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(54) A moulding method and system for kiln firing

(57) The invention relates to a method and system for modulating the firing temperature in a rotary kiln e.g. for cement production. The method consists in determining the absolute content of one or more inorganic constitutents present in the coal feed, feeding such data together with other data including the temperature in the kiln to a computer which determines the total ash content in the coal from the data, and, in the event that the temperature in the kiln is different to the required temperature or that there is a variation in the ash content, providing an output signal from the computer to allow feeding of a sweetner fuel to the burner with or without change in the flow of coal. Alternatively, only the amount of flow of coal to the burner is reduced or increased.

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Fig.1.

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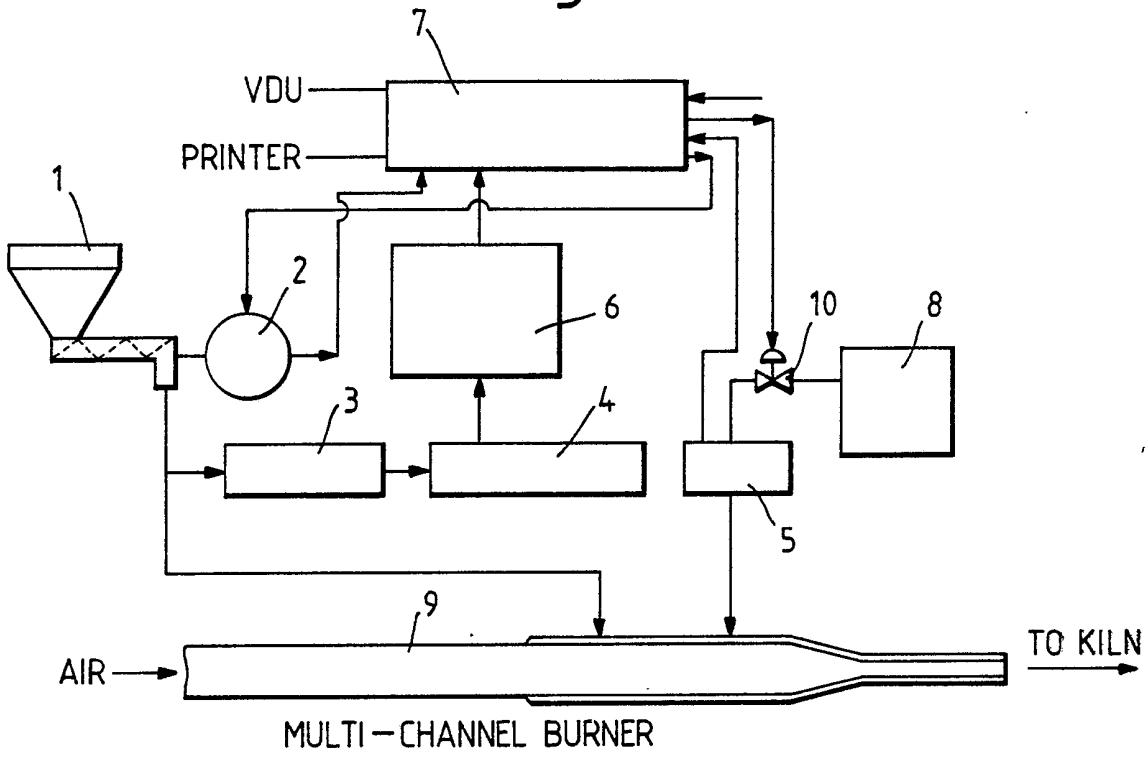

Fig.2.

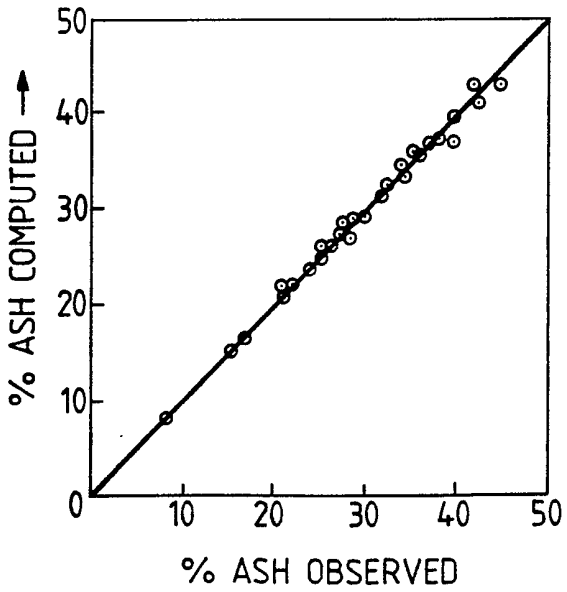

Fig.3.

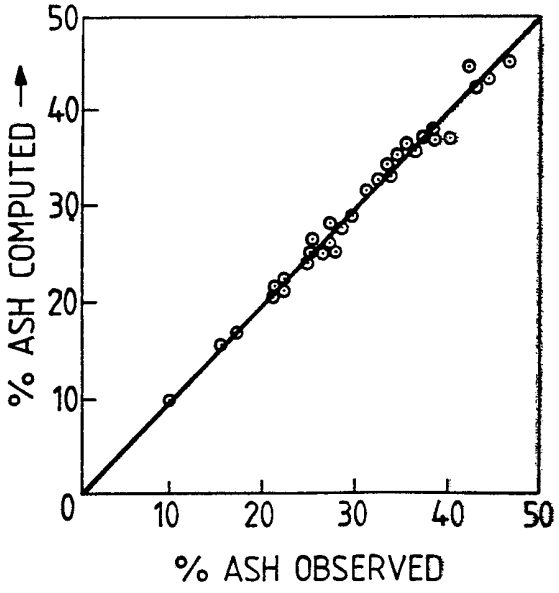

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Fig.4.

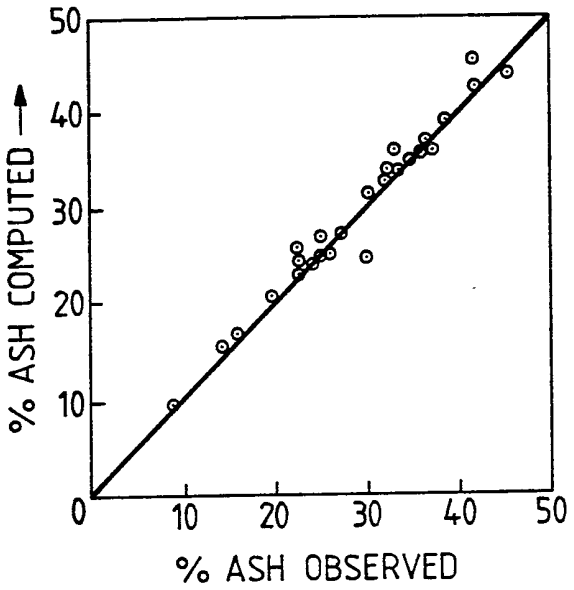

Fig.5.

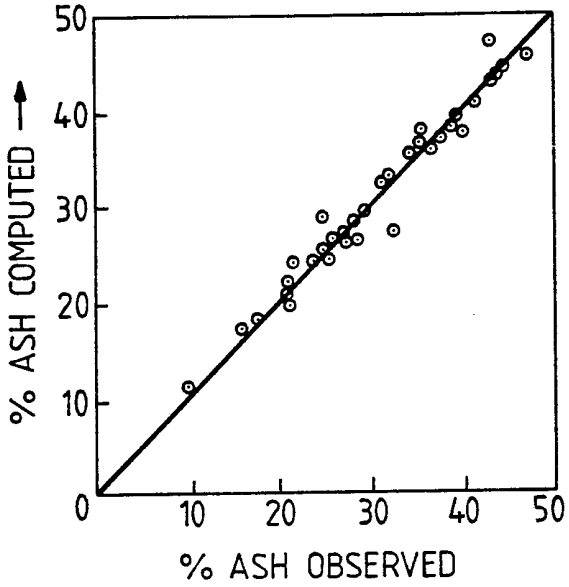

Fig.6.

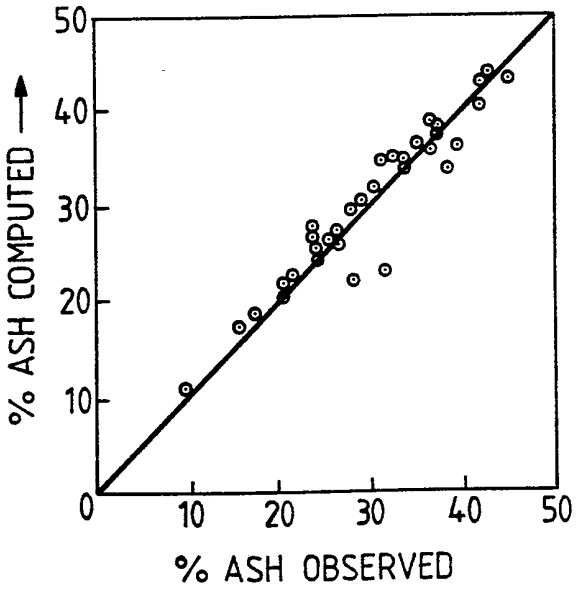

Fig. 7.

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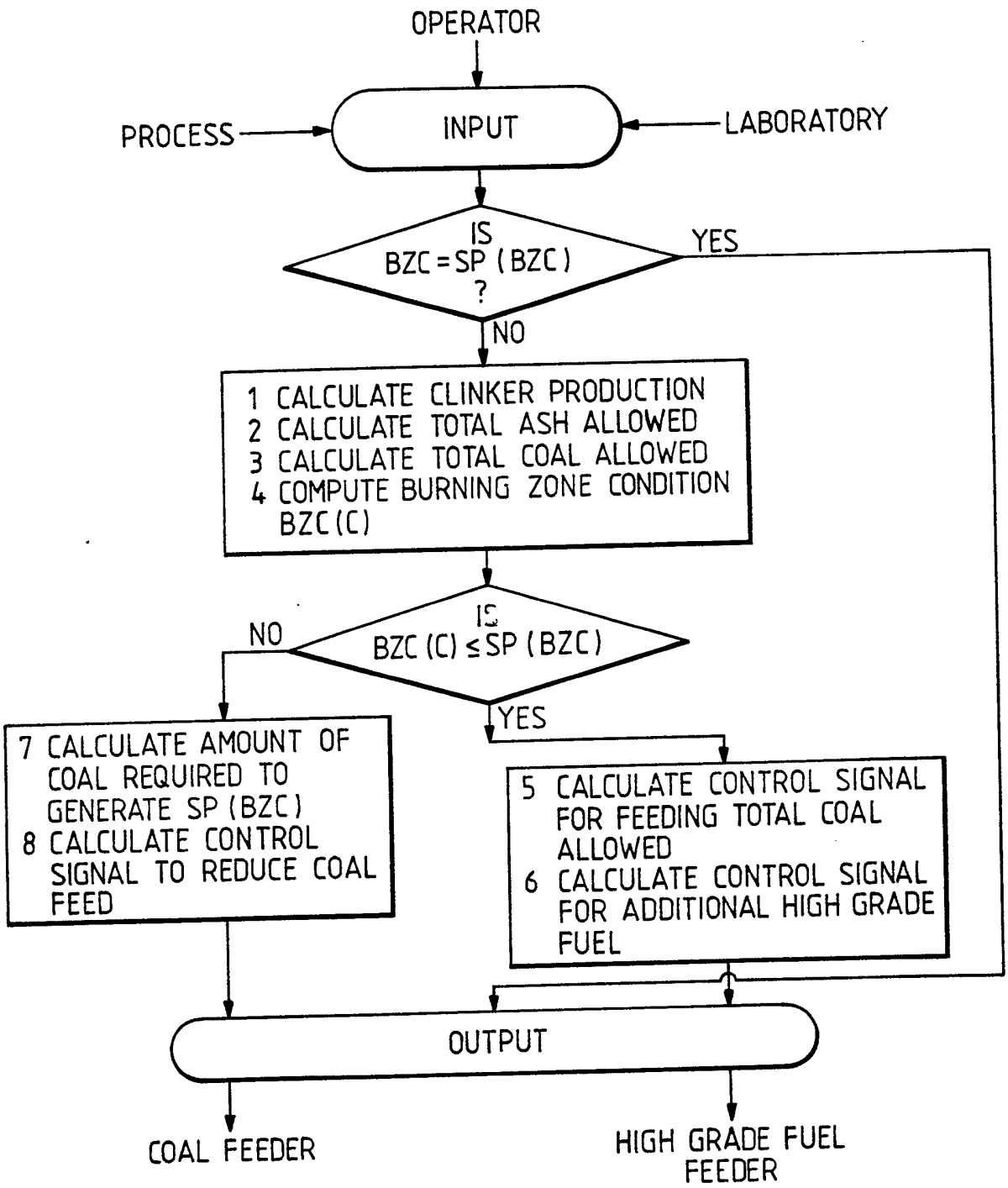
LOGIC DIAGRAM FOR SOFTWARE



TITLE: A MOULDING METHOD AND SUSTEM FOR KILN FIRING.

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This invention relates to a modulating method of kiln firing with pulverized coal burners and a system for carrying out the method. The invention is particularly intended for rotary kilns for the production of cement clinkers but is not limited thereto. The kilns are fed with a mix, which in the case of cement clinker producing kilns, comprises limestone, clay, and certain selected additives depending on the composition and desired properties of the cement produced. A stream of pulverized coal and air is supplied to the kiln through a burner and burnt therein to process the mix and convert the same into clinker.

In the manufacture of cement clinker, one of the desired process parameters consist in providing the burning zone of the rotary kiln with the desired temperature and then maintaining such a temperature. Such burning conditions are necessary so as to produce a clinker with the desired uniform quality. It is known that a variable quality of coal or use of high ash containing coals can affect the burning conditions of a rotary kiln and, thereby, affect the quality and uniformity of clinker and adversely affect the life of the refractory lining etc.

The use of high ash containing coal is attended with several distinct disadvantages. One such disadvantage is that a high ash content coal, when employed as a fuel in a rotary kiln, lowers the C_3S content in the clinker and, thereby increases the grinding energy of clinker and reduces the strength of the cement so obtained. Further, it also reduces the output as a high ash content coal produces less heat in the burning zone of the rotary kiln. It is known that coal in a pulverized state is fed as a fuel to a rotary kiln. A high ash content coal is difficult to grind, but which is necessary as only coal in a pulverized state is to be fed to the kiln. Furthermore, the use of high ash content coal requires a better quality of limestone in the mix. Yet another disadvantage is that a high ash content coal results in ring formation within the kiln. Such ring formations reduce the total effective diameter of the kiln. Furthermore, a high ash content coal takes a longer time to burn and provides less heat.

Various processes are known for the beneficiation of coal in order to remove ash forming mineral matters in coal. One such process consists in grinding coal to a fine size and then adding certain chemicals thereto, which is then subjected to the step of froth flotation. A disadvantage associated with such a process is of higher

costs and, further, the rejects are to be thrown away as a pollutant. Yet another disadvantage is that the coal is moist and must be subjected to the step of drying before it is fed to the kiln.

Several disadvantages are also associated with coal having a variable composition. One such disadvantage is that the calorific value would vary and, thereby, resulting in temperature fluctuations. Further, the temperature profile throughout the kiln changes and, whereby, clinker with the desired phase composition is not obtained. Further, as a varying temperature provides a non uniform burning of the clinker, a yellow or unburnt clinker is generally obtained. Another disadvantage is that a fluctuating temperature provides an unstable coating at the burning zone and reduces the life of the refractory lining of the kiln.

An object of this invention is to propose a modulating method of kiln firing and a system therefor which ensures a uniform temperature in the burning zone of a rotary kiln.

Another object of this invention is to propose a modulating method of kiln firing and a system therefor which assists in achieving prolonged life of the refractory lining of the kiln.

Still another object of this invention is to propose a modulating method of kiln firing and a system therefor which provides an improved and uniform quality of clinker.

Yet another object of this invention is to propose a modulating method of kiln firing and a system therefor which obviates the disadvantages associated with those of the prior art.

The said method comprises in the steps of periodically drawing samples of coal from the feed line for feeding pulverized coal to a burner, preparing a feed sample for an on-line analyses, determining the absolute content of one or more inorganic constituents present in the coal feed sample by an analysor, feeding such a data to a process computer along with information regarding the temperature in the kiln, determining the total ash content in the coal from said data and in the event that the temperature in the kiln is below or above its predetermined value, the process computer provides signals for allowing, if required, addition of a sweetener fuel with or without change in the flow of coal or signals only for reducing or increasing the flow of coal to said burner.

The system for allowing a modulating method of kiln firing of the present invention, for enabling uniformity

in the burning zone conditions in the kiln, comprises a feed line for supplying pulverized coal to a multi channel burner, an automatic sampler connected to said feed line for periodically drawing samples of coal, a sample preparation unit connected to said sampler for preparing a coal feed, an on-line analyzer connected to said preparation unit for determining the absolute content of one or more inorganic constituents present in said coal feed, a computer for receiving the data from said analyser in conjunction with other data from the kiln, the ash content present in the sample being determined from the absolute content of said one or more inorganic constituent, said computer providing signals, if required, to means for addition of a sweetener fuel with or without change in the flow of coal or means only for reducing or increasing the flow or coal to said burner.

The method and the modulation system of the present invention enables to achieve uniformity in burning zone conditions in the kiln, and which provides a uniform quality of clinker. Furthermore, it increases the life of the refractory lining of the kiln.

In accordance with the present invention, it has now been found that the absolute content of one or more inorganic constituents present in the sample and as

determined from the analyzer provides practically instantaneous data on the ash content present in the coal sample. The time required for ash determination by conventional method is about 2-3 hours.

FIG.1 is a schematic outlay of the coal quality modulation system;

FIG.2 to 6 shows the calculated ash based on silica, iron, alumina, calcium and magnesium correlation respectively vs. reported ash; and

FIG.7 shows the logic diagram for the software.

In Figure 1, the pulverized coal feeder (1) which supply weighed quantities of pulverized coal to a multichannel burner (9) is driven by a variable speed drive (2). An automatic sampler (3) shall remove sample continuously which is collected in a small hopper, mixed and then part or whole of it taken to the sample preparation unit (4). In the unit (4) the pulverized coal is mixed with a binder and compressed into briquettes in a known manner. The said briquettes are fed to an on-line analyser unit (6) wherein the percentage of

silica, alumina, iron, magnesium and calcium oxide are determined. The information regarding the percentage of the contents of silica, alumina and others of said substances is fed to process computer (7). Information regarding instantaneous value of the temperature in the kiln (not shown) is also supplied to the computer (7). If the temperature in the kiln is too high it is evident that coal having higher calorific value is being supplied and the computer (7) will cause control of the variable speed drive (2) to reduce the coal supplied to the burner. On the other hand reduced temperature would indicate either lower calorific value of coal due to the higher ash content of coal. In such an event computer (7) will actuate the means (10) for supplying a sweetener fuel such as fuel oil or fuel gas from storage (8) to the multi-channel burner (9) through a flow meter (5). Simultaneously or alternatively, computer (7) may actuate variable speed drive (2) to change supply of coal to burner (9).

The analyser (6) is a suitable analytical equipment for quick and accurate measurement of inorganic constituents in coal. The controlling microprocessor or dedicated computer of this equipment or the main process control computer is used to convert this data to ash content of coal in accordance with the established statistical

relationship of the type reported above. In another modification, 6 can be the direct on-line ash determinator also.

The process computer has interfaces with laboratory; process and operations controls and operations controls and executes the control in accordance with software, flow sheet of which is shown in figure 7.

Reference is now made to Table 1 which shows the calculations carried out on 35 different samples of coal. The calculations relate to the percentage amount of SiO_2, Fe_2O_3, Al_2O_3, CaO and M_gO present in such of the samples. Based upon such calculations and the multiple regression analysis, the following multiple regression equations have been evolved by carrying out the said analysis and the results for Examples 1 to 5 are shown in Figs.2-6.

Ex.1 Ash % = 1.03 + 1.075 (SiO_2) + 1.442(Fe_2O_3)+1.035 (Al_2O_3)+ 1.034(CaO) + 1.36 (MgO)

Multiple correlation coefficient=0.9923

Ex.2 Ash % = 0.2589+1.153 (SiO_2) +1.388(Fe_2O_3)+0.849 (Al_2O_3)+2.166(MgO) : Multiple correlation coefficient = 0.9848

Ex.3 Ash % = 1.464 +1.195 (SiO_2)+2.074(Fe_2O_3)+0.482 (Al_2O_3) : Multiple coefficient =0.9646

Ex.4 Ash % = $2.289 + 1.315\ (SiO_2) + 2.403(Fe_2O_3)$

Multiple correlation coefficient=0.9612

Ex.5 Ash % = $5.608 + 1.439\ (SiO_2)$

Multiple correlation coefficient=0.9021.

Based on the value of the multiple correlation coefficient, it is seen from the above set of equations that depending on the complexity of the coal, a statistically valid and practically acceptable simple or complex relationship can always be evolved for indirect estimation of ash content.

TABLE 1

COAL ANALYSIS DATA

Sl No	Percent Ash in Coal	Percent Inorganic Constituents in Coal				
		SiO_2	Fe_2O_3	Al_2O_3	CaO	MgO
1	2	3	4	5	6	7
1	24.36	13.6	1.77	8.06	0.48	0.13
2	26.04	13.8	2.30	8.68	0.74	0.11
3	15.97	8.48	1.55	4.73	0.38	0.13
4	20.80	11.19	1.62	6.34	0.56	0.16
5	17.68	9.20	1.52	5.38	0.66	0.13
6	34.96	20.83	2.05	7.27	2.53	0.25
7	24.24	14.37	2.62	4.82	0.64	0.24
8	40.65	24.67	2.42	9.16	0.86	0.23
9	36.76	19.72	3.28	10.03	1.18	0.32
10	31.83	19.17	2.10	7.69	0.50	0.45
11	27.03	10.63	3.60	7.95	1.62	0.09
12	40.30	22.79	3.40	10.62	0.38	0.21
13	40.27	22.67	5.08	9.84	0.40	-
14	9.92	4.14	1.35	1.84	0.94	0.07
15	34.64	21.08	1.77	8.27	1.48	0.18
16	31.37	18.97	1.92	7.55	0.59	0.49
17	41.05	25.43	2.26	8.14	2.81	4.49
18	33.70	20.09	1.89	8.57	1.21	0.28
19	29.72	19.22	1.28	7.28	0.92	0.08
20	36.26	18.09	3.02	9.20	1.08	0.29
21	29.17	17.05	2.28	7.74	0.73	0.17
22	32.90	20.05	1.42	8.57	1.04	0.36
23	30.95	11.47	3.68	5.99	3.72	3.41
24	43.96	25.36	2.69	9.54	2.75	0.52
25	24.60	13.02	2.18	6.79	0.99	0.69
26	34.98	20.35	2.19	9.06	1.07	0.32
27	27.90	16.16	1.65	6.51	1.60	0.31
28	26.31	14.42	1.75	6.01	1.98	0.30
29	23.74	14.10	1.32	5.78	1.27	0.22
30	32.23	18.37	3.14	8.76	0.63	0.27

Contd....

TABLE 1

COAL ANALYSIS DATA

1	2	3	4	5	6	7
31	25.43	14.39	1.62	5.73	2.53	0.23
32	26.92	15.85	1.52	6.09	2.35	0.30
33	21.24	11.37	1.82	5.84	1.79	-
34	21.04	10.86	1.62	6.40	1.77	-
35	21.64	11.85	2.31	5.73	1.51	-

CLAIMS:

1. A modulating method of kiln firing with pulverized coal burner which comprises in the steps of periodically drawing samples of coal from the feed line supplying pulverized coal to a burner, preparing a feed sample for an on-line analyzer, determining absolute content of one or more inorganic constituents present in the coal feed sample by said analyser, feeding such a data to a process computer along with other data such as the temperature of the kiln, determining the total ash content in the coal from the data, and in the event that the temperature in the kiln is different to the required temperature or that there be a variation in the total ash fed to the kiln and as determined from said data the process computer provides signals for allowing, if required, addition of a sweetener fuel with or without change in the flow of coal or signals only for reducing or increasing the flow of coal to said burner.

2. A method as claimed in claim 1 wherein the absolute content of silica, iron, alumina, calcium and magnesium present in the coal is calculated for determining the total ash content.

3. A method as claimed in claim 1 wherein the absolute content of alumina iron, silica and magnesium is calculated for determining the total ash content.

4. A method as claimed in claim 1 wherein the absolute content of silica, alumina and iron is present in coal is calculated for determining the total ash content.

5. A method as claimed in claim 1 wherein the absolute content of silica and iron or only silica is calculated for determining the total ash content.

6. A coal quality modulation system for enabling uniformity in the burning zone conditions in the kiln comprise a feed line for supplying pulverized coal to a milti channel burner, an automatic sampler connected to said feed line for periodically drawing samples of coal, a sample preparation unit connected to said sampler, an on line analyzer connected to said preparation unit for determining the absolute content of at least of one of the inorganic constituents in the sample, a computer for receiving the data from said analyser in conjunction with other data from the kiln, the ash content present in the sample being determined from the absolute content of said inorganic constituent, said computer providing signals, if required, to means for addition of a sweetener fuel with or without increase in the flow of coal or means only for reducing or increasing the flow of coal to said burner.

7. A coal quality modulation system as claimed in claim 6 comprising a weightment means for supplying predetermined amount of pulverized coal to the feed line, a conveyer for conveying coal from the weightment means to the feed line, and a variable speed drive adapted to receive a signal from said process computer for driving said conveyor.

8. A modulating method of kiln firing as claimed in Claim 1 substantially as described by way of example disclosed herein.

9. A coal quality modulating system as claimed in Claim 1, substantially as described with reference to Figure 1 of the accompanying drawings.

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