(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 223 573**
A2

(12) # EUROPEAN PATENT APPLICATION

(21) Application number: **86308894.4**

(51) Int. Cl.[4]: **F 23 K 1/02**

(22) Date of filing: **14.11.86**

(30) Priority: **16.11.85 JP 256900/85**

(43) Date of publication of application:
27.05.87 Bulletin 87/22

(84) Designated Contracting States: **DE IT SE**

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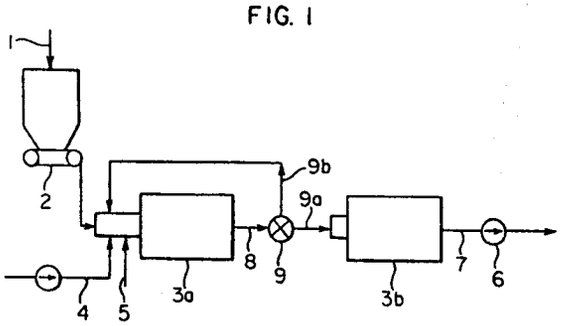
(54) **Method of preparing fine-particle high-loaded coal-water slurry and equipment for preparing the same.**

(57) A method of preparing fine-particle high loaded coal-water slurry and equipment for preparing the same. Slurry flowing out from a first stage mill is supplied to a second stage mill so as to be ground therein after almost all coarse particles have been substantially removed therefrom.

FIG. 1



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Description

METHOD OF PREPARING FINE-PARTICLE HIGH-LOADED COAL-WATER SLURRY AND EQUIPMENT FOR PREPARING THE SAME

DETAILED DESCRIPTION OF THE INVENTION:

[Field of the invention]

The present invention relates to a method of preparing fine-particle high-loaded coal-water slurry which contains extremely small amount of coarse particles and equipment for preparing the same.

[Description of the Prior Art]

High-loaded coal-water slurry is a fluid mixture of solid coal suspended in water, which is prepared in order not only to facilitate the transportation and storage thereof but also to allow the direct combustion thereof to be performed like oil. Further, since this fluidification of coal makes it possible to incorporate an ash removing process into the preparing procedure, fuel having low ash and sulfur concentration can be obtained.

As methods of preparing this high-loaded coal-water slurry, a wet method, a dry method, a method which is a combination of wet and dry methods, etc. are known. The wet method includes such methods as a method and a lower coal concentration higher coal concentration method.

In the higher coal concentration method, wet grinding is conducted by utilizing a ball mill or the like while supplying crushed coal, water, and a dispersion agent comprising surfactant, thereby producing high-loaded coal-water slurry having the coal content of not less than 60% by weight. If required, a stabilization agent may also be added.

When high-loaded coal-water slurry is burnt in combustion equipment such as a boiler, the required combustion period is determined in accordance with the coal fuel ratio, the ash content, the particle size of the coal, the oxygen concentration, the combustion temperature, etc. Therefore, when the period during which the slurry stays within the combustion equipment is insufficient to allow for the required combustion period, the combustion residue comprising fly ash, etc. which is discharged together with the combustion gases will contain unburnt carbon, thus resulting in a calorific loss. In addition, when the air ration is reduced and the combustion temperature is also lowered to a certain extent with the intention of reducing the generation of NOx in the exhaust gases as a result of the combustion, the combustion period will have to be increased.

In particular, when burning high-loaded coal-water slurry containing relatively large amount of coarse particles, an increase in the amount of unburnt carbon in the residue comprising fly ash etc., or the emission of NOx due to an increase in the air ratio, are noticeable consequences.

Accordingly, the method of preparing high-loaded coal-water slurry and equipment for preparing the same are required to be capable of preparing high loaded coal-water slurry in which coarse particles are minimized.

It is also required that this method is economically feasible.

Fig. 3 shows a conventional method of preparing fine-particle high-loaded coal-water slurry and conventional equipment for preparing the same. In Fig. 3, coal 1, which has been crushed previously, is supplied by a weighing feeder to a mill 3, for example a ball mill, together with water 4 and dispersion agent 5. The coal 1 is then ground and mixed into slurry within the mill 3 and flows out as fine-particle high loaded coal-water slurry 7, which is then transferred by means of a pump 6. The mill 3 has a length which is large compared to its diameter, the ratio of the length to the diameter being usually 4 to 8. The ratio of the length to the diameter of a mill employed in an ordinary method of preparing high-loaded coal-water slurry and ordinary equipment for preparing the same is 2 to 3. Increasing the ratio of length to diameter of the same makes it possible to increase the residence time of the coal-water mixture in the mill, thus promoting the grinding operation performed by the grinding medium, and thereby producing fine-particle high loaded coal-water slurry with fine particles.

Fig. 4 shows another conventional method of preparing fine-particle high loaded coal-water slurry and another type of conventional equipment for preparing the same. In Fig. 4, reference numbers 3a, 3b and 9 respectively designate the first mill, the second mill, and a classifier. Reference numbers 1, 2, 4, and 5 respectively designate elements corresponding to those shown in Fig. 3. Slurry 8 from the first mill 3a is classified by the classifier 9, and most of the slurry 8 is made to flow as a lower flow 9a, while an upper flow 9b formed by the remaining part of the slurry is led to the second mill 3b wherein it is ground to form slurry 10. If required, ash in these parts of the slurry is removed by the coal cleaning device 11. Reference number 12 designates tailings. The slurry 9a and the slurry 10 thus introduced into a coal cleaning device 11 are low coal concentration slurry, each having a coal content of not more than 30% by weight.

Slurry 13 from the coal cleaner 11 is introduced into a dehydrating device 14 which removes water 15 therefrom, and the resulting slurry is made into cake having a coal content of not less than 60% by weight. Subsequently, the cake is made into a fluid in a device 16. In this way, fine-particle high-loaded coal-water slurry 7 is produced and is transferred by means of the pump 6.

However, both of the above conventional methods of preparing fine-particle high loaded coal-water slurry and equipment for preparing the same are not satisfactory in terms of simplicity in process and equipment, and reduction of coarse particles. To be specific, when use is made of a long mill which is so dimensioned that the

ratio of length to diameter thereof is 4 to 8, fine-particle high loaded coal-water slurry may be prepared by its promoted grinding operation. With this arrangement, however, part of insufficiently ground coal are discharged from the mill before being subjected to an adequate amount of grinding action, thus resulting in the production of a slurry in which coarse particles still remain, even though it is relatively reduced compared to that of a shorter mill. Particularly in the preparing procedure of high loaded coal-water slurry having a coal content of not less than 60% by weight, this (coarse particles remaining) problem is aggravated, since the viscosity of the mixture rises as the grinding process proceeds.

In another conventional case, where two mills are used, most of the slurry from the first mill is sent directly to the subsequent process and only the remaining part is sent to the second mill. Since both grinding operations are preformed in a condition of diluted slurry, and a dehydrating device, a conditioning device, etc. are required for producing high loaded coal-water slurry, this arrangement suffers from the problem that the equipment and operation manner are unavoidably complexed.

SUMMARY OF THE INVENTION

The present invention has succeeded in solving the problems encountered by the prior arts, and an object of the present invention is to provided a method of preparing fine-particle high loaded coal-water slurry and equipment for preparing the same are excellent in the respect that they are capable of preparing high loaded coal-water slurry having minimal coarse particles, and thus the unburnt carbon amount in the combustion residue and the NOx concentration in the exhaust gases are reduced substantially, when the slurry is supplied to combustion equipment to be burnt therein.

In order to achieve the above object, according to the present invention, slurry flowing out from a first stage mill is supplied to a second stage mill after considerable amount of coarse particles contained in the slurry have been removed therefrom. Further according to the present invention, a first stage mill to which coal, water, and a dispersion agent are supplied, a classifier which removes coarser particles contained in slurry flowing out from the first stage mill, and a second stage mill to which the resulting slurry having been thus considerably removed of the coarse particles is supplied are arranged in series.

A ball mill which is so dimensioned that the ratio of length to diameter is 2 to 4 is used for the first and second stage mills. As the classifier, a vibrating screen, cylinder-shaped classifier, horizontal disc-shaped classifier, or horizontally movable classifier may be used.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS:

Preferred embodiments of the present invention will be described below with reference to the accompanying drawings.

Fig. 1 is the flow sheet of a method of preparing fine-particle high loaded coal-water slurry in accordance with the embodiment of the present invention; Fig. 2 is a diagram used to explain the particle size distribution obtained in accordance with the method of the invention and that of the prior arts; Figs. 3 and 4 are flow sheets of conventional methods of preparing fine-particle high loaded coal-water slurry.

Fig. 1 shows the embodiment of the present invention. A first stage mill 3a is supplied with coal 1, water 4, and a dispersion agent 5 under the operation of a weighing feeder 2 in such a manner that slurry having a predetermined coal content can be obtained. The coal 1 is ground within the first stage mill 3a and the mixture flows out as slurry 8. The slurry 8 is then led to a classifier 9 wherein coarser particles 9b contained in the slurry 8 are removed from the mixture. A lower flow 9a is directly supplied to a second stage mill 3b wherein it is successively ground, flows out from the second stage mill 3b as fine-particle high loaded coal-water slurry 7 containing minimal coarse particles, and then is transferred by means of a pump 6.

The coarser particles 9b may be sent back to the first stage mill 3a through suitable means and may be ground together with coal 1, water 4, and a dispersion agent 5.

The slurry 8, the lower flow 9a, and the fine-particle high loaded coal-water slurry 7 have practically the same coal content which is not less than 60% by weight.

Although at the first stage mill 3a, part of the coal which has been insufficiently ground is made to flow out from the first stage mill 3a as slurry containing coarse particles which has not been subjected to a sufficient degree of grinding action, the lower flow 9a containing lesser amount of coarse particles is supplied to the mill 3b where it is ground again. Therefore, since the coarse particles are substantially low in this stage of grinding, the coal particles can be adequately subjected to grinding action without any disturbance, thus promoting the grinding operation and thereby producing fine-particle high loaded coal-water slurry 7 which contains minimal coarse particles.

In each of the first stage mill 3a and the second stage mill 3b, a ball mill which is so dimensioned that the ratio of length to diameter is 2 to 4 is used. Therefore, within the first stage and second stage mills 3a and 3b, grinding can so proceed in the state of high loaded coal-water slurry with adequately long residence time to prepare fine-particle high loaded coal-water slurry having a (specified) particle size distribution. This arrangement achieves a remarkably finer particle size distribution or arrangement in comparison to that of the case of a single mill having the length to diameter ratio of approximately 3.

If mills having various improvements with respect to the structure and operating parameters are used as the first and second stage mills, this will enable realization of a method of preparing fine-particle high loaded coal-water slurry and equipment for preparing the same which exhibit excellent grinding efficiency (reduced power consumption) and the grindability.

As for the classifier, a vibration screen having a screening surface, a structure employing cylindrical classifying members having slits, a structure employing rotatable horizontal disc classifying members having screening surfaces, a structure employing horizontally movable classifying members having screening surfaces which are movable in a continuous manner, or the like may be used. Classification is defined here as an operation of removing such particle from the original slurry that degrade grinding. In this embodiment of the invention, coarser particles contained in the slurry from the first stage mill are removed for the purpose of facilitating the grinding in the second stage mill. Consequently, the aperture size of the classifier 9 can be made much larger than the mean particle size of the fine-particle high loaded coal-water slurry 7, and this arrangement allows the slurry 9 to pass through the classifier 9 with ease even though the slurry 8 may have a high degree of viscosity. Therefore, the capability of the classifier 9 can be increased, and furthermore, even when preparing a large volume of fine-particle high loaded coal-water slurry, it is possible to handle the slurry without employing a classifier having an unreasonably large size.

Experiments conducted in accordance with the above embodiment will be described below. The coal used in the experiments had the following properties:

PROPERTIES \ BRAND			COAL A
PROXIMATE ANALYSIS	WATER	%	4.3
	ASH	%	13.2
	VOLATILE COMPONENTS	%	32.8
	FIXED CARBON	%	49.7
CALORIFIC VALUE		Kcal/kg	6,630
FUEL RATIO			1.52
GRINDABILITY		HGI	50

Fig. 2 shows the particle size of fine-particle high loaded coal-water slurry obtained in accordance with the above embodiment, as compared to the particle size of slurry in the prior arts. In Fig. 2, a curve group a indicates the particle size obtained by the present invention, a curve group b indicates that obtained by a conventional mill having the length to diameter ratio of 5, and a curve c indicates that obtained by a conventional mill having the length to diameter ratio of 3. The abscissa axis indicates the cumulative weight percentage under the size of 74 μm, which is an index of suitable particle size for combustion of fine-particle high loaded coal-water slurry, while the ordinate axis indicates the cumulative weight percentage over the size of 150 μm, which is an index of unsuitable particle size. Each of the curve groups collectively indicates the data values of a number of experiments. As will be clearly seen from Fig. 2, ordinate value (cumulative oversize of 150 μm corresponding to a abscissa value 85% (cumulative undersize of 74 μm) is much lower in curve group a (the present invention) than in curve groups b and c (prior arts).

In addition, the combustion properties of fine-particle high-loaded coal and water slurry were found to be as follows. Bituminous coal was used as raw coal, and the combustion equipment used had an electrical output of 600 MW.

			METHOD OF THE INVENTION	METHOD OF THE PRIOR ART
PARTICLE SIZE	-74 μm	%	85	85
	+150 μm	%	1.1	2.9
PERCENTAGE OF TWO STAGE COMBUSTION		%	30	30
UNBURNT CARBON CONTENT		%	2.0	4.0
NOx		ppm	180	200

As a result, it is clear that the present invention makes it possible to prepare fine-particle high loaded coal-water slurry containing minimal coarse particles, and also possible, when the slurry is supplied to combustion equipment to be burned therein, to reduce the amount of the unburnt carbon in the combustion residue, and to lower the NOx concentration in the exhaust gases.

Incidentally, the arrangement of the mills and the classifier of the present invention is not limited to what has been described in the above embodiment.

As described above in relation to the embodiments, according to the present invention, because the second stage mill is supplied with slurry from the first stage mill after coarser particles have been removed from the slurry by means of the classifier, and the slurry is then ground in the second stage mill, and also because the grinding is performed for an adequate period, fine-particle high loaded coal-water slurry containing minimal coarse particles can be prepared by relatively simple method and equipment without any complicated equipment or operation, and in addition, when the slurry is supplied to combustion equipment to be burnt therein, the amount of unburnt carbon in the combustion residue can be reduced and also the NOx concentration in the exhaust gases can be lowered. Further, according to the present invention, since the capability of the classifier can be increased, various advantages are attainable, such as the possibility of mass production of fine-particle high loaded coal-water slurry, and the possibility of excellent grinding efficiency (reduced power consumption) and grindability.

Claims

1. A method of preparing fine-particle high loaded coal-water slurry comprising the steps of: supplying coal, water, and a dispersion agent to a first stage mill so as to grind the same therein; removing substantial amount of coarse particles contained in slurry flowing out from said first stage mill; and supplying the resulting slurry having been thus substantially removed of the coarse particles to a second stage mill so as to grind the same therein.

2. Equipment for preparing fine-particle high loaded coal-water slurry in which a first stage mill to which coal, water, and a dispersion agent are supplied and which grinds the same, a classifier which removes coarser particles contained in slurry flowing out from said first stage mill, and a second stage mill to which the resulting slurry having been thus removed of the coarser particles is supplied and which grinds the same are arranged in series.

3. Equipment for preparing fine-particle high loaded coal-water slurry as claimed in claim 2, wherein each of said first stage mill and said second stage mill is comprised of a ball mill which is so dimensioned that the ratio of the length thereof to the diameter thereof is 2 to 4.

4. Equipment for preparing fine-particle high loaded coal-water slurry as claimed in claim 2, wherein a vibrating screen is used as said classifier.

5. Equipment for preparing fine-particle high loaded coal-water slurry as claimed in claim 2, wherein cylinder-shaped classifier are used as said classifier.

6. Equipment for preparing fine-particle high loaded coal-water slurry as claimed in claim 2, wherein horizontal disc-shaped classifier are used as said classifier.

7. Equipment for preparing fine-particle high loaded coal-water slurry as claimed in claim 2, wherein horizontally movable disc-shaped classifier are used as said classifier.

FIG. 1

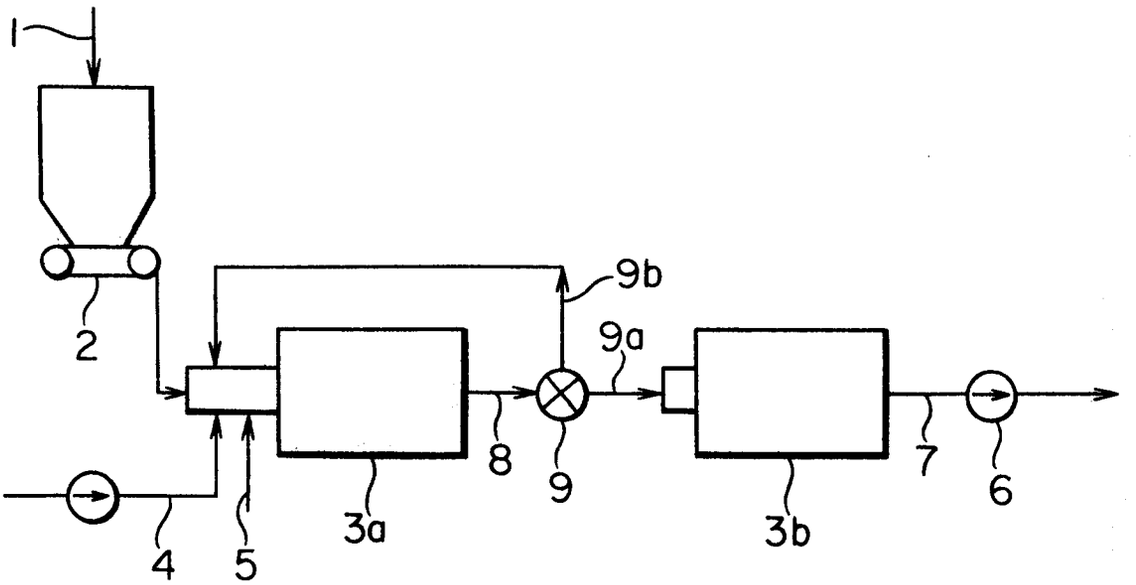
1
2
9b
9a
8
9
7
6
4
5
3a
3b

FIG. 2

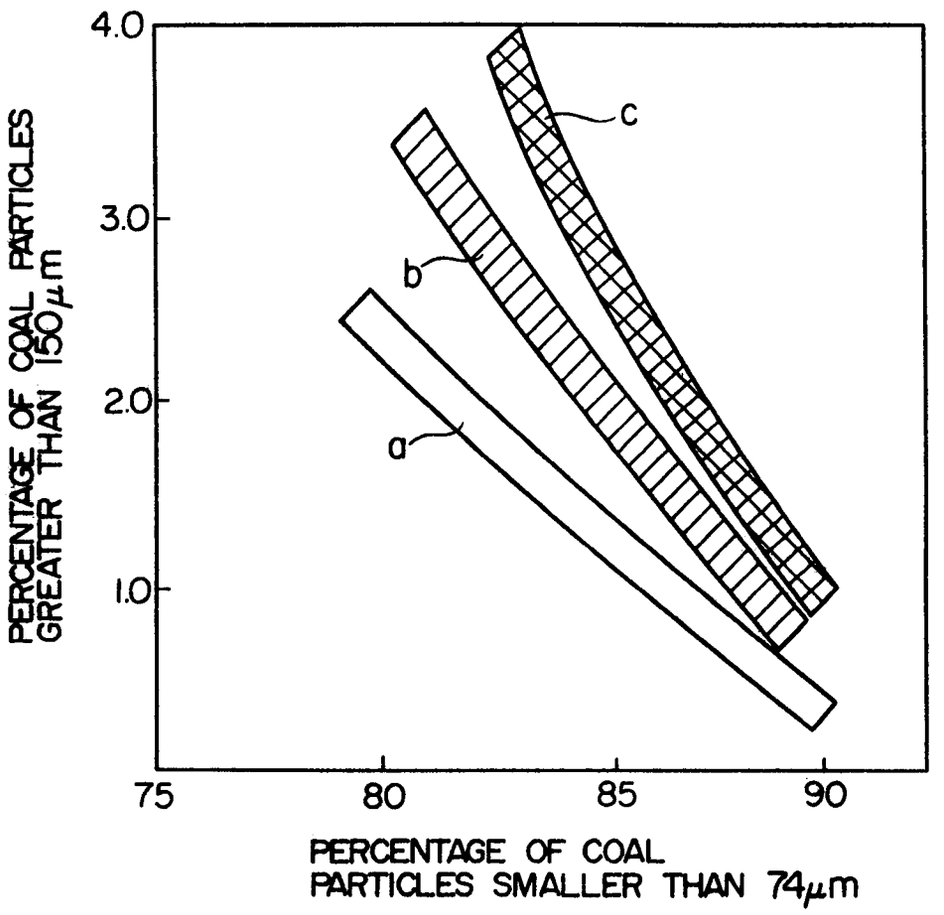
4.0
3.0
2.0
1.0
PERCENTAGE OF COAL PARTICLES GREATER THAN 150μm
a
b
c
75
80
85
90
PERCENTAGE OF COAL PARTICLES SMALLER THAN 74μm

FIG. 3 PRIOR ART

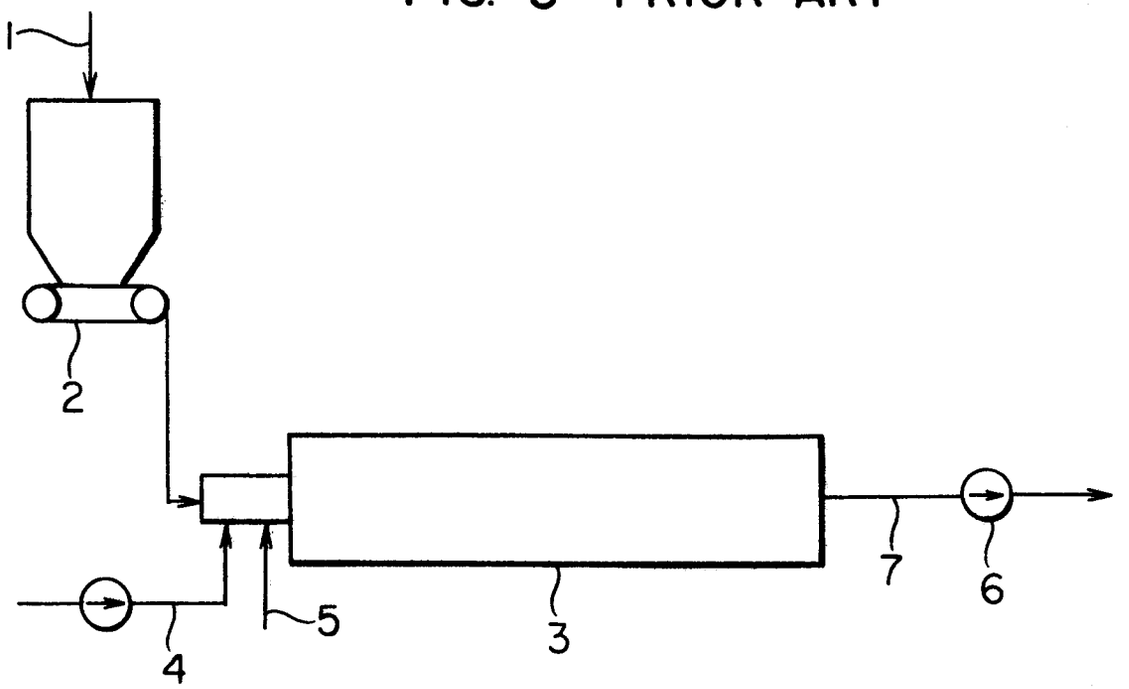

FIG. 4 PRIOR ART