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(54) A METHOD FOR THERMAL TREATMENT OF DUSTLIKE MATERIAL PARTICULARLY FOR THE PURPOSE OF BURNING CEMENT IN SEVERAL STAGES

(71) We, KLOCKNER-HUMBOLDT-DEUTZ AKTIENGESELLSCHAFT of Deutz-Mulheimer-Strasse 111, 5 Koln 80, Federal Republic of Germany, a German Body Corporate, 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:

The invention relates to a method of thermal treatment of dustlike material, for example calcining cement in several stages, wherein the material is pre-heated in a pre-heater and then roasted in a furnace, and is subjected in a separate state to a burning process in a hot flow of gas before entry into this furnace.

When manufacturing cement, alumina, lime, dolomite or the like, the heat treatment of the fine grain raw powder takes place, for example, by first feeding prepared raw material to a suspension pre-heater comprising several cyclones connected one above the other. In this, the particles of raw material are preheated in counter flow, by means of hot exhaust gas from a rotary kiln or furnace, the particles, rising up through the cyclones, being decarbonated to a certain degree before being introduced into the rotary kiln, and there being subjected to final roasting. As in this conventional method almost all of the thermal energy is supplied to the rotary kiln or furnace, then at high throughputs the thermal efficiency and output capacity of the kiln or furnace is limited by non uniform heat distribution in the rotary kiln or furnace and the service life of the refractory brick in the burning zone is significantly reduced. In order to be able to make the dimensions of the cross-section and/or the length of the rotary kiln or furnace smaller, it has already been attempted to undertake the low temperature process for calcining the raw powder, which process uses up heat, in a pre-heating zone arranged between the pre-heater and the rotary kiln. This requires that intimate intermingling of fuel and raw material takes place in the pre-heating zone so that the heat of the fuel may be transferred to the individual particles of raw powder for the purpose of calcining the raw powder.

German Offenlegungsschrift No. 2 361 427 describes a pre-heating zone which is constructed like a shaft and contains a mixing zone arranged in the shaft for receiving separately the fuel and raw cement materials. The mixture of the fuel and raw cement material is then brought into contact with the flow of gas from a rotary kiln, said flow of gas containing oxygen and flowing upwards in the shaft. Of course, with this type of arrangement, uniform mixing is not expected in the supply pipe as, from experience, intimate intermingling can only take place there with the aid of mechanical mixers. A further disadvantage of the mixing of fuel and raw powder before feeding into the gas flow lies in the fact that undesirable chemical reactions are produced between the fuel and, for example, the alkaliferrous or sulphureous raw material, these chemical reactions acting unfavourably on the entire burning process.

From German Offenlegungsschrift 2 324 519 it is known to arrange the material discharge line of the cyclone above the lowermost cyclone of a pre-heater and within burning zone arranged between the pre-heater and the rotary kiln, together with a fuel line of which the opening is covered by the flow of material. Even with this arrangement, the distribution of the material is still uneven so that at certain points the concentration of raw material is so high in the burning zone that poor conditions prevail there, while at other points the concentration of raw materials is relatively small so that, at these points, particularly high temperature peaks may occur resulting in overburning of the particles of material. Thus the beginnings of coarsening of the grain size and formation of the molten phase will restrict the flowability of the raw material considerably and will lead to disruption in the whole plant.

In German Offenlegungsschrift 23 65 653, an additional burning zone is provided in a device for heat treatment of fine grain material having a pre-heating shaft through which exhaust gases from a rotary kiln flow, through which burning zone the material is passed twice, once falling downwards and once climbing upwards. In order to achieve this, the gas velocity must not be too large. It should be above approximately 7m/sec. in the burning zone. This specification of the velocity for the hot gases is in the range which is common today, namely between 7 and 20 m/sec. Uniform mixing of fuel and material in the pre-heating shaft, and thus uniform heat treatment of the material, is not however achieved, as the gases flowing upwards in the burning zone cannot breakup the strand-like concentration of material and the fuel emits the heat to the outer particles of material of the "strands" so that individual particles are heated too highly and others too little. Moreover, undesirably high exhaust gas temperatures arise, as the quantity of fuel theoretically set to match the quantity of raw material cannot fully transfer its heat for the purpose of dissociating the particles of raw material, and thus heats up the hot flow of gas to an undesirably high degree.

The present invention seeks to enable the mixing together of fuel, raw material and gases containing oxygen so intimately that, while avoiding or reducing some or all of the deficiencies of the known embodiments, the individual particles of fuel can be directly associated with the individual particles of raw material. In subsequent combustion of the fuels, a uniform heat transmission to the raw material can then be ensured.

According to the invention, there is provided a method of thermal treatment of fine grain material comprising pre-heating the material in a pre-heater, roasting the material in a kiln or furnace and subjecting the material to a separate burning process prior to entry to the kiln or furnace in a flow of hot gas with a speed of between 25 and 40 m/sec at the point at which fine grain material and fuel are introduced.

Surprisingly it has been proved that substantially better mixing of fuel, raw cement powder and oxygen required for combustion takes place as a result of this measure so that the individual particles of fuel can be directly associated to the particles of raw powder and optimum transmission of heat is effected from the oxidising fuel to the particles of raw powder.

In this manner partial overburning of the raw powder and its damaging results, for example the formation of molten substances and baking together of the particles of material, can be completely avoided. These damaging results would considerably impair the flowability and ability to disperse of the raw powder in the gas flow. The hot gases flowing upwards at a high speed of 25 to approximately 40 m/sec cause such great turbulence in the exhaust gas pipe carrying gas between the baking furnace or kiln and the pre-heater that the raw powder introduced into the gas flow is separated and finely dispersed immediately and is carried along by the flow of gas almost without delay. The fuel introduced into the gas flow is also finely divided immediately by the turbulent flow of hot gases. Thus the individual particles of fuel meet individual particles of material present in finely dispersed form and optimum conditions of heat transmission to the particles of raw powder occur in the subsequent burning process.

In a refinement of the invention provision may be made for the high speed zone of gas flow to begin in the plane of supply of the material and fuel and for it to be as long as the full combustion path of the fuel supplied to the burning stage. As a result of this measure the turbulent flow of hot gas is maintained to ensure that the finely dispersed fuel particles and the particles of raw powder come into contact with one another over a large period of time, so that they are able to react with the oxygen of the hot gas even at the end of the combustion path. As a result, the entire fuel introduced into the separate burning stage is oxidised with certainty and its heat is produced within the combustion path for the purpose of calcining the raw powder. The specific fuel consumption with the separate burning process is thus reduced, the loss due to the exhaust gas is kept small, and the heat requirements of the entire plant are reduced.

Preferably, the material is injected into the flow of the gas in a direction which differs from the direction of flow of gas, and is preferably at an angle of approximately 90° to 180° to the direction of the flow of gas. As a result of this measure, the fine dispersal of the raw powder in the turbulent gas flow is further improved, particularly if the raw powder is introduced into the flow of gas with a certain kinetic energy so that when the raw powder and turbulent gas flow meet, the raw powder is torn apart suddenly and is dispersed in the gas flow. As a result of this measure too, the raw powder deeply penetrates the flow of gas and is immediately distributed evenly over the cross-section of the exhaust gas pipe carrying the flow of gas.

The hot flow of gas may be drawn directly out of the roasting kiln or furnace. The oxygen required for the separate burning process may however be drawn either through the kiln, or may be supplied entirely separately.

The invention will now be described in greater detail by way of example, with reference to the drawing, the single figure of which illustrates one embodiment of the invention.

The drawing shows in detail an inlet chamber 2 located in front of a rotary kiln 1, the inlet end of which is shown in reduced form. A material supply 3 opens into the inlet chamber 2 from the lowermost cyclone 4 of a suspension pre-heater. Above the cyclone 4 is located a gas off-take 5 also supplied with material, which leads to the next highest cyclone 6 of the pre-heater. An exhaust gas line 7 runs substantially vertically between the inlet chamber of the rotary kiln 1 and the suspension pre-heater. This pre-heater comprises cyclone 4 and several other cyclones. A material supply line 8 from a cyclone 6 and a fuel supply line 9 open into the exhaust gas line 7. The fuel supply line 9 preferably has one or several nozzles arranged in the wall of the exhaust gas line 7, which nozzles are arranged in the vicinity of the material supply line 8, for example, as shown, approximately level therewith. Below the point where the material supply line 8 opens is a deflector device 10 for the material to be treated. An adjustable deflector slide 11 thereof extends perpendicular to the direction of the rising gas flow into the exhaust gas line 7. At the level of the entry of the supply line 8, an air line 12 enters the exhaust gas line 7 which air line 12 is connected to a cooler of the kiln plant which is not shown and which supplies the oxygen to the separate burning stage which is required for the burning process.

In accordance with the method, the following series of events takes place in the embodiment shown.

The hot gas leaving the inlet chamber 2 of the rotary kiln 1 flows in the gas line 7 at a speed between 25 and approximately 40 m/sec. to the lowermost cyclone 4 of the heat exchanger. Strong turbulence occurs as a result of this high speed within the exhaust gas line. Pre-heated raw powder from the cyclone 6 is guided into the turbulent flow of hot gas via the material supply line 8, preferably at a considerable speed and against the impact device 10 so that the concentrated flow of raw powder is finely divided by the slider 11 and forces its way far into the exhaust line 7. Here, this raw powder meets the highly turbulent flow of gas and is momentarily torn apart in the flow and is finely and evenly dispersed over the cross-section of the gas pipe 7, and it is immediately taken along by the flow of gas.

The flow of air which contains oxygen via air line 12 also comes under turbulence immediately from the turbulent hot exhaust flows so that an ideal mixture of finely dispersed particles of raw powder and oxygen enriched hot air is formed. The mixture rises in a turbulent manner in the exhaust gas line 7 and comes into contact with the finely distributed particles of fuel, whereby the particles of fuel surround the particles of raw powder as a result of their intimate and frequent contact therewith. By this means heat is completely transferred for the purpose of calcination of the particles of raw powder.

As the turbulent flow of gas begins approximately in the plane of the supply of material and is at least as long as the combustion path of the supplied fuel, then it may be ensured that the fuel introduced into the separate burning stage for the purpose of achieving a certain degree of calcination has completely transferred its heat energy to the particles of raw powder and none remains in the flow of gas at the end of the combustion path. The particles of raw powder, at least partially calcined, are then separated in the cyclone 4 and are passed from there into the rotary kiln 1 via the raw powder line 3. The hot gases passed out of the cyclone 4 via the gas off-take 5 into the higher cyclone 6 are further processed for the purpose of heating the raw powder passed in counter flow into the upper cyclone stages of the heating exchanger.

The method in accordance with the invention was tested at two different plants for manufacturing cement.

In a plant A for manufacturing cement, a fuel supply device for a separate burning process was arranged in the exhaust gas line between the rotary kiln and the cyclone heat exchanger. Pre-heated raw cement powder was passed out of the heat exchanger into the burning stage and 20% of the quantity of fuel required for the entire manufacturing process was sprayed through the fuel supply device. The speed of the flow of hot gas in this burning stage was set at 15 m/sec. It was established that the exhaust gases leaving the heat exchanger have an exhaust temperature approximately 20°C. higher than was observed under normal conditions, i.e. without a second burning point, because there was insufficient transmission of heat from the fuel to the particles of raw powder.

However, in a manufacturing plant B with the same quantity of fuel fired into the separate burning stage, but a gas flow speed of approximately 30 m/sec. in accordance with the invention, the exhaust temperature was no higher than in the mode of operation of a plant without the second burning point. This can be attributed to the fact that the fuel sprayed in was able completely to transfer its heat energy to the raw cement powder to be treated within the separate burning stage as a result of optimum mixing with the particles of raw powder and as a result of the oxygen in the air required for combustion.

Use of the method in accordance with the invention is not limited to the embodiment shown but may also be applied in any other preburning device, which is arranged between the roasting kiln or furnace and the pre-heater of a heat treatment plant for fine grain material.

WHAT WE CLAIM IS:

1. A method of thermal treatment of fine grain material comprising pre-heating the material in a pre-heater, roasting the material in a kiln or furnace, and subjecting the material to a separate burning process prior to entry to the kiln or furnace in a flow of hot gas with a speed of between 25 and 40m/sec. at the point at which fine grain material and fuel are introduced.

2. A method according to claim 1, wherein the gas flow maintains said speed over a path which is as long as the required full combustion path of the fuel supplied.

3. A method according to claim 1 or 2, wherein the material is supplied in a direction which differs from the direction of the gas flow.

4. A method according to claim 3, wherein the direction of material supply is at an angle of between 90° and 180° to the direction of flow of gas.

5. A method according to any one of claims 1 to 4, wherein the hot flow of gas is drawn directly out of the roasting kiln or furnace.

6. A method according to any one of claims 1 to 5, wherein oxygen required for the separate burning process is supplied separately to the gas flow in the same region of the gas flow as the supply of material and fuel.

7. A method of heat treatment of fine grain material substantially as described herein with reference to the drawing.

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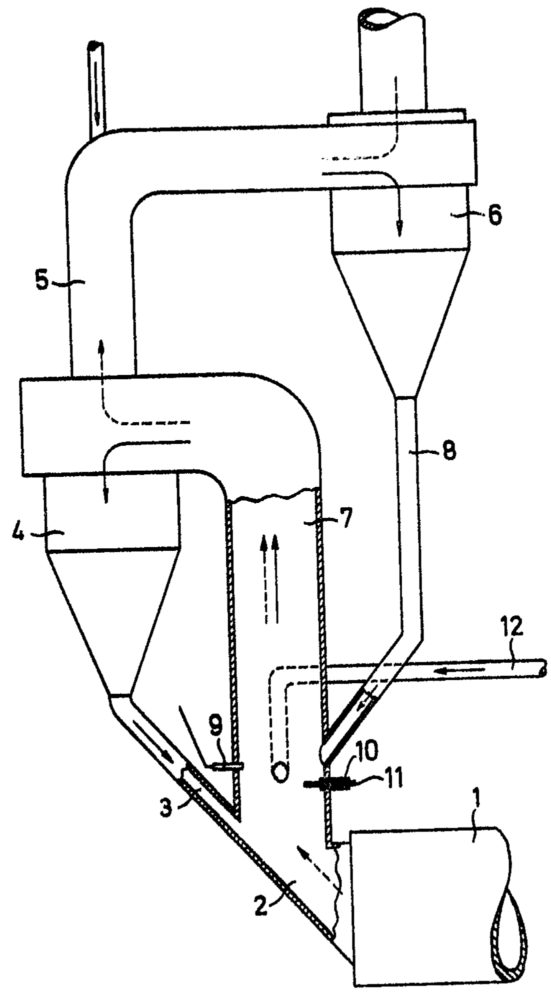
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