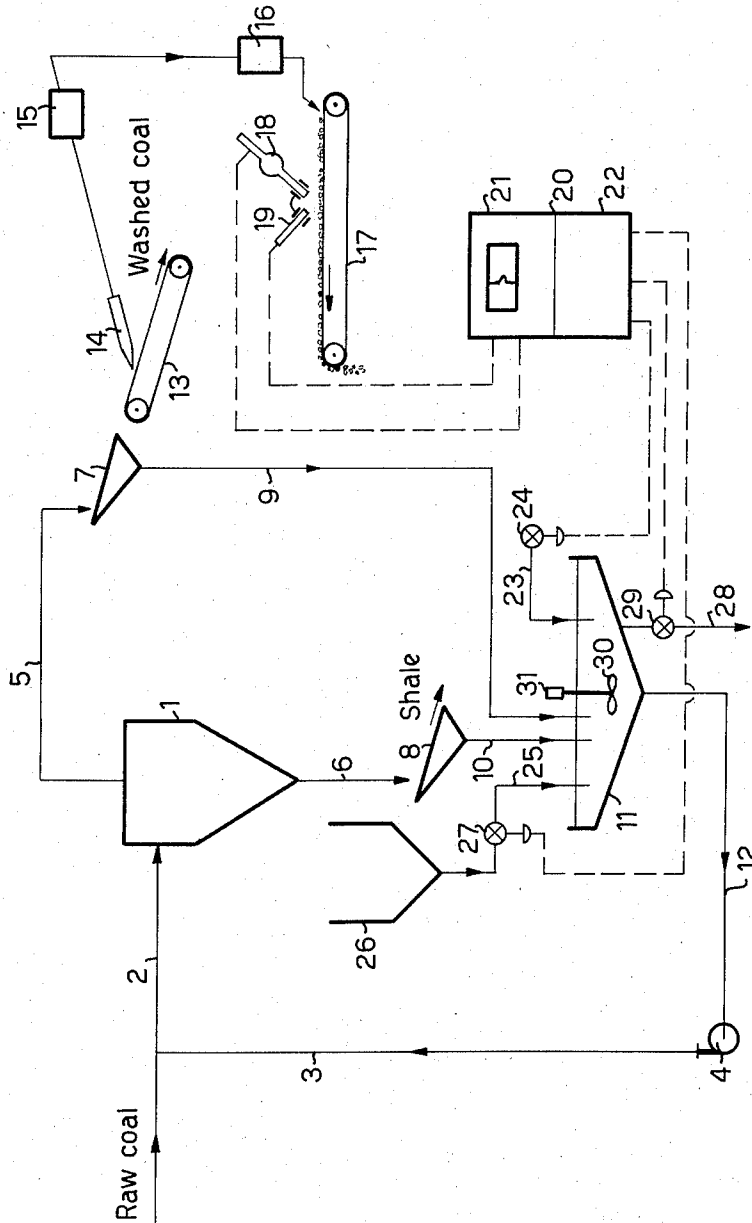


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COAL TESTING METHOD
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COAL TESTING METHOD

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6 Claims. (Cl. 250—53)

The present invention relates to a method of testing coal to determine the content of incombustible material present therein.

The invention, moreover, relates to the application of said method in the control, particularly the automatic continuous control, of coal dressing processes.

In the mining industry, particularly in connection with the automatic control of coal dressing processes, there is a need for methods enabling the content of incombustible material (hereinafter and in the claims hereof called "the ash content") in the coal, to be rapidly determined, and attention has been directed toward physical methods which not only avoid any necessity for combustion of the coal but also avoid any question of chemical conversion of the coal during the measurement, and, in some cases, also to avoid the necessity of taking separate samples of the coal.

Thus one proposal which has been made which is in principle attractive is to use the difference in the capacity of different coal samples diffusely to scatter Roentgen radiation as a measure of the difference in the ash content of the samples. As a matter of fact, the ash content of the coal would be directly proportional to the ratio between the intensities of the incident and dispersed Roentgen radiations. The results so far obtained with this method in practice, however, have not been satisfactory. This may apparently be ascribed to the fact that variation in the capacity of coal diffusely to scatter Roentgen radiation (hereinafter and in the claims hereof referred to as "the Roentgen ray dispersion capacity") depends not only on variation in the total ash content of the coal, but also on variation in the relatively complex composition of the incombustible material constituting the said ash content. In this connection, fluctuation in the iron content of the coal appears particularly to influence the Roentgen ray dispersion capacity, and this capacity is also influenced, although to a lesser degree, by fluctuation in the calcium content of the coal.

The main object of the present invention is to provide a method of testing coal to determine the ash content thereof by means of measurement of the Roentgen ray dispersion capacity of the coal which method yields substantially reliable results in spite of the relatively great fluctuations in the composition of the incombustible material present in the coal to be tested as are encountered in practice.

Particularly, the object of the invention is to provide such method for dealing with coal of widely fluctuating iron content as is generally the case with raw run-of-mine coal of any description.

A further object of the invention is to provide an improved method of the kind defined for dealing with coal in which besides the iron content also the calcium content shows appreciable fluctuation in practice.

Still further objects and the entire scope of applicability of the invention will become apparent from the detailed description given hereinafter and in the appended claims. It should be understood, however, that

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the description is given by way of illustration and not of limitation.

According to the present invention, there is employed for the said ash content measurement, a technical Roentgen radiation composed substantially entirely of rays having a wave length greater than 1.74 A. U.

The term "technical Roentgen radiation" as employed herein and in the claims hereof, is to be understood as meaning radiation composed substantially entirely of rays having a wave length smaller than 4.5 A. U.

The single figure of the drawing is a diagrammatic illustration of the process of the present invention wherein quality control of coal is achieved by automatically controlling the specific gravity of the washing suspension in a coal washer.

Referring more specifically to the drawing, raw coal is fed to a hydrocyclone washer 1 by a conduit 2, together with a heavy suspension, e. g., consisting of a dispersion of loess in water, which is introduced into conduit 2 by conduit 3 under the action of pump 4. Washed coal leaves the hydrocyclone 1, together with the suspension, through conduit 5 as the light fraction, and shale, likewise together with the suspension, leaves the hydrocyclone 1 through conduit 6 as the heavy fraction. The light and the heavy fractions are led over draining screens 7 and 8, respectively, and the underflow suspension is led through lines 9 and 10, respectively, to reservoir 11, from which it is recirculated to hydrocyclone 1 by conduits 12 and 3 through pump 4.

The washed coal leaving the draining screen 7 is led over a belt conveyor 13. A sampler 14 takes samples from the coal travelling on the conveyor 13. The sample is ground in mill 15 and dried in drier 16, whereupon the sample, which is now in condition for measurement is passed onto the sample conveyor 17 where it is radiated by X-rays from X-ray tube 18, generating a technical Roentgen radiation as hereinbefore defined according to the invention. The Roentgen radiation dispersed by the sample is detected by a detector 19. Impulses corresponding to the primary radiation and to the dispersed radiation, respectively, are fed to the apparatus 20, including a registering instrument 21 and an impulse transmitter 22, the impulses of the latter serving to automatically control the specific gravity of the circulating washing suspension.

The reservoir 11 is associated with a fresh water conduit 23 with control valve 24, with a make-up suspension conduit 25 with reservoir 26 and control valve 27, and with a suspension drain link 28 with control valve 29. The impulses from the transmitter 22, which are in linear relationship with the ash content of the washed coal sample travelling on the conveyor 17, are fed to the control valve 24, 27 and/or 29 in such a manner that an increase in the said ash content engenders a decrease in the specific gravity of the suspension in the reservoir 11, e. g., by adding water through conduit 23 and draining suspension through conduit 28, if necessary.

When the ash content of the washed coal decreases, the impulses from the transmitter 22 are utilized in such a way that the specific gravity of the suspension in the reservoir 11 is increased, e. g., by adding make-up concentrated suspensions through conduit 25 and draining suspension through conduit 28, if necessary. Reservoir 11 is provided with mixer 30 actuated by motor 31 for homogenizing the suspension contained therein.

When applying the invention, it is found that the correlation between the ash content of coal and the ratio between the effective intensities of the incident and dispersed Roentgen radiations is sufficient for practical purposes.

As the effective intensity of the dispersed Roentgen radiation is relatively small, it is advantageous, within

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the limits permitted by the invention, to use a radiation of the greatest possible hardness and effective intensity. It is therefore preferred to generate the Roentgen radiation to be employed in a tube provided with a cobalt anode and combined, if desired, with a monochromator and/or a filter, the said tube being operated at such a voltage that practically no rays with a wave length smaller than 1.74 A. U. are emitted.

Greater accuracy of measurement may be obtained by employing a technical Roentgen radiation composed substantially entirely of rays having a wave length greater than 3.06 A. U. If such radiation is employed, however, the demands on the measuring apparatus are increased; in many cases, for example, it will be necessary to operate in vacuo. The apparatus to be employed for the present measurement may be of simple design and be composed of parts known in themselves. The apparatus should include an X-ray source, means for locating a sample of the coal to be tested in the path of the radiation beam emanated by the said source or for passing a continuous stream of the said coal through the said radiation and, preferably electronic, detection means for measuring the intensity of radiation dispersed by the irradiated coal. In case the intensity of the radiation emanated by the X-ray source would not be sufficiently constant, the apparatus should include means for detecting the intensity of the incident radiation and means for estimating the ratio between the intensities of the incident and dispersed radiations. The measuring apparatus may furthermore be calibrated to give a direct reading of ash content in accordance with the measured Roentgen ray dispersion capacity.

The method according to the invention may be applied in determining fluctuations in the ash content of coal which is to be dressed or of the dressed product for the purpose of determining adjustment of the dressing plant. In dressing processes, e. g., in the washing of raw run-of-mine coal, it is frequently desired to control the process in dependence on ash content fluctuation with the object of obtaining a coal fraction of a quality conforming to a predetermined quality standard, which in practice means that the ash content of the fraction must remain within certain limits. In coal washing for example, unless an appropriate adjustment of the separatory devices is effected, variations in the ash content of the dressed coal might arise as a consequence of considerable fluctuation in the ash content of the raw run-of-mine coal.

Those ash content fluctuations recurring at relatively short periods are normally automatically levelled by that mixing of the coal which occurs during its transportation, e. g., up to the dressing plant, and in the dressing plant itself. The more marked fluctuations which occur over longer periods, however, necessitate taking special measures for adjustment of the dressing plant operation.

In coal preparation practice it is customary regularly to draw samples from the dressed coal, to determine the ash content of the samples, and to control the dressing process, e. g., by controlling the specific gravity of the separating medium in a fluid washer, in dependence on fluctuations in ash content occurring as between successive samples.

In the application of such a control, the important conditions to be observed are that the samples be representative of the coal obtained during a given period and that there be only a short time interval between the moment of sampling and the moment when the measured value of the ash content is converted, automatically or otherwise, into an adjustment of the washing or other dressing process.

For realising an effective control, therefore, it is necessary to combine a frequent drawing of small, representative samples with the speediest possible determination of ash content fluctuation while moreover the measuring apparatus should preferably be of such a nature as to

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yield operative impulses or the like which can be directly utilized for automatically governing the control of the dressing process.

By means of the present invention, the rapid ash content determination which is necessary for providing such a control is facilitated. Moreover the apparatus employed for comparison of the incident and dispersed radiation intensities may be designed to yield impulses serving for automatically governing the control of the dressing process. Furthermore, it is possible to exercise said control continuously by carrying out a continuous measurement of the Roentgen ray dispersion capacity of a continuous stream of the material to be tested, or of a sample part of such continuous stream.

Employing the method according to the invention in a coal washery plant, using the fluctuations in Roentgen ray dispersion capacity of the coal for effecting automatic control of the coal washers the latter have been automatically controlled to maintain the ash content of the dressed coal constant within 0.5%.

It should be understood that the Roentgen ray dispersion capacity variation is referred to as a sufficiently reliable measure of ash content variation on the assumption that there is no appreciable fluctuation in the composition of the combustible content of the coal. If therefore the method according to the invention is applied in coal dressing for determining ash content fluctuation over long periods in which variation in the composition of the combustible part of the coal is liable to occur this composition must be otherwise determined at appropriate intervals and any variation must be taken into account in determining the true ash content or in adjusting the automatic control device for the dressing apparatus.

Whether the invention be employed for providing statistical record of ash content for any purpose such as for affording guide to the necessary manual adjustments of a certain process or for providing an automatic control, the measurement may as aforesaid be effected continuously or intermittently in relation to separate representative samples. Measuring apparatus recording ash content fluctuation may be designed to yield its visual or other indication of change in ash content value in direct dependence on the change from one detected dispersion capacity to another or on a comparison between each successive detected capacity value and a given standard.

I claim:

1. A method of testing coal to determine the ash content thereof, comprising the step of measuring the Roentgen ray dispersion capacity of the coal employing a technical Roentgen radiation composed entirely of rays having a wave length greater than 1.74 A. U. and less than 4.5 A. U.

2. A method of testing coal to determine the ash content thereof, comprising the step of measuring the Roentgen ray dispersion capacity of the coal employing a technical Roentgen radiation composed entirely of rays having a wave length greater than 3.06 A. U. and less than 4.5 A. U.

3. A coal preparation process in which quality control is to be applied in dependence on fluctuations in the ash content of the coal to be treated comprising the steps of regularly measuring the Roentgen ray dispersion capacity of the coal to be treated employing a technical Roentgen radiation composed entirely of rays having a wave length greater than 1.74 A. U. and less than 4.5 A. U., deriving impulses from the measuring device corresponding to the dispersion capacities measured, and automatically controlling the preparation process in accordance with fluctuations in said impulses.

4. A coal preparation process in which quality control is to be applied in dependence on fluctuations in the ash content of the coal to be treated comprising the steps of regularly measuring the Roentgen ray dispersion capacity of the coal to be treated employing a technical

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Roentgen radiation composed entirely of rays having a wave length greater than 3.06 A. U. and less than 4.5 A. U., deriving impulses from the measuring device corresponding to the dispersion capacities measured, and automatically controlling the preparation process in accordance with fluctuations in said impulses.

5. A coal preparation process in which quality control is to be applied in dependence on fluctuations in the ash content of the coal obtained comprising the steps of regularly measuring the Roentgen ray dispersion capacity of the coal obtained employing a technical Roentgen radiation composed entirely of rays having a wave length greater than 1.74 A. U. and less than 4.5 A. U., deriving impulses from the measuring device corresponding to the dispersion capacities measured, and automatically controlling the preparation process in accordance with fluctuations in said impulses.

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6. A coal preparation process in which quality control is to be applied in dependence on fluctuations in the ash content of the coal obtained comprising the steps of regularly measuring the Roentgen ray dispersion capacity of the coal obtained employing a technical Roentgen radiation composed entirely of rays having a wave length greater than 3.06 A. U. and less than 4.5 A. U., deriving impulses from the measuring device corresponding to the dispersion capacities measured, and automatically controlling the preparation process in accordance with fluctuations in said impulses.

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