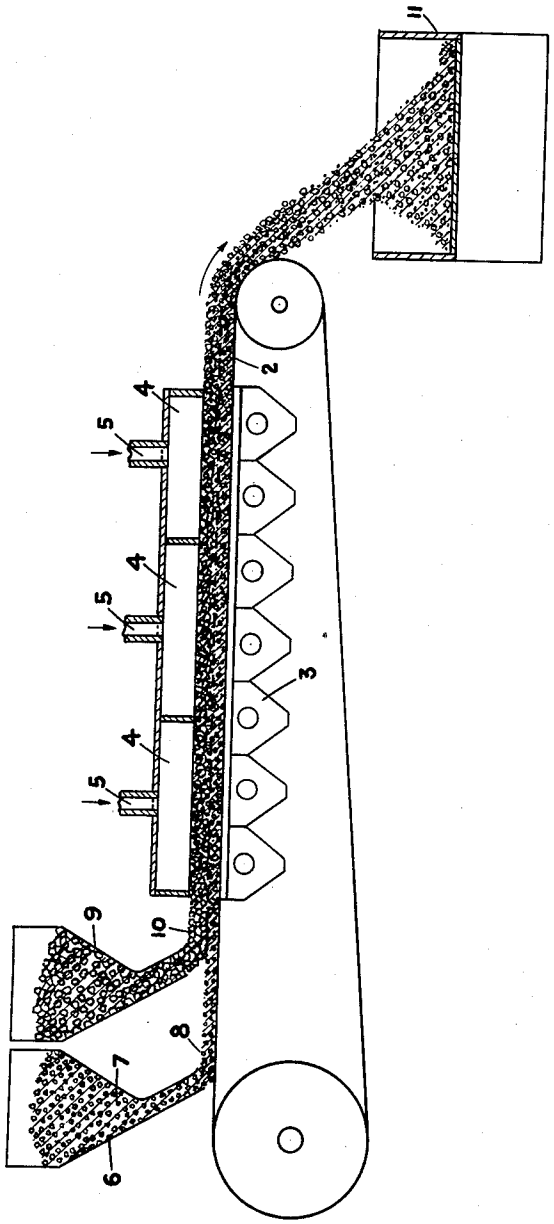
Feb. 2, 1960

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2,923,539

CALCINING OR LIKE PROCESS

Filed May 2, 1956



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United States Patent Office 2,923,539 Patented Feb. 2, 1960

2,923,539

CALCINING OR LIKE PROCESS

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Application May 2, 1956, Serial No. 582,297

3 Claims. (Cl. 263—53)

This invention relates to the calcining or burning of mineral substances and to like operations, and is for a process by which said operations may be effected more uniformly with less contamination of finished product, and with greater economy than is afforded by present methods.

The invention will be specifically described in connection with the calcining or burning of limestone to produce lime, but in its broader aspects it is applicable to the burning or roasting of other mineral substances.

A conventional method for the burning of limestone involves the use of a shaft furnace in which there is a vertical column comprising layers of limestone and coke. Air is forced up through this column and as the coke burns the heated gases drive CO_2 out of the limestone, reducing it to calcium oxide. Usually with this procedure a substantial part of the original material has to be discarded either because it is too fine to be charged into the shaft, or the smaller masses are contaminated with the coke ash in the finished product and are discarded as waste. Only the lump material is considered desirable, and this in many cases is contaminated by ash which is fused thereto. It has been proposed to use gaseous fuels in place of coke, but under most conditions this is too expensive. In other instances it has been proposed to use heated air alone which is passed through the charge, but this results in an unevenly burned or non-uniform product.

It has also been proposed to place the limestone on a continuous sintering band which is carried over a succession of wind-boxes, and to draw hot air down through the sintering band and thereby effect the reaction, but this has proved unsatisfactory because of several reasons, one of which is that the material is non-uniformly burned, some of it being overburned, or sintered, and some of it being insufficiently burned. Another difficulty with the use of a sintering band or suction sintering apparatus of this type is the large volume of air which must be passed through the material and the relatively large amount of power required in this operation as compared to a simple shaft furnace.

The object of the present invention is to provide a method by which such a down draft type of sintering procedure may be used, but which will result in a more uniformly burned product, and one which is less likely to be contaminated by fuel ash, and in which the energy consumption, while somewhat more than the cost of operating a shaft furnace, is more economical due to the higher yield of useable product from each ton of raw material.

The invention may be more readily understood by reference to the accompanying drawing which is a schematic longitudinal section through a continuous band sintering apparatus designed for the practice of this process.

Referring briefly to the drawing, it shows a continuous sintering band 2 of any usual or preferred construction. Generally it comprises a connected series of pallets having a grate-like bottom which supports the charge, and through which air may be drawn. Under the top reach of this continuous band there is a series of wind-boxes 3 over which the band moves and in which suction is maintained by draft fans or other devices (not shown). Over the top of the band are a succession of hoods or enclosures 4 having inlets 5 through which heated gases such as heated air or hot oxygen containing combustion gases may be introduced into each hood and drawn by suction through the charge which is carried on the surface of the belt 2.

According to the preferred procedure of the present invention, finely divided limestone, that is limestone crushed to a size between about 3 and 15 mm., is mixed with coke, anthracite or other suitable solid fuel in an amount which is insufficient to convert the limstone into lime under ordinary combustion procedures. In the drawing, 6 designates a hopper for feeding this mixture 7 onto the top of the endless band 2, and the charge of coke and granulated limestone on the belt is designated 8. Placed on top of this charge of coke and limstone is a second layer of crushed limestone which is coarser than the limestone in the first layer, it ranging in a mesh size from 15 to 30 mm., although the exact size is not critical. It will be noted that the second layer is comprised of limestone only without any admixture of coke or other fuel. 9 designates the hopper for discharging this material onto the layer 8, and the upper layer of limestone is designated 10. The layer 10 is substantially thicker in depth than the layer 8.

After the charge has been formed on the belt into two layers as thus described, it is carried progressively under the hoods 4 where hot gases, preferably oxygen containing gases, such as air, or combustion gases containing a surplus of air are drawn down through the charge and carried off through the wind-boxes 3. The gas is at a temperature of 1100° C. to 1200° C. In the initial part of the travel the hot gases contact the upper layer, driving out carbon dioxide, the heated gas and carbon dioxide passing down through the bottom layer. In this initial part of the travel the temperature of the gas reduces quite rapidly so that by the time it reaches the lower layer the temperature is insufficient to ignite the coke, while the concentration of carbon dioxide is so high as to suppress combustion, but the temperature of the bottom layer is gradually increased. As the belt progresses, it continues to travel under the hoods 4. The temperature of the air or other oxidizing gas reaching the lower layer will constantly increase due to the less absorption of heat in the upper layer, and at the same time the content of CO_2 will diminish because of the material in the top reaching a more complete state of reduction or de-acidification. Eventually the kindling temperature of the coke around 700° C. will have been reached and the gas, which must now be air or oxygen containing gas, coming through from above will support combustion so that burning takes place in the lower layer, some heat then being supplied in the lower layer by combustion of the coke, and some being supplied by the incoming gases. By the time the top layer has been completely burned, combustion will have been completed in the lower layer and the limestone will have been uniformly burned. It will be seen that by this procedure the larger pieces of limestone are subjected to the highest temperature for the longest period of time, and that the small pieces in the bottom layer are subjected to heat sufficient to convert it to lime for a shorter period of time. This has several advantages in that it permits the finer material which can not be used in a shaft furnace at all to be beneficially processed by the present method. The temperature reached in the lower layer can always be kept to a point below that at which the coke ash will combine with or adhere to the

lime or other mineral being processed, and upon completion the coke ash will be a dust which can be easily separated out with a wind or other suitable type of separator, schematically indicated at 11. Because part of the heat is generated by the combustion of the coke, the volume of air required to effect the burning of the lime is very substantially reduced, and therefore the power requirements of the process are made low enough so that the other economies effected by the process make it comparable to, or more economical than, the conventional shaft furnace or rotary kiln.

With the present invention the pressure difference between the top and bottom of the bed need only be of the order of 20 to 40 mm. of water, and the volume of gas can be reduced to approximately 20 to 25 $m.^3/min./m.^2$ of grate surface in contrast to the rate of 85 $m.^3/min./m.^2$ of grate surface required in normal practice. It is especially possible to reduce the volume of hot gases after the solid fuel in the lower layer has been ignited. Not only is the volume of oxidizing gas reduced, but the CO_2 content of the flue gases is higher. Because of the condition of burning, the coke ashes in the lower layer do not combine with the lime, but are reduced to a powdered state and can be removed from the product by wind sifting.

The power necessary for the operation of the sintering band is also substantially reduced from 45–48 kw. h. per ton of CaO to approximately 15 kw. h. per ton of CaO. This is only slightly higher than that required for the reduction of a ton of lime in a shaft furnace where the power cost is of the order of 5 to 8 kw. per ton of CaO, and the slight difference of power cost in favor of a shaft furnace is offset by the other economies of this process.

The same procedure of using two layers on a sintering band, one of which contains solid fuel and the other of which does not, can be advantageously used for other operations, as for example the sintering of pellets or the chlorinating and roasting or sintering of certain pyrite substances where chlorine is mixed with the heated air.

It will be understood that the apparatus illustrated is merely schematic and that the invention is not restricted to any particular form of apparatus, but finds its utility in connection with the down draft process of sintering, burning or roasting, and as above indicated, while especially efficient in the burning of lime, is adaptable to other processes.

What is claimed as new is:

1. A process for the burning of lime which comprises subjecting the limestone to a down draft of hot oxygen containing gases and in which the limestone is arranged in two layers with the under layer being constituted of finely crushed limestone particles mixed with solid fuel and the upper layer being comprised of more coarsely crushed limestone fragments only, heat being supplied to the upper layer exclusively from the hot oxygen containing gases until it is partly calcined.

2. The method of burning limestone on a continuous down draft sintering apparatus which comprises first charging a layer of finely divided limestone mixed with solid fuel on the sintering band and then applying a coarser layer of limestone fragments only on the first layer and progressively moving the band on which the layers are so formed through a down draft of heated oxidizing gas as the exclusive source of heat and in which the temperature of the gas initially contacting the charge on the band is sufficiently high to release carbon dioxide from the limestone fragments which it first contacts, and igniting the fuel in the first layer only after the upper layer has been partially calcined.

3. The method of calcining both fine and coarse carbonate rock to reduce it to an oxide and prevent overburning of the fine or the sintering thereof to fuel ash, which comprises mixing the fines with coke and placing the mixture on a down-draft sintering band, covering the mixture with coarse fragments of rock only, and then drawing heated oxidizing gas down through the bed of material so formed to provide the only heat for the initial stage of the operation, whereby said coarse fragments will be first contacted by the hot gases and cool the gases and liberate carbon dioxide which will retard the combustion of the solid fuel, continuing such operation of supuplying hot gases as the only source of heat until the coarse fragments have become heated and partially burned and to a point where the heated gases are sufficiently hot to ignite the solid fuel and the volume of carbon dioxide liberated from the coarse fragments ceases to prevent combustion, and thereafter continuing the operation until the solid fuel is reduced to ash, the coarse fragments thereby being burned for the entire period of treatment while the fines are initially protected and reduced only after the calcining of the coarse material is well advanced.

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