozzles of our invention it is possible in a relatively simple manner to comminute a coal dust-water mixture suspension without any difficulty and thereafter to reliably burn it. Care must always be taken however that the water of the mixture does not vaporize in the supply line because this line would otherwise immediately become clogged. This can be controlled and regulated with suitable measuring devices. Furthermore, it is unnecessary to spray additional water or compressed air into the mixture to effect comminution thereof, but rather only the water required in the mixture for maintaining the flow capability of the coal dust is used.

We claim:

1. Method of pressure spraying and burning a coal dust-water mixture which comprises heating the coal dust and the water contained in the mixture, prior to discharging the same from a nozzle at a pressure of several atmospheres excess pressure, to a temperature that is just below the water-vaporizing temperature corresponding to the pressure produced upstream of the nozzle, so that the water is pressure-relieved and vaporizes directly after passing through the nozzle.

2. Device for pressure spraying and burning a coal dust-water mixture comprising a supply line for the coal dust-water mixture, means for heating said supply line to a temperature just below vaporizing temperature of the water in said supply line, and orifice means at an end of said supply line for discharging the coal dust-water mixture in a spray.

3. Device according to claim 2 wherein said orifice means comprises a plate closing said end of said supply line, said plate being formed with an axial bore.

4. Device according to claim 2 wherein said end of said supply line is closed by a plate and said orifice means comprises an end portion of said supply line located adjacent said plate and formed with at least one radial bore.

5. Device according to claim 2 including a flow-twisting device received in said supply line upstream of said orifice means.

6. System of pressure spraying and burning a coal dust-water mixture comprising coal dust-water mixture supply means, a supply line connecting said supply means to a combustion chamber, pump means disposed in said supply line for pressurizing the mixture therein, means for heating the mixture in the supply line to a temperature just below the vaporizing temperature of water at the prevailing pressure of the mixture in the supply line, and orifice means at the downstream end of said supply for discharging the mixture in pressure-relieved and vaporized form into said combustion chamber.

7. System according to claim 6 including a return line branching off from said supply line at a location downstream of said pump for returning excess mixture to said supply means.

8. System according to claim 6 wherein said heating means comprises a heat exchanger traversable by superheated steam.

9. System according to claim 6 wherein said heating means comprises an electric heater located adjacent said supply line.

10. System according to claim 6 wherein a length of said supply line upstream of said heating means extends into said combustion chamber for preheating the mixture passing through said length.