Title: METHOD OF INCREASING THE CLINKER OUTPUT OF AN EXISTING CEMENT PLANT AND OF PRODUCING STEAM

Abstract: In a method of increasing the clinker output of an existing cement plant and of producing steam, a raw meal is preheated in a preheater (50), then burned in a rotary kiln (16) to form clinker, and the clinker is cooled in a clinker cooler (20). Calcined raw meal, consisting essentially of lime and combustion residues like ash, carbon and desulfurization residues is fed to the preheater (50). Process air from the clinker cooler (20) is directed to the preheater (50) in countercurrent flow to the direction of flow of the calcined raw meal. The calcined preheated raw meal is directed to the rotary kiln (16). The kiln exhaust gases are 100% bypassed and used for steam production in a boiler (60). The kiln exhaust gases are quenched to a temperature of about 800-900°C prior to their heat exchange in the water/steam cycle.
Method of increasing the clinker output of an existing cement plant
and of producing steam

Field of the invention

The invention relates to a method of increasing the clinker output of an existing
cement plant and of producing steam, said method comprising the steps of pre-
heating a raw meal in a preheater, said preheater being a multistage suspen-
sion type preheater including a plurality of serially connected cyclone type gas
solids separators, burning the preheated raw meal in a rotary kiln to form
clinker, and then cooling the clinker in a clinker cooler.

Discussion of Background

In prior art cement plants the cement raw meal is introduced at an inlet at the
top of the preheater, passing through the preheater in counter-current with the
exhaust gases from the kiln. The exhaust gases are drawn up through the pre-
heater and discharged by means of an exhaust gas fan. The raw meal is con-
veyed from the preheater to the rotary kiln where, by means of heat from a
burner, the raw meal is burnt into clinker. The clinker drops into the cooler
where it is cooled using air.
It is known in cement technology that many materials for cement clinker manufacture contain secondary constituents such as alkali compounds, chlorine, sulfur, heavy metals, etc. which evaporate in the region of the sintering zone as alkali chloride and alkali sulfate compounds. They condense again in the pre-heating region and thus build circulations, which not only adversely affect the quality of the cement clinker, but can also considerably damage the process itself. To suppress an alkali circulation in a cement clinker combustion apparatus, as well as to reduce the alkali content in the cement clinker, it is known to bifurcate and lead away a part of the kiln exhaust containing alkali compounds through what is known as a gas bypass (5-20% of kiln gas).

Particularly in connection with the raw material with a high content of sulfate, it is very important to control temperature variations in the burning zone. This is due to the tendency of the sulfate to decompose into SO₂ in the burning zone (1200-1400°C) and to condense in the cooler regions of the kiln (700-900°C). When the burning zone temperature is increased, the evaporation of SO₂ will increase, which will result in higher concentrations of sulfates in the cooler regions of the kiln. It has been found that in the presence of significant concentrations of sulphurous material in the preheating zone, the condensation of chlorides on the preheater feedstock particles results in the formation of a minor, but significant, quantity of a melt phase at temperatures as low as 680°C, which, upon reaction with the oxide components in the feedstock at the high CO₂ partial pressures prevailing in the suspension preheater cyclones, solidifies through the formation of the mineral spurrite (2C2S·CaCO₃). With more than 5% spurrite in the feedstock the situation may become so critical that continued kiln operation becomes impossible because of ring formations in the kiln or the formation of build-ups or blockages in the preheater system.
If the burning zone temperature has decreased too much, a severe dust circulation between kiln and cooler may result and continued kiln operation becomes impossible unless the sulfate input is reduced or eliminated.

A method of preparing cement clinker from carboniferous shale is described in US 4, 256, 502. The increase of the clinker output is done via a second tower by injecting shale into that second tower; the kiln gas is treated within this second tower, which in normal operation is to be considered as a 100% bypass. If this known plant is run with tower 13 alone then there is no kiln gas treatment. The gas is added to the cooling air prior to calciner 18. And there is no increase in clinker output, as limestone is introduced (which moreover has to be calcined after preheating). If the known plant according to US 4, 256, 502 is run with both towers 13 and 20, but without injecting shale, than the kiln gas is directed through tower 20 as in prior art plants, i.e. there is neither kiln gas treatment nor clinker increase.

**Summary of the invention**

Accordingly, the object of the invention is to increase the clinker output of an existing cement plant by utilizing major parts of the plant unchanged and to produce steam of high parameters with gaseous media of the cement plant in considerably reducing the above described disadvantages.

This is achieved, according to the invention, in that the raw meal fed to the preheater is calcined raw meal, consisting essentially of lime and combustion residues like ash, carbon and desulfurization residues.

The advantages of the invention are to be seen in that, inter alia, in avoiding calcination of the material fed to the preheater, a considerably reduction of the
specific kiln heat consumption is performed. In fact if the raw meal is introduced in calcined form, a considerable increase in clinker production is performed while burning the same amount of the fuel in the kiln. Moreover, on the contrary to prior art arrangement of cement plants in which the hot clinker cooler air is one of the main sources of losses, in the proposed new arrangement it is possible to use the hot air of the clinker cooler to a maximum extend. Thus the use of hot cooler air for preheating the precalcined material as well as the use of the kiln gases for steam production means another reduction of the specific kiln heat consumption. Moreover this air is free from \( \text{SO}_2 \) thus avoiding or at least significantly reducing the risk of blockages in the preheating zone, as the sulphurous material is introduced directly at the kiln inlet at a temperature greater than 800 C.

Furthermore the new method allows to significantly reduce the flue gas generated per kg of produced clinker and therefore the specific energy losses associated with the kiln flue gases are less.

The use of the calcined raw mix according to this method leads to an overall reduction of \( \text{CO}_2 \) and \( \text{NO}_x \) emissions associated with the amount of clinker produced.

In comparison to US 4, 256,502 the new method avoids recarbonation of the lime within the tower in bypassing the gas. There is no need for a second tower to increase the clinker output and no need for a calciner between the tower and the kiln.

In a suggested scenario to produce calcined raw meal for the cement production in a power plant, it is assumed that the power plant delivers power to the grid and produces a mixture of sulfated lime (degree of sulfating around 2-10%) and combustion residues like ash and carbon. Using this lime and the residues as cement raw material makes it possible to reduce considerably the heat consumption associated with the clinker production in the cement plant and at the same time, increase the production of the clinker.
It is known that lime can re-carbonate \((\text{CaO} + \text{CO}_2 \rightarrow \text{CaO}_3)\) above the 540°C and below the 800°C that is the typical temperature range of the solids in the last cyclones of the pre-heater tower. The new method avoids this problem, as the preheating medium does not contain \(\text{CO}_2\).

The method is particularly interesting when the cement plant and the power plant producing the calcined raw mix are located on the same site. The use of the combustion products like ash and carbon of the power process in the cement process avoids disposal of solids from the power plant.

It is particularly expedient if the kiln exhaust gases are quenched to a temperature of about 800-900°C prior to their heat exchange in the water/steam cycle. This measure avoids the building up of sticky material forwarded to the downstream boiler.

If the kiln exhaust gases, after their heat exchange in the boiler are fed to a circulating fluidized bed boiler of a power plant, the \(\text{NO}_x\) component of the gases shall be further reduced.

Part of the process air from the clinker cooler can be directed, after de-dusting, to a steam producing heat exchanger, which preferably is a heat recovery boiler. The temperature of this process air can be increased using a supplementary firing system to produce steam of high parameters in the heat recovery boiler. This increases the output of the power plant. Of course the produced steam can also be used in other processes than power production. Moreover the supplementary firing allows adjusting the steam parameters as required by the end user.
Brief description of the invention

A more complete appreciation of the invention and many of the attendant advantages thereof will be readily obtained as the same becomes better understood by reference to the following detailed description when considered in connection with an exemplary embodiment schematically shown in the accompanying drawing. The only figure illustrates the apparatus involved in the increased cement production and the preparation of the calcined raw mix in a power plant with a circulating fluidized bed steam generator. Only the elements essential for understanding the invention are shown. Arrows illustrate the flow direction of the working media.

Description of the preferred embodiment

Referring to the drawing, the existing equipment necessary for performing the cement production consists mainly of a raw mix preheater 50, a rotary kiln 16 and a clinker cooler 20.

The preheater 50 is a vertically arranged multistage suspension type preheater including a plurality of serially connected cyclone type gas/solids separators 51-54. The cyclones each have an inlet “a” for gaseous medium and entrained cement raw mix, an outlet “b” for separated gaseous medium and an outlet “c” for separated solids. The preheater is equipped with an inlet 17 for cement raw mix. This inlet 17 is arranged in the conduit connecting the inlet “a” for gaseous medium and entrained cement raw meal of the uppermost cyclone 51 to the outlet “b” for separated gaseous medium of the adjacent cyclone 52. Solids being separated in cyclone 51 flow down into a conduit connecting the air outlet of cyclone 53 to the inlet of the adjacent lower cyclone 52. In this conduit the solids are entrained and conveyed to cyclone 52, where they are separated. Thus solids are moving down to the next lower cyclones 53 and 54. During the
alternate entrainment and separation process, the raw mix is heated up by the
gaseous medium supplied to the preheater tower. This air flows through the
preheater in countercurrent relation to the flow of the raw mix, i.e. from cyclone
54 to cyclone 53, to cyclone 52 and finally to cyclone 51. Spent preheating
gaseous medium leaves the uppermost cyclone 51 via outlet "b" to a known
dedusting system. The preheated raw mix is supplied to the kiln 16 via a line
57.

This kiln has a feed end 44 and a discharge end 45 with a combustion zone
near the discharge end. In the rotary kiln 16, the preheated and precalcined raw
mix is burned into cement clinker. For the combustion in the kiln 16, a certain
amount of fuel, i.e. coal is injected at the discharge end 45 via a burner
together with primary air.

Via air intake lines 23, ambient air is introduced in the system by fans 22 to the
clinker cooler and heated therein by cooling down the cement clinker. The
heated air exits the clinker cooler in a first stream and is supplied to the kiln 16
as kiln combustion (secondary) air. The cement clinker is then forwarded from
the discharge end 45 of the kiln into the cement cooler 20, which might be a
moving grate. The cooled clinker is finally supplied via line 21 to a cement
grinder, which is not shown.

So far, cement production and the apparatus involved are known. In prior art
plants, the gaseous medium used for preheating the raw mix is the kiln gas
exhausting the feed end 44 of the kiln. It is now intended to increase the clinker
production in this existing plant by using at least the preheater tower 50 and the
kiln 16, to make better use of the cooler air and to give the kiln gases a sepa-
rate treatment.
According to the invention this is done by feeding calcined raw meal, consisting essentially of lime and combustion residues like ash, carbon and desulfurization residues, via inlet 17 into the preheater 50. A second feature is to direct process air from the clinker cooler 20 in countercurrent flow to the direction of flow of the calcined raw meal. Thus air preheated in the clinker cooler is supplied to the preheater tower via tertiary air line 26 and via riser duct 56.

Due to the increased amount of produced clinker, it is understood that the clinker cooler 20 has to be replaced by a larger apparatus in order to perform its function.

The kiln exhaust gases are 100% vented and used for steam production in a boiler 60. Via a duct 46 they are fed into a quenching device 61 to cool them down to a temperature of about 800-900°C.

The kiln exhaust gases can be quenched either with air via line 62, either with water via line 75, or with solids like limestone via line 63 or like calcined raw meal via line 64.

This calcined raw meal may be withdrawn either from the feed line 17 of the preheater 50 or from the solids duct “c” of a cyclone of the preheater having the appropriate temperature for cooling down the kiln gas. It contributes to the desulfurization of the kiln gases. The use of this fine ground material enhances the condensation of alkalis, chlorides, sulfates and heavy metals. The same advantages are obtained if limestone is injected. This limestone is a good heat sink as it is calcined to lime. Using water for quenching allows evaporating wastewater from any part of the cement and/or power plant. Using air is the most cost-effective solution, as air is sucked in the system due to its pressure level.
The kiln exhaust gases are then forwarded to a dust separator 65, which in the present example is a cyclone. After dedusting, the gases are fed to a boiler 60 and are used for steam generating. The steam produced in the boiler may be used in the water/steam cycle of the power plant. As the kiln gases have high temperature, high steam parameters can be obtained.

By the new way of preheating precalcined raw mix and treating the exhaust gases, it is possible to suppress the alkali and chloride circulation and the other volatile matters in the cement clinker combustion device, as well as to reduce their concentrations in the cement clinker. These components are contained in the now bypassed kiln gases and thus are not internally recirculated. This will improve substantially the kiln operation, i.e. no ring formation. In case that the cement plant operates as a stand alone, the kiln exhaust gases might be treated in view of NO\textsubscript{x} and SO\textsubscript{x} reduction based on the local environmental requirements.

After their heat exchange in the boiler 60, the kiln exhaust gases are fed by a fan 66 to a circulating fluidized bed boiler 1 of a power plant, in which boiler the NO\textsubscript{x} component of the gases is reduced. Based on the sulfur content in the fuel and/or in the raw material, a DeSox-system might be required before feeding the kiln gases to the circulating fluidized bed boiler. This DeSox-system can be arranged either in the high temperature region (above 700°C) or at the low temperature end downstream the boiler 60. It is understood that depending on the heat content of the gases, they may be used for preheating the circulating fluidized bed boiler combustion air prior to their introduction in this boiler.

The remaining air of the clinker cooler 20 is not discharged – like in prior art plants – but is now used for steam production. Via line 67 it is forwarded to a de-duster 68, which in this example is a cyclone. After having been dedusted, the air is forwarded with a fan 69 to a steam producing heat exchanger 70.
This heat exchanger is preferably a heat recovery boiler with supplementary firing. A hydrocarbon, i.e. coal is fed to the boiler via supply line 71 and is burned with a part of the process air withdrawn from the main air flow and forwarded by a fan 72 via a line 73 as combustion air. Thus it is possible to produce steam with high parameters as usual in power plants. The steam produced in the boiler may be forwarded in the water/steam cycle of the power plant; i.e. it can be fed into a common header. This steam insertion optimizes the efficiency of the total plant.

The flue gases from the heat recovery boiler are discharged via a line 74 to the stack of the power plant.

The solids separated in the cyclones 65 and 68 might be added to the cement clinker in line 21.

The drawing illustrates in its upper part in a simplified block diagram the clinker making process and shows how the calcined raw meal, consisting essentially of lime and combustion residues like ash, carbon and desulfurization residues, is produced in the combustor of a power plant.

Via air intake line 29 a fan 27 sucks the major portion of ambient air in the system. This air is preheated in an air preheater 28. Via line 30 the air is fed to the combustor 1, in which it penetrates via a fluidizing air supply 5 and a secondary or overbed air supply 4.

Depending on the apparatus type, the gas/air mixture can be introduced into the combustor on different levels. In the example shown on the drawing, in which the reactor is an upright circulating fluidized-bed steam generator with a flow stream from bottom to top, the fluidizing air is introduced at the bottom
through an air distributor. The secondary air is fed through one or more elevations of ports in the lower combustor. The reactor is provided with four other inlets. One carbonaceous residue supplies line 6, one inlet 2 for the coal and two inlets 3 and 3a for the raw cement mix.

Coal is introduced mechanically or pneumatically to the lower portion of the reactor via supply 2. This coal can be either crushed or pulverized. Like the air, coal may be injected on different levels of the reactor. If the coal is in form of crushed material with a size of approximately 6 mm, it can be fed by gravity.

Combustion takes place throughout the combustor, which is filled by bed material. Flue gas and entrained solids leave the combustor and enter one or more cyclones 8, where the solids are separated.

The flue gas and the fly ash exit the gas outlet of the separation device 8 via a flue gas line 32. These separated gases are further treated before disposal. They are first cooled down in a gas cooler 33, thereby heating up water in an economizer 34 integrated in the water/steam cycle of a steam turbine island 42. In order to avoid recarbonation of the lime, the gases in line 32 are cooled at a fast rate, i.e. greater than 30 K/sec. Downstream the gases are further cooled in the air preheater 28. The gas is supposed to leave this gas cooler 28 with a temperature of about 100-150°C. Downstream the gas cooler a solids filter 37 is provided in the line 38 to remove from the gas all the remaining solids. This filter 37 could be a fabric filter or an electrostatic precipitator. A fan 40 is installed in the gas line exiting the filter, preferably on the clean side of the filter 37. Its purpose is to control the pressure in the system close to atmospheric conditions. The cleaned gas leaves the system via the stack 41. The solids separated in the filter 37 are fed via line 39 to an appropriate location in the cement system.
The solids separated in the cyclone 8 are recycled to the combustor via line 6. The major portion is directly returned to the fluidizing bed via line 7. Some solid is diverted via line 10 to an external fluidized-bed heat exchanger 9 and then added to the portion in line 7. The bed temperature in the combustor 1 is essentially uniform and is maintained at an optimum level for sulfur capture and combustion efficiency by heat absorption in the walls of the combustor. In the present example the heat exchange is supposed to occur in an evaporator 35. Superheating of the steam and - for large steam turbine units with a reheat cycle - reheating is performed preferably by further heat removal from the hot solids absorption in the fluidized-bed heat exchanger 9 and/or in the gas-cooler 33. This heat exchanger 9 is containing immersed tube bundles. The flow rate of the solids through apparatus 9 via line 10 can be used to control the steam temperature. The produced superheated steam is fed to the turbine island 42 comprising at least one steam turbine driving a generator producing electrical power. Additional steam is produced for the turbine in the clinker cooler 20 from cooling the hot clinker discharged from the kiln 16 via line 19.

Sulfur compounds in the fuel or in the cement raw materials are mainly released in the CFB reactor 1 as SO₂. In traditional CFB steam production units, the amount of limestone needs to be minimized - Ca/S molar ratio typically around 2 - to minimize operating costs. In the present method, Ca/S molar ratios greater than 3 can be used in the CFB to improve the sulfur capture from flue gas exiting the system via stack 41. No attendant increase in operating costs results since a very high amount of calcium relative to sulfur is inherent in the cement clinker making process.

The CFB is now used for a coproduction of steam and calcined raw mix for the cement production, in which coproduction the ashes of the power production are used to replace part of the cement raw mix in the cement production. Indeed coal ashes are similar in composition to calcined clays. Moreover all of
the coal residues are converted into cement; the sulfur is absorbed by clinker component CaO.

As described above, two inlets 3 and 3a for the raw cement mix are provided in the reactor 1. Via line 3, a part of limestone is fed into the reactor in pulverized form; typically 90% of the limestone particles are smaller than 90 microns, the size being appropriate for the cement clinkering process. Via line 3a the remaining part of crushed limestone is introduced to form bed and circulating material. At temperatures above about 800°C, limestone CaCO₃ is calcined into CaO. CaO combines with SO₂ released from coal combustion and oxygen to form gypsum CaSO₄. SO₂ can be disposed by standard wet or dry scrubbing methods using limestone.

Draining off solids controls solids inventory in the combustor. The hot solids drained of the fluidizing bed via line 11 are cooled down through an ash cooler 43. They are introduced in a grinder 12 in which they are ground to an extent that 90% are below 90 μm. They are mixed with additives introduced in the grinder by a line 14 and with some of the cement raw mix (not shown). These corrective additives are used, if any essential chemical compound needed in the mixture of coal ash and limestone like iron oxide or silica content are not present in the required amount.

The ground material is supplied to a blender 13, in which is added the lime CaO via a supply 15. This amount of lime is constituted by the solids separated in the filter 37 and is fed via line 39. To achieve this amount of lime coming from filter 37, the cyclone 8 is designed to separate the predominant char and crushed cement material from the remaining components. Since the mean size of the ash and the lime is typically smaller than 50μm it will escape the cyclone, while the char and the crushed lime/limestone, which is far greater in size will
be retained in the cyclone. Thus the fly ash escaping the cyclone consists predominantly of lime and is forwarded with the flue gas in line 32.

The calcined raw mix of the correct size and composition for cement clinker making is then forwarded to the cement plant.

The invention may be illustrated in more detail with reference to a numerical example: it goes without saying that absolute values cannot be specified in connection with the said numerical values with regard to the dimensioning of the involved apparatus, since absolute values are in any case not meaningful enough on account of their dependence on numerous parameters.

The clinker output is supposed to be at 37.5 kg/sec. To produce this amount, 87 kg/sec of ambient air is sucked by fan 22 into the clinker cooler 20 and cools the clinker down to around 70°C. Exhaust air in the amount of 34.5 kg/sec leaves the cooler at around 750°C and is fed to the preheater 50. Another part of the air leaving the cooler in the amount of 14.5 kg/sec is fed to the kiln as combustion air and as transportation and primary air for the coal, which is in the amount of 1.8 kg/sec. The remaining air leaving the cooler in the amount of 38 kg/sec at 300°C is bypassing the kiln via line 67 and is forwarded to the boiler 60, where it is heated up by the supplementary firing to 850°C and produces steam of the required parameters which are preferably the live steam parameters.

The gas amount out of the kiln is about 21.3 kg/sec at 1050°C. After heat exchange in the preheater tower 20, this gas with a temperature of about 200°C may be used to preheat the combustion air of the CFB and is then forwarded into the CFB.
Raw mix of the correct size and composition and precalcined at 90% in the amount of 40.5 kg/sec is introduced into the preheater 50 at ambient temperature. It is heated up by the cooler air to around 720°C. After heat exchange in the tower, this air with a temperature of about 280°C may be used to dry the ready raw mix in a milling process, if any. Thereafter it is dedusted and discharged at a temperature of about 100°C.

Thus it is seen that, compared to the prior art operation, the clinker production is now considerably increased.

It might be that the precalcined raw material produced in the power plant contains some carbon coming from the fly ash. This carbon is separated in the filter 37 with the lime and is added to the bottom ash of the combustor in the blender 13. In this case either the coal amount to the kiln has to be reduced appropriately or the amount of air through the kiln has to be augmented to burn the supplemental carbon.

Obviously, numerous modifications and variations of the present invention are possible in light of the above teachings. It is therefore to be understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically described herein.
List of Designations

1 circulating fluidized bed
2 hydrocarbon feed line
3, 3a limestone feed line
4 secondary (overbed) air line to 1
5 fluidizing air supply
6 solids return line
7 solids return line bypassing 9
8 cyclone
9 fluidized bed heat exchanger
10 solids return line to 9
11 hot bed material discharge
12 grinder
13 blender
14 additive supply to 12
15 lime supply to 13
16 kiln
17 calcined material line to 50
18 fuel supply to 16, coal
19 kiln clinker discharge line, nodules
20 clinker cooler
21 line to clinker grinder
22 fan
23 air supply to 20
25 air supply to 16
26 tertiary air line to air preheater 50
27 fan
28 air heater
29 air supply to air heater
30 hot air discharge from air heater, air supply to 1
32 gas and fly ash line in boiler backpass
33 steam heat exchanger
34 economizer
35 evaporator
36 superheater and reheater
37 filter, electrostatic precipitator
38 gas exhaust line
39 lime discharge line from 37
40 fan
41 stack
42 steam turbine island
43  ash cooler
44  feed end of 16
45  discharge end of 16
46  duct
50  second preheater
51-54 cyclone
a  inlet for air and entrained cement raw mix
b  outlet for separated air
c  outlet for separated solids
56  riser duct
57  feed line to kiln 16
60  boiler
61  quenching device
62  air line
63  limestone line
64  calcined raw meal line
65  dust separator
66  fan
67  air line
68  de-duster
69  fan
70  steam producing heat exchanger
71  hydrocarbon supply line
72  fan
73  combustion air line
74  flue gas line
75  water line
Claims

1. A method of increasing the clinker output of an existing cement plant and of producing steam, said method comprising the steps of preheating a raw meal in a preheater (50), said preheater being a multistage suspension type preheater including a plurality of serially connected cyclone type gas solids separators (51-54), directing the preheated raw meal into a rotary kiln (16), burning the preheated raw meal in the rotary kiln (16) to form clinker, cooling the clinker in a clinker cooler (20), directing process air from the clinker cooler (20) to the preheater (50) in countercurrent flow to the direction of flow of the raw meal, bypassing the kiln exhaust gases at 100 % and using them for steam production in a boiler (60), characterized in that the raw meal fed to the preheater (50) is calcined raw meal, consisting essentially of lime and combustion residues like ash, carbon and desulfurization residues.

2. A process according to claim 1, wherein the kiln exhaust gases are quenched to a temperature of about 800-900°C prior to their heat exchange in the water/steam cycle.

3. A process according to claim 2, wherein the kiln exhaust gases are quenched with air.

4. A process according to claim 2, wherein the kiln exhaust gases are quenched with water.
5. A process according to claim 1, wherein the kiln exhaust gases after their heat exchange in the boiler (60) are fed by a fan (66) to a circulating fluidized bed boiler (1) of a power plant.

6. A process according to claim 1, wherein part of the process air from the clinker cooler (20) is directed, after de-dusting, to a steam producing heat exchanger (70).

7. A process according to claim 6, wherein the steam producing heat exchanger (70) is a heat recovery boiler.

8. A process according to claim 7, wherein part (73) of the process air from the clinker cooler (20) being directed to the boiler (70) is used as combustion air for supplementary firing in the heat recovery boiler.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 C04B7/47

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 C04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic database consulted during the international search (name of database and, where practical, search terms used)

WPI Data, EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
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<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
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Date of the actual completion of the international search: 9 July 2001

Date of mailing of the international search report: 16/07/2001

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