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(19)

(54) A PROCESS FOR THE PREPARATION OF WATER-IN-OIL EMULSION CONTAINING FINELY-DIVIDED COAL

(71) We, CONVAIR INVESTMENTS LIMITED, a body corporate organized and existing under the laws of The Bahamas, of Sassoon House; Nassau, The Bahamas do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:

This invention relates to a process for the preparation of a water-in-oil emulsion containing finely-divided coal.

In the Complete Specification of our United Kingdom specification No. 1,496,373 to which the present Application is one for a Patent of Addition, there is described and claimed a process for the production of a water-in-oil emulsion containing finely-divided coal, which process comprises mixing finely-divided coal having an average particle size of less than 100 μ with water so as to form a slurry, adding a water-immiscible oil to the slurry and agitating the resultant mixture with vibrations having an intensity of at least 11.625 watts cm^{-2}, thereby producing a water-in-oil emulsion containing finely divided coal. To produce the finely-divided coal used in the process, it is necessary to grind the coal beforehand and this prevents some coals having a high water content being used in the process because these coals cannot be ground satisfactorily to a powder suitable for use in the process; attempts at grinding produce only a sticky paste. To use such coals in invert emulsions it has hitherto been necessary to use large quantities of energy to reduce the water content of the coal before grinding.

It has now been discovered that a water-in-oil emulsion containing finely-divided coal may be produced from coals of high water content by a modification of the process disclosed in the aforementioned U.K. Specification No. 1,496,373.

Accordingly, the invention provides a process for the production of a combustible water-in-oil emulsion containing finely-divided coal, in which process a water-containing coal is ground and in which process a water-immiscible oil and the coal, and if necessary water are mixed, so as to produce a mixture of finely-divided coal, oil and water, and in which the mixture of finely-divided coal, oil and water is thereafter subjected to agitation with vibrations having an intensity of at least 11.625 watts cm^{-2}, and sufficient to cause cavitation, thereby producing a combustible water-in-oil emulsion containing finely-divided coal.

It should be understood that the water in the coal used in the process of the invention may be chemically or physically bound within the coal so that the coal may appear dry to the touch.

In the process of the invention, the oil may be added to the water-containing coal before and/or during and/or after the grinding of the coal. For example, a mixture of oil and coal may be ground to produce an intimate coal/water/oil mixture, or the coal may be ground alone to a paste and the oil thereafter added; provided that the coal contains sufficient water (see below), the resultant paste/oil mixture will emulsify in a satisfactory manner under the high intensity agitation later used. In many cases, it may be advantageous to add part of the oil to the coal before grinding and the remainder of the oil after grinding.

Some coals containing a high proportion of water, for example 40 to 50% by weight will emulsify properly without any additional water. In some cases, however, where the water content of the coal is lower (for example 10 to 15% by weight) it is necessary to add some additional water to the coal before and/or during and/or after grinding in order to produce a coal/oil/water mixture which will emulsify properly on agitation.

The amounts of water added will, of course, be smaller than the amounts added to the coal slurried in the process described in the aforementioned United Kingdom specification No. 1,496,373, and the necessary amounts of water can easily be determined by empirical tests.

The emulsification step in the process of the present invention is conducted in exactly the same manner as in the process disclosed in the aforementioned specification No. 1,496,373. Thus, preferably the agitation used is sonic vibrations, the preferred sonic vibrations having a frequency of 15,000 to 30,000 Hz, and thus being either high frequency sonic vibrations of 15,000 to 20,000 Hz or ultrasonic vibrations of 20,000 to 30,000 Hz (throughout this specification the generic term "sonic" is used to cover both audible and ultrasonic frequencies). The efficacy of the agitation in emulsifying the water in the oil depends upon strong cavitation and is thus dependent upon the intensity of the vibrations and not on the total power of their source. The intensity must be at least 11.625 watts cm^{-2} and is desirably within the range of from 38.75 to 54.25 watts cm^{-2}. While there is a definite lower limit for sonic intensity below which satisfactory emulsions will not be produced, there is no sharp upper limit. However, there is no significant improvement at intensities above 54.25 watts cm^{-2} and higher intensities add to the cost of producing the emulsion. In other words, the preferred upper limit is not a sharp physical limit but is dictated by economic considerations. A discussion of apparatus for producing such sonic vibrations is given in the aforementioned Specification No. 1,496,373. If non-sonic vibrations are used, they may conveniently be produced by relative motion between a liquid and a solid surface.

If the amount of oil added to the coal in the process of the invention is greater than that required to form the emulsion, the excess oil may form an oil phase separate from the emulsion, and if desired this oil phase may be separated before the emulsion is used.

The process of the invention is preferably conducted in such a manner that the majority of water droplets in the resulting emulsion have a diameter in the range of from 2μ to 20μ since, as described in the aforementioned Specification No. 1,496,373 such an emulsion, upon atomisation, burns with a flame which is clear and which does not have the appearance of a flame from pulverised coal.

As in the process described in the aforementioned Specification No. 1,496,373, so also in the process of the present invention, if the coal and/or oil used contain(s) sulphur, there is preferably introduced into the coal and/or into the oil and/or into the coal/oil mixture prior to agitation thereof, an alkaline reagent. This alkaline reagent is conveniently introduced in the form of a slurry. The alkaline reagent is desirably limestone or lime and is desirably present in excess of the stoichiometric amount required to react with the sulphur in the coal and/or oil. Preferably, the alkaline reagent is present in at least 50% excess of that required to react with the sulphur in the coal and/or oil, and most desirably is present in at least twice the stoichiometric amount.

Naturally, the invention extends to a water-in-oil emulsion produced by the process of the invention. The invention also provides a method of burning sulphur-containing coal and/or sulphur-containing oil, which method comprises subjecting the coal and/or oil to a process of the invention in which an alkaline reagent is introduced into the coal and/or into the oil and/or into the coal/oil mixture prior to agitation thereof, and thereafter burning the resultant emulsion. Preferable, the method further includes separating, from the combustion gases, the alkali sulphate produced.

A preferred embodiment of the invention will now be described, though by way of illustration only, with reference to the Figure of the accompanying drawings, which is a flow sheet for a plant carrying out the process of the invention.

In the preferred process of the invention, coal containing substantially 30% by weight of water and oil were fed to a grinder 1 in the proportion of three parts by weight of coal for each part by weight of oil. The coal/oil mixture emerging from the grinder 1 was then further mixed in a premixer 2 with oil and a lime slurry, one part by weight of oil being added for each four parts by weight of coal/oil mixture (thus, overall, two parts by weight of oil are used for each three parts by weight of coal). The amount of lime slurry added was sufficient to supply twice the amount of lime stoichiometrically equivalent to the sulphur in the coal and oil, and the proportions of the three components entering the premixer 2 were controlled by three controllers 3.

From the premixer 2, the coal/oil/lime mixture (which of course contained water droplets derived from the water in the coal) was passed to an ultrasonic reactor 4 which was precisely similar to that illustrated in Figure 4 of the drawings accompanying Specification No. 1,496,373 the intensity of agitation employed lay in the range of from 38.75 to 54.25 watts cm^{-2} and the frequency in the range of from 20,000 to 22,000 Hz.

The emulsion leaving the ultrasonic reactor 4 flowed into a separator 5 provided with a weir 6. This weir 6 permitted some supernatant oil to flow into a compartment 7

from which a recycling line 8 recycled it to the premixer 2.

The coal/water/oil/lime emulsion emerging from the separator 5 was passed into an ultrasonic atomiser 9 and the atomised emulsion burned in a combustion chamber 10. The combustion gases were passed through an electrostatic precipitator 11 which removed finely divided calcium sulphate. The cleaned combustion gas was then vented to the atmosphere.

Combustion of the emulsion in the combustion chamber 10 produced a clear flame which did not have the appearance of a flame from pulverised coal. Combustion was complete.

We make no claim herein to any process claimed in Patent No. 1,496,373. Subject to the foregoing disclaimer

WHAT WE CLAIM IS:-

1. A process for the production of a combustible water-in-oil emulsion containing finely-divided coal, in which process a water-containing coal is ground and in which process a water-immiscible oil and the coal, and if necessary water are mixed, so as to produce a mixture of finely-divided coal, oil and water, and in which the mixture of finely-divided coal, oil and water is thereafter subjected to agitation with vibrations having an intensity of at least 11.625 watts cm^{-2}, and sufficient to cause cavitation, thereby producing a combustible water-in-oil emulsion containing finely-divided coal.

2. A process as claimed in claim 1, in which, before agitation, water is added to the coal and/or coal/oil mixture.

3. A process as claimed in claim 1 or 2, in which the vibrations are sonic vibrations.

4. A process as claimed in claim 3, in which the vibrations have a frequency in the range of from 15,000 to 30,000 Hz.

5. A process as claimed in any of the preceding claims, in which the vibrations have an intensity of from 38.75 to 54.25 watts cm^{-2}.

6. A process as claimed in any of the preceding claims, in which the amount of oil added to the coal is in excess of that required to form the emulsion and after agitation the excess oil forms an oil phase separate from the emulsion.

7. A process as claimed in claim 6, in which the oil phase is thereafter separated from the emulsion.

8. A process as claimed in any of the preceding claims in which, before the coal is ground, water is added thereto.

9. A process as claimed in claim 1 or 2, in which the vibrations are non-sonic and are produced by relative motion between a liquid and a solid surface.

10. A process as claimed in any of the preceding claims, in which the majority of water droplets in the resulting emulsion have a diameter in the range of from 2μ to 20μ.

11. A process as claimed in any of the preceding claims, in which the coal and/or oil contains sulphur and in which there is introduced into the coal and/or into the oil and/or into the mixture thereof, prior to agitation, an alkaline reagent.

12. A process as claimed in claim 11, in which the alkaline reagent is introduced in the form of a slurry.

13. A process as claimed in claim 11 or 12, in which the alkaline reagent is limestone or lime.

14. A process as claimed in any of claims 11 to 13 in which the alkaline reagent is present in excess of the stoichiometric amount required to react with the sulphur in the coal and/or oil.

15. A process as claimed in claim 14, in which the alkaline reagent is present in at least 50% excess.

16. A process as claimed in claim 15, in which the alkaline reagent is present in at least twice the stoichiometric amount.

17. A process for the production of a water-in-oil emulsion containing finely-divided coal, substantially as herein described with reference to and as illustrated in the accompanying drawings.

18. A combustible water-in-oil emulsion containing finely-divided coal, produced by a process as claimed in any of the preceding claims.

19. A method of burning sulphur-containing coal and/or sulphur-containing oil, which method comprises subjecting the coal and/or oil to the process claimed in any of the claims 11 to 16 and thereafter burning the resultant emulsion.

20. A method as claimed in claim 19, in which the alkali sulphate produced is thereafter separated from the combustion gases.

21. A method according to claim 11 of burning sulphur-containing coal and/or sulphur-containing oil substantially as herein described with reference to the accompanying drawings.

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1596682 COMPLETE SPECIFICATION
1 SHEET *This drawing is a reproduction of the Original on a reduced scale*