

[54] METHOD AND FURNACE FOR HEAT TREATING MATERIAL

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[51] Int. Cl.² F23J 15/00; F27B 7/02

[58] Field of Search 432/2, 26, 72, 78, 79, 432/106, 116, 117

[56] References Cited

UNITED STATES PATENTS

3,671,027	6/1972	Frans	432/117
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Primary Examiner—John J. Camby

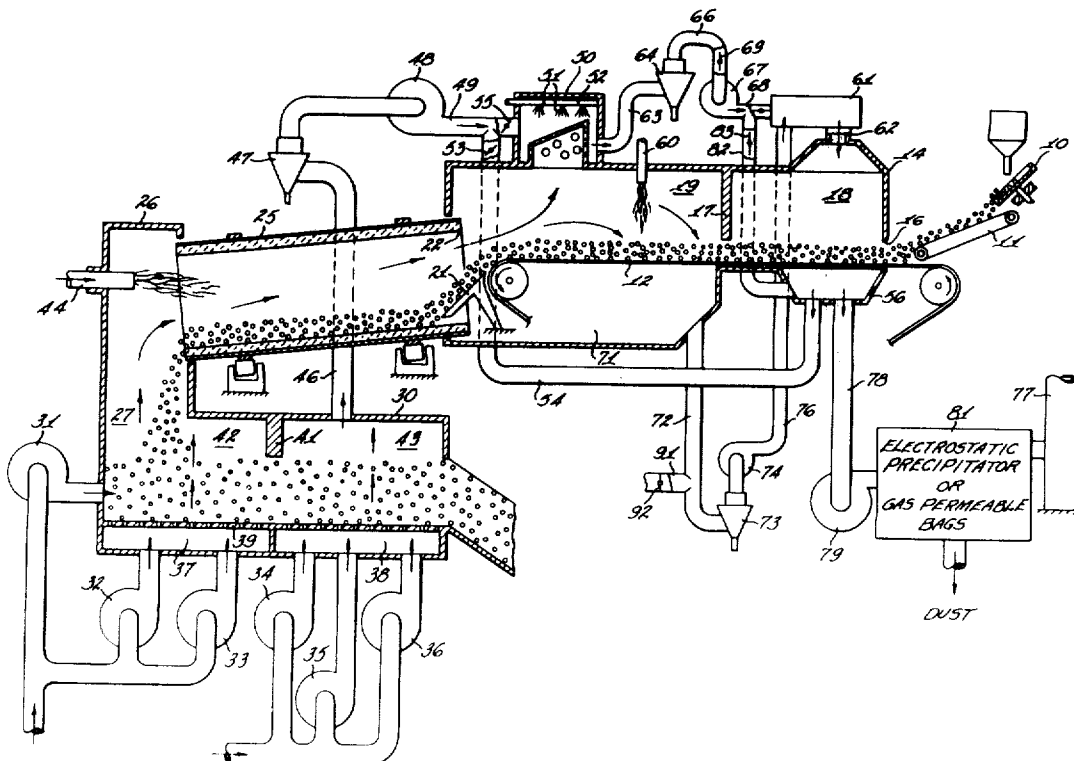
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[57] ABSTRACT

Exhaust gas from the cooler is pulled through a mechanical dust collector by a cooler recoup fan and de-

livered as tempering air to a mixing box in which moisture is added to moisturize and also temper the hot bypass gases. The portion of hot gases coming from the kiln and passing into the preheat or preburn chamber that is drawn into the mixing box where such gases were mixed with atmospheric air in U.S. Pat. No. 3,653,645 are mixed with either cooler exhaust air and tempering water or a combination of cooler exhaust air and tempering water and atmospheric air. Excess cooler exhaust gases not utilized in the mixing box are directed to the windbox of the furnace preconditioning chamber on the suction side of the grate to raise the exhaust gas temperature from the grate above acid dew point which reduces corrosion problems. The exhaust gases having a controlled moisture content are cleaned in an electrostatic precipitator and exhausted through a stack. Utilizing the recouped cooler gases as a tempering medium for the gases from the preheat chamber of the furnace eliminates the need for a cooler electrostatic precipitator or gas permeable bags, lowers fuel consumption at the required higher grate waste gas temperature, lowers total system waste gas volume with properly moisturized waste gas providing better electrostatic precipitator performance and maintains the waste gas temperature above acid dew point.

10 Claims, 1 Drawing Figure



METHOD AND FURNACE FOR HEAT TREATING MATERIAL

BACKGROUND OF THE INVENTION

The present invention relates to a method and apparatus for burning limestone and clay to produce Portland cement low in alkali. The invention provides improvements in the methods and apparatus disclosed in U.S. Pat. Nos. 3,313,534 and 3,653,645.

The above-mentioned patents disclose systems in which minerals are deposited on a traveling grate and carried through a drying or conditioning chamber, a preheat chamber, and then are deposited in a rotary kiln for final burning. Hot gases in the kiln heat the minerals to high temperatures and then pass from the kiln to the preheat chamber preburning the material before passing up a waste gas stack at a low temperature. Other patents relating to such systems include Lellep U.S. Pat. No. 2,580,235; Stowasser U.S. Pat. No. 2,925,336; Baxa U.S. Pat. No. 3,110,483; and Bade U.S. Pat. No. 3,110,751.

Problems in the operation of the systems disclosed in the aforementioned patents is that the number of electrostatic precipitator or gas permeable bag dust collectors required, the higher fuel consumption and/or high maintenance cost due to corrosion resulting from an acid dew point problem. The problem of acid dew point in gases directed to the stack relates to the inability of controlling both the temperature and the moisture content of the gases. As a result, serious corrosion problems are experienced both in the precipitator and in the stack.

It is, therefore, an object of the present invention to provide an improved method and apparatus for utilizing the waste gases of the cooler as tempering air in lieu of ambient outside air and moisturizing the bypass gases and utilizing such gases in the preconditioning chamber of a furnace to effect a considerable reduction in system fuel consumption at a higher grate waste gas temperature.

Yet another object of the present invention is to provide an improved method and apparatus for utilizing recouped gases and moisturized bypass gases at the suction side of the preconditioning chamber to effect both temperature and moisture control of the gas directed to the exhaust precipitator and stack.

Still another object of the present invention is to provide an improved method and apparatus for utilizing excess waste gases of the cooler at the suction side of the preconditioning chamber to effect temperature control of the gases directed to the exhaust electrostatic precipitator and stack.

A further object of the present invention is to provide an improved method and apparatus for heat treating materials in which a cooler electrostatic precipitator or gas permeable bag is eliminated.

A still further object of the present invention is to provide an improved method and apparatus for keeping waste gas temperature above acid dew point to reduce the effects of corrosion.

SUMMARY OF THE INVENTION

According to the present invention, provision is made for pulling cooler exhaust gases through a mechanical dust collector by a cooler exhaust fan which delivers the gases to the grate. Control of these gases is effected so that most of the gases go to a bypass mixing

box with the balance of the gases being directed to the grate waste gas system. A tempering air damper controls the temperature of the bypass gases while the cooler recoup excess air duct damper controls the duct pressure to the bypass mixing box. Moisture is added to the bypass gases in the mixing box to provide a controlled moisture content. The moisturized gases from the mixing box are delivered at the desired temperature or a higher temperature to the hot end of the preconditioning chamber or to a temperature averaging box where they are tempered by the off-gas from the preheat chamber so that the temperature of the mixture of gases delivered to the preconditioning chamber is at the desired controlled temperature. Some of the bypass gas from the preheat chamber is delivered to the suction side of the preconditioning chamber windbox where it is mixed with the off-gases of the preconditioning chamber. This gas mixture is blended with the higher temperature excess cooler exhaust gases prior to delivery to an electrostatic precipitator and stack at a temperature above acid dew point and having a predetermined moisture content by volume.

DESCRIPTION OF THE DRAWINGS

The FIGURE is a diagrammatical view in side elevation, partly in section, of an apparatus for performing a process according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the FIGURE of the drawing, raw material is prepared for the apparatus to be described, by a suitable agglomerating device which may be as shown; for example, a balling or pelletizing pan 10 or a drum. A feeder 11 deposits the green (i.e., untreated) pellets of raw materials on a gas pervious traveling grate 12. A housing structure 14 is arranged to enclose a space over the grate 12 and define a material inlet opening 16. A baffle wall 17 is suspended from the roof of housing 14 to a predetermined distance above grate 12 and operates to divide the space enclosed by housing 14 into a preconditioning or drying chamber 18 and a preheat or preburn chamber 19. Green pellets on grate 12 will be transported through the drying chamber 18, then the preburn chamber 19, and then discharged down a chute 21 into an inlet opening 22 of a refractory lined rotary kiln 25.

Rotary kiln 25 slopes downwardly from chute 21 toward a hood 26 that encloses the discharge end of the kiln 25 and defines a passage 27 from kiln 25 to a cooler 30. The downward slope of the rotary kiln 25 causes material received from chute 21 to pass through kiln 25, then into hood 26 and through passage 27 to the cooler 30, which may be a device as shown in U.S. Pat. No. 2,256,017 of 1941, divided into stages as will be described.

The cooler 30 is provided with blowers 31, 32, 33, 34, 35 and 36 which may be driven by variable speed driving motors (not shown) that blow controlled quantities of air upwardly through windboxes 37, 38 and then through material on an air pervious grate 39. A baffle 41 may be provided to divide cooler 30 into a first stage or primary cooling chamber 42 and a second stage or final cooling chamber 43 over grate 39. Cool air supplied by blowers 31, 32 and 33 is blown upwardly through windbox 37, grate 39, chamber 42, and passage 27 into the firing hood 26. A burner 44 is mounted on and projects into the interior of hood 26 to

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deliver and burn fuel that raises the temperature of gases passing into kiln 25 to the desired high temperature level required for material receiving heat treatment in the kiln. Gas flow input from the discharge end of kiln 25 and up chute 21 and into the material preheat chamber 19 will be in a temperature range of 1,800°-2,500° Fahrenheit.

The waste gas from the cooler 30 is recouped and utilized in the drying or preconditioning chamber 18. To this end, the cooler gases in the upper portion of the final cooling chamber 43 is drawn into an exhaust duct 46 leading to a mechanical dust collector 47. The cooler gases are drawn from the mechanical dust collector 47 by a cooler recoup fan 48. The recouped gases are passed by fan 48 into a duct 49 and thence into a ported cage mixing box 50 and utilized as tempering gases therein. Mixing box 50 communicates with the upper interior portion of the preheating section 19 so that a portion of the hot gases flowing from the upper end of the kiln 25 are drawn into the mixing box 50. The other portion of the gases from the kiln which does not pass into the mixing box is mixed with auxiliary heat from a burner 60, and the mixture passes through the material on the grate 12. The gases drawn into the mixing box 50 are at a temperature in the range of 2,200° Fahrenheit. The 2,200° Fahrenheit temperature of these gases is much too hot to utilize in drying section 18. Thus, the cooler gases from the final cooling section 43 are mixed with the bypassed portion of gases from the kiln 25 in the mixing box 50. The recouped mixed gases are also moisturized in the mixing box 50 by means of sprays 51 that are a part of a water system 52. Pressure in tempering air duct to the mixing box 50 is maintained constant by means of a motorized damper 53 in an excess recoup gas duct 54. A damper 55 in the duct 49 regulates the quantity of the tempered air that is passed into the mixing box 50. The opposite end of the excess recoup gas duct 54 is in communication with the suction or negative pressure side of the preconditioning or drying section 18, mixing box 50 of the furnace, and a portion of the gases obtained from the cooler chamber 43 is utilized therein as will be subsequently described. Thus, excess recouped gases are bypassed into the duct 54 and directed to the suction or negative pressure windbox 56 of the preconditioning chamber 18.

The tempered and moisturized gas in the mixing box 50 is directed to an inlet or inlet manifold 61 which communicates with the preconditioning chamber 18 via a duct 62. To this end a duct 63 operates to connect the mixing box 50 with a mechanical collector 64 where the dust is collected. From the mechanical collector 64 the tempered gas is drawn through a duct 66 by a fan 67. A duct 68 connects the fan 67 to the manifold 61. The total volume of the bypass gas from the mixing box 50 to the fan 67 is controlled by a damper 69 located in the duct 66.

The off-gas in the lower portion of the preheating chamber at substantially 600° Fahrenheit are drawn off into a connecting duct 72. The alkali laden gases are passed through a mechanical collector 73. From the collector 73 a fan 74 forces the gases via a connecting duct 76 into the manifold 61 associated with the preconditioning chamber 18. The gases in the negative pressure windbox 56 side of the chamber 18 are waste gases which are disposed of to a stack 77 via a duct 78 connected to the windbox 56 and a fan 79 which blows the waste gases through a connected electrostatic pre-

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cipitator 81. However, the temperature of the gases to the stack must be controlled. This is necessary because of the electrostatic precipitator 81 or gas permeable bags utilized at the stack. It has also been found that by controlling the temperature of the waste gases from the preconditioning chamber 18 to 200°-300° Fahrenheit and insuring that the gas has a moisture content of about 10 percent or higher by volume, the gases to precipitator 81 and stack 77 will be above acid dew point thereby materially reducing corrosion effect. To this end a portion of the moisturized gases flowing in duct 68 is diverted into a connecting duct 82 which communicates with the windbox 56 of the chamber 18 below the grate 12 on the negative pressure side thereof. This moisturized gas mixes with the excess recouped cooler gases and the off-gases from the preconditioning chamber 18 to temper the temperature of the waste gases passed to the electrostatic precipitator 81 and thence to the stack 77. Thus, control of the waste gases is effected so that the waste gas temperature is maintained at substantially 250° Fahrenheit which is above the acid dew point and at the same time maintaining the moisture content of the waste gases at substantially 10 percent or higher by volume.

A damper 83 in duct 82 operates to establish the ratio of the gases passed to the manifold 61 and thus to the preconditioning chamber 18. Therefore, the temperature of the reclaimed gas utilized for drying the material in the preconditioning chamber 18 can be controlled as desired.

By recouping the cooler gases and tempering the extremely hot gases from the kiln with the gases from the cooler chamber and adding moisture to the mixed gases and utilizing the moisturized recouped gas as drying gases in the preconditioning chamber 18, a considerable saving in fuel is obtained. With the recouped bypassed gas to the preconditioning or drying chamber, the drying gases are maintained at 500°-600° Fahrenheit without an excess of system fuel being utilized to effect the complete drying of the green pellets passing through the chamber 18. With the green pellets being completely dried in the preconditioning chamber 18, the temperature in the preheat chamber 19 can be elevated so that the pellets are essentially calcined before entering into the kiln 25.

In the event that the temperature of the gases passing from the lower portion 71 of the preheat chamber 19 to the manifold 61 is too high to be utilized in the preconditioning chamber 18 for drying purposes, provisions have been provided to temper these gases. To this end, an ambient air duct 91 is connected to the duct 72 and will pass ambient air into the duct 72 when desired. However, in the usual operation, it is not necessary to temper the gases passing from the lower portion 71 of the preheat chamber 19. Thus, a damper 92 in the duct 91 is normally closed to effectively block any substantial flow of ambient air into the duct 72.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. In a mineral furnacing apparatus having structure defining at least a chamber for preconditioning material having a material inlet opening, a chamber for preheating material, a chamber for final heating material having a material inlet opening adjacent the preheating chamber and having a material outlet opening and at least one cooling chamber having a material inlet opening adjacent the material output opening of the final

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heating chamber, the chambers being connected together in series flow arrangement to define a material flow stream from the preconditioning chamber to the preheating chamber, to the final heating chamber and thence to cooling chamber with the final heating chamber and the preheating chamber defining a passage for a counterflow of gas from the final heating chamber to the preheating chamber, and gas conveying means connecting said cooling chamber and said preheating chamber to said preconditioning chamber, said gas conveying means comprising:

A mixing box connected to the preheating chamber in which gases at a relatively high temperature are produced in position adjacent the material inlet passage of the final heating chamber and on a side of the material stream facing the flow of gas through the passage;

a first duct means connected on a first end thereof to said mixing box and connected on a second end thereof to said mixing box and connected on the a second end thereof preconditioning chamber;

a preheating chamber windbox operatively disposed below the material stream;

a second duct means connected on a first end thereof to the preheating chamber windbox and a second end thereof being connected to the preconditioning chamber at a location above the material stream;

a third duct means connected on a first end thereof to said mixing box and connected on a second end thereof to the cooling chamber; and,

moisturizing means connected to said mixing box to moisturize the gases in said mixing box;

whereby the gases from the preheat chamber are tempered with gases from the cooler chamber and said mixture of tempered gases are moisturized and directed to the preconditioning chamber as preconditioning gases at a controlled temperature for drying material in the preconditioning chamber and for controlling waste gas temperature and moisture content.

2. A mineral furnacing apparatus according to claim 1 wherein there is a fourth duct means connected on a first end thereof to said third duct means at a position to bypass some of the cooling chamber gases around said mixing box, said fourth duct means on a second end thereof being connected to the windbox of the preconditioning chamber at a location on the side of the material stream opposite to the flow of the tempered moisturized gas to the material in the preconditioning chamber; and,

a fifth duct means connected on a first end thereof to said first duct means at a location ahead of the connection of the second end of said first duct means with the preconditioning chamber, said fifth duct means on a second end thereof being conducted to the windbox of the preconditioning chamber on the same side thereof to which said second end of said fourth duct means is connected to the windbox of the preconditioning chamber;

whereby moisturized tempered gases from said mixing box is directed to the preconditioning chamber and mixed with gases from the cooler chamber to temper the temperature of the exhaust gases from the preconditioning chamber to a desired temperature and moisture content.

3. A mineral furnacing apparatus according to claim 2 wherein there is also provided a dust collecting means

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operably connected to said preconditioning chamber windbox

4. A mineral furnacing apparatus according to claim 1 including a fan in said third duct means between the cooling chamber and said mixing box for drawing gas out of the cooler chamber and delivering the gas to said mixing box; and,

a dust collecting and discharge means in said third duct means between said cooler chamber and said fan operable to collect dust particles larger than 10 to 20 microns.

5. A mineral furnacing apparatus according to claim 2 wherein there is provided a dampener means in said fourth duct, said dampener means being operable to maintain a constant pressure in the tempering air duct to the mixing box.

6. A mineral furnacing apparatus according to claim 3 wherein said moisturized exhaust gases from said preconditioning chamber are directed into an exhaust duct connected on a first side to said preconditioning chamber windbox in a location below the material flow stream, and connected on a second end thereof to an exhaust stack;

a fan in said exhaust duct means for drawing the moisturized and tempered exhaust gas from the preconditioning chamber windbox into the stack; and,

a dust precipitator connected in said exhaust duct and operable to collect particles smaller than 10 to 20 microns for removing the particles prior to the gas being directed to stack;

whereby moisturized exhaust gases from the preconditioning chamber windbox at a temperature above acid dew point is drawn therefrom and passed to said precipitator for filtering prior to being passed to said stack.

7. A mineral furnacing apparatus according to claim 6 wherein said exhaust duct fan is operable to provide a negative pressure on the order of 2 to 16 inches of water column in the preconditioning chamber windbox at the below the stream of material.

8. In a process for heat treating material in a material treating furnace arrangement in which a stream of material is progressed through a preconditioning chamber, a preheat chamber, a final heating chamber in which gases and volatilized alkalies are produced from the material therein and a cooler chamber in which gases from material being cooled are recouped and passed to the final heating chamber; comprising the steps of:

A. bypassing a first portion of the gases and volatilized alkalies produced in the final heating chamber away from the material in the preheat chamber;

B. tempering the first portion of the gases and volatilized alkalies with low temperature recouped gases from the cooler chamber;

C. mixing the first portion of the gases and volatilized alkalies from the final heating chamber with the low temperature gases from the cooler chamber;

D. moisturizing the mixture of gases of step C;

E. directing a portion of the moisturized gases to the preconditioning chamber;

F. drawing a second portion of the gases from the final heating chamber into contact with material in the preheating chamber;

G. drawing the second portion of gases from the final heating chamber that has contacted the material in the preheating chamber through the material;

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H. admitting a supply of auxiliary heat into the preheating chamber and into contact with the second portion of the gases from the final heating chamber after the first portion of the gases from the final heating chamber has been directed away from the second portion gases and as the second portion of gas is drawn through the material in the preheating chamber;

I. joining the gases which have passed through the material in the preheating chamber with a first portion of the moisturized gases of step E to heat the material in the preconditioning chamber;

J. drawing the material heating gases in the preconditioning chamber through the material therein for exhausting the gas and also drawing a second portion of the moisturized gases and a second portion of the gas from the cooler chamber into the winbox of the preconditioning chamber to raise the temperature of the exhaust gas that has passed through the material in the preconditioning chamber before passing the exhaust gases to stack, so that the temperature of the gases passing to stack are above acid dew point and have a 10 percent or higher moisture content by volume.

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9. In a process for conditioning waste exhaust gases from a material heat treating furnace having a material preconditioning section including a windbox, a material preheat section, a kiln and a cooler; comprising the steps of:

A. passing a varying amount of bypass gas from the cooler sections of the furnace to the windbox of the preconditioning section; and,

B. blending the combined bypass gas and spent off-gas from the preconditioning section with off-gases from the preheat section in the windbox of the preconditioning section to establish a minimum temperature of the waste exhaust gas.

10. A process for conditioning waste exhaust gas according to claim 9; including the additional steps of: moisturizing said bypass gas; and,

wherein the blending of the gases in the windbox of the preconditioning section is controlled to establish the minimum volume of exhaust gas and at a temperature above acid dew point and with a minimum moisture content of 10 percent or higher by volume.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,920,380

Dated January 14, 1976

Inventor(s) Glenn A. Heian

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 4, line numbered 68, "output" should be ---outlet---

Column 5, line numbered 21, "said mixing box and connected on the a second end thereof" should be deleted.

Column 5, line numbered 22, ---the--- was omitted before the word "preconditioning".

Column 6, line numbered 41, "windbow" should be ---windbox---

Column 7, line numbered 17, "winbox" should be ---windbox---

Signed and Sealed this

twenty-third Day of March 1976

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks