Title: KILN FOR THE PRODUCTION OF CALCIUM OXIDE

Abstract: Furnace for producing calcium oxide, comprising a container (2) which internally has a baking chamber (5) provided with a central axis (6) and with a calcination zone (7) for the calcareous material, provided with burners (10, 11), characterised in that it comprises, at said calcination zone, at least a first group of said burners (10) positioned, with the respective outlets (14), substantially at a same first distance (A) from said central axis (6) and at least a second group of said burners (11) positioned, with the respective outlets (14), substantially at a same second distance (B) from said axis (6), said first group of burners (10) being overlapped to said second group of burners (11) relative to the dropping direction of the calcareous material and said second distance (A) being less than said first distance (B).
"KILN FOR THE PRODUCTION OF CALCIUM OXIDE"

TECHNICAL FIELD OF THE INVENTION

The present invention relates to a furnace for producing calcium oxide.

More in particular, the present invention relates to a vertical furnace, of the static type, for producing calcium oxide.

PRIOR ART

As is known, lime for industrial uses is traditionally obtained baking calcareous material into furnaces: the product that comes out of said furnaces consists, in particular, of calcium oxide.

Some of the known furnaces, so called countercurrent-flow vertical, shaft or column furnaces, consist of a large substantially cylindrical container with vertical axis defining a large baking chamber, wherein the calcareous material in the form of stones is introduced from the top, by gravity. This material, in its drop inside the baking chamber, usually crosses a first so called heating zone, an intermediate so called calcination or reaction zone - wherein the calcium oxide is obtained - and finally a third cooling zone, at the outlet whereof it is sent towards a discharge region of the baking product.
The baking of the calcareous material is obtained by one or more burners arranged in particular in the above calcination zone: such burners are usually inserted into side openings passing through the container wall, so as to penetrate inside the chamber by a certain depth; the latter clearly depends on the furnace size and on that of the burners themselves, for which a certain mechanical resistance to the action exerted by the drop of the calcareous material must be ensured.

These known furnaces, which may be even of considerable size to meet large production requirements, feature a significant unevenness of the thermal load inside the baking chamber, which causes a consequent unevenness also in the calcination of the calcareous material. In particular, especially for large-diameter furnaces, there are zones in the chamber, especially those closer to the burner inlets, where the thermal load is very high, and whereat even excessive baking conditions may be reached, and other zones, that is, those further from the burner inlets, where the thermal load is not as much high, and therefore unsatisfactory baking conditions, and thus of calcination of the material, are there obtained.

This unevenness of the thermal load translates, finally, into a quality of the product coming out of
the furnace which often does not fulfil the expectation of the modern lime market.

OBJECTS OF INVENTION

5 The technical task of the present invention therefore is to provide a furnace for producing lime which should allow obtaining an even thermal load inside the baking chamber, preventing the concurrent presence of zones of excessive baking and zones of insufficient baking that finally cause a poor quality product.

This object is achieved by the furnace for producing lime according to the annexed claim 1.

Thanks to the presence of at least two groups of overlapped burners, having respective inlets substantially equally spaced from the axis of the baking chamber, and at decreasing distances in the dropping direction of the material being baked, an even distribution of the thermal load is obtained inside the same chamber, since the same burners are effectively operating in respective circular or annular zones of the chamber that substantially cover the entire section thereof.

A homogeneous calcium oxide is thus obtained, of a high quality and low reactivity, without phenomena of overbaked and/or non-baked material.
Further advantageous features are described in the dependent claims.

BRIEF DESCRIPTION OF THE DRAWINGS

The features of the invention shall be better understood by any man skilled in the art from the following description and annexed drawing tables, provided by way of a non-limiting example, wherein:

- figure 1 shows a diametrical section of the furnace according to the present invention;
- figure 2 shows a cross section of the furnace according to plane II-II of figure 1;
- figure 3 shows a cross section of the same furnace according to plane III-III of figure 1;
- figure 4 shows a cross section of the same furnace according to plane IV-IV of figure 1;
- figure 5 shows a diametrical section of the furnace according to the present invention, in another embodiment;
- figure 6 shows a cross section of the furnace according to plane VI-VI of figure 5;
- figure 7 shows a cross section of the furnace according to plane VII-VII of figure 5;
- figure 8 shows a cross section of the furnace according to plane VIII-VIII of figure 5.
EMBODIMENTS OF THE INVENTION

It is first of all to be noted that in the following embodiments, single specific features described with reference to specific embodiments are actually interchangeable with other different features, existing in other embodiments.

With reference to the annexed figure 1, reference numeral 1 globally indicates a furnace for producing calcium oxide according the present invention, in an embodiment thereof.

The furnace comprises a container, globally indicated with reference numeral 2; container 2 has a cylindrical shape with circular section, and is arranged vertically.

Container 2 is made, for example, of refractory material, or of a material of another nature, with suitable features of resistance to high temperatures.

At the top thereof, container 2 comprises an inlet 3 for the calcareous material; such calcareous material is introduced in furnace 1 in the form, for example, of stones of a variable size.

At inlet 3 of container 2 there are provided traditional means for feeding the calcareous material, not shown for simplicity and because they do not in any case constitute an object of the present invention.
At the base thereof, container 2 comprises an outlet 4 for the material produced in furnace 1, which is generated by the baking of the calcareous material introduced from inlet 3. At outlet 4 there are provided means, not shown for simplicity, for collecting and conveying the material produced in furnace 1. Such means are of the known and traditional type and do not in any case constitute an object of the present invention.

Container 2 internally comprises a baking chamber 5 for the calcareous material introduced from inlet 3. The baking chamber 5 comprises a central axis 6, which is coincident with the symmetry axis of container 2. The baking chamber 5 further comprises a calcination zone 7 for the calcareous material, wherein the chemical reaction for forming the calcium oxide takes place, substantially located at the central portion of container 2.

The baking chamber 5 comprises a heating zone 8 for the calcareous material, located at the top of container 2 at inlet 3; the baking chamber 5 further comprises a cooling zone 9 for the calcium oxide produced from the reaction occurred in the calcination zone 7.

Burners 10, 11, 12 are provided in the calcination zone 7 of the baking chamber 5 which provide the thermal
energy required for the chemical reaction of transformation of the calcareous material into calcium oxide to take place.
The furnace comprises means for feeding the fuel to burners 10, 11, 12, which in figure 1 are not shown as they are of the essentially known and traditional type, and which therefore do not require further analysis in the present description.
As is also visible in figures 2, 3, 4, burners 10, 11, 12 are inserted into respective through holes 13 through the thickness of container 2.
More in detail, the furnace comprises at least a first group of burners 10 positioned, with the respective inlets 14, substantially at a same first distance A from the central axis 6 of the baking chamber 5, and at least a second group of burners 11 positioned, with the respective inlets 14, substantially at a same second distance B from the central axis 6; moreover, the first group of burners 10 is overlapped to the second group of burners 11 relative to the dropping direction of the calcareous material. The above second distance B is less than the above first distance A, as is visible in figure 1.
This arrangement of the first and of the second group of burners 10, 11, as shall be better explained
hereinafter, allows an even distribution of the thermal load inside the baking chamber 5, with consequent improvement of the quality of the product made inside furnace 1.

The furnace further comprises at least a third group of burners 12, positioned underneath the second group of burners 11. Burners 12 of the third group are placed at a same third distance C from the central axis 6: as is seen in figure 1, the third distance C is less than the second distance B.

Burners 10 of the first group are substantially coplanar relative to each other; in other words, the intersections of the axes thereof with the cylindrical surface of container 2 are comprised in a first plane 15 that is orthogonal to the central axis 6.

The burners of the first group 10, moreover, are inclined by a same first predetermined angle a relative to the first plane 15, with advantages that shall be better explained hereinafter.

With reference now to figure 2, which shows a section of the furnace taken exactly at the above first plane 15, it is noted that burners 10 of the first group are arranged angularly equally spaced from each other. By way of an example only, they are twenty-four but clearly they may be in any number, in relation to the
specific application requirements. Likewise, burners 11 of the second group are substantially coplanar relative to each other, that is, the intersections of the axes thereof with the cylindrical surface of container 2 are comprised in a second plane 16 that is orthogonal to the central axis 6. Moreover, the burners of the second group are inclined by a second predetermined angle $\beta$ relative to the above second plane 16, with the advantages that shall be better explained hereinafter.

With reference now to figure 3, which shows a section of the furnace taken at the second plane 16, it is noted that also burners 11 of the second group are arranged angularly equally spaced from each other. Their number is at least half the number of burners of the first group 10.

Likewise, burners 12 of the third group are substantially coplanar relative to each other, that is, the intersections of the axes thereof with the cylindrical surface of container 2 are comprised in a third plane 17 that is orthogonal to the central axis 6. Burners 12 of the third group 12, moreover, are inclined by a third predetermined angle $\gamma$ relative to
said third plane, with the technical advantages that shall be better explained hereinafter.

With reference now to figure 4, which shows a section of the furnace taken at the third plane 17, it is noted that also burners 12 of the third group are arranged angularly equally spaced from each other. Their number is at least half the number of burners of the second group 11.

With reference again to figure 1, burners 10 of the first group and burners 12 of the third group are arranged substantially axially equally spaced from burners 11 of the second group; in other words, the first plane 15 and the third plane 17 are substantially equally spaced from the second plane 16.

In other embodiments, the first plane 15 and the third plane 17 may be placed at different reciprocal distances from the second plane 16, in relation to the specific application requirements.

In the present embodiment of the furnace according to the invention, the second angle $\beta$ and the third angle $\gamma$ coincide with the first angle $\alpha$. More in detail, by way of a non-limiting example only, such first, second, third angle $\alpha, \beta, \gamma$ are 10°.

The baking chamber 5 of the furnace is suitably pressurised, so as to prevent the forming of
preferential passage channels for the calcareous material.
The arrangement of burners 10, 11, 12 in separate groups according to the features described allows obtaining important technical advantages.
In the first place, as may be seen looking at figures 1, 2, 3, 4, each group of burners 10, 11, 12 is effectively operating in different zones of the baking chamber 5. More in particular, the burners of the first group 10 - reference shall be made to figure 2 - effectively carry out the baking of the calcareous material at a first zone 18 of chamber 5 which, seen in section, consists of a circular rim, concentric to the central axis 6, with outer circumference substantially passing by inlets 14 of the burners of the first group 10, that is, having a radius equal to the first distance A, and inner circumference that may be imagined substantially and ideally as passing by inlets 14 of the burners of the second group 11, that is, having radius equal to the second distance B. Actually, the first baking zone 18, thanks to the inclination of the burners of the first group 10, also has a certain axial extension, which develops in the dropping direction of the calcareous material being-baked.
Moreover, the burners of the second group 11 reference shall be made to figure 3 - effectively carry out the baking of the calcareous material at a second zone 19 of chamber 5 which, seen in section, again consists of a circular rim, concentric to the central axis 6, with outer circumference substantially passing by inlets 14 of the burners of the second group 11, that is, with a radius equal to the second distance B, and inner circumference that may be imagined substantially and ideally as passing by the inlets of the burners of the third group 12, that is, having radius equal to the third distance C. The second zone 19, therefore, is substantially circumscribed by the first zone 18.

The second baking zone 19, thanks to the inclination of the burners of the second group 11, actually has also a certain axial extension, which develops in the dropping direction of the material being baked.

The same applies also to the burners of the third group 12: in section, they are effectively effective in a third zone 20 of chamber 5 which substantially is a circle concentric to the central axis, with radius equal to the third distance C. Therefore, the third zone 20 is substantially circumscribed by the second zone 19.
Clearly, also the third zone 20 has a certain axial extension in the dropping direction of the material being baked.

In brief, therefore, the first, second, third group of burners 10, 11, 12 are respectively operating in the first, second and third zone 18, 19, 20 so that the combination of these last mentioned covers substantially the entire volume of the end portion of the calcination zone 7: in these zones 18, 19, 20, therefore, the thermal load is substantially even, as any particle or portion, even small, of the dropping material always is sufficiently close to at least one inlet of one of the burners of groups 10, 11, 12.

Moreover, the inclination of the burners of groups 10, 11, 12, with reference to the respective planes 15, 16, 17, allows extending the above zones 18, 19, 20 also in the axial direction, thus creating a wide volume wherein the thermal load is substantially even.

Moreover, the inclination of the burners of groups 10, 11, 12, relative to the respective planes 15, 16, 17 allows obtaining a further important advantage, consisting in the significant reduction of the "sharpening" effect, that is, the scraping on the surface of the same burners 10, 11, 12 due to the continuous shocks and frictions of the calcareous stones, even of
small size, resulting from the crushing which, as known, largely exhibit also sharp and pointed edges. In other words, the inclination imparted to burners 10, 11, 12 allows reducing the impact angle of the calcareous stones on the surface of the same burners: in this way, the effect of surface scraping is limited, which if very strong would require the frequent maintenance and/or replacement of the same burners. It has thus been seen that the invention achieves the intended objects.

Another embodiment of the furnace according to the present invention is shown in figures 5, 6, 7, 8. In the following description, the parts corresponding to those of figures 1, 2, 3, 4 are indicated by the same reference numerals and shall not be described further.

In this embodiment, furnace 1 comprises an axial burner 21 within the baking chamber 5. Such axial burner 21 is placed at the base of container 2. The axial burner 21 has a substantially mushroom-like shape, of the known type, with a top cap 22 and a series of external holes 23, whereto the fuel arrives from a single bottom manifold 24.

In this embodiment, in the practice, the axial burner 21 replaces the third group of burners 12 present in
the above embodiment. As may be seen in figure 5 and also in figures 6, 7, the burners of the first group 10 and of the second group 11 are substantially identical to those described in the previous embodiment, and shall not be described further.

This embodiment of the furnace according to the invention is particularly advantageous in the situations where the required production of calcium oxide is high, and thus accordingly the furnace has a large diameter. In fact, the axial burner 21 contributes to the baking of the calcareous material just in the central portion, where external burners, although of quite large size, like those of the first group 10 and of the second group 11, could not operate effectively from the point of view of the thermal load.

The present invention has been described according to preferred embodiments but equivalent versions may be conceived without departing from the scope of protection offered by the following claims.
CLAIMS

1. Furnace for producing calcium oxide, comprising a container (2) which internally has a baking chamber (5) provided with a central axis (6) and with a calcination zone (7) for the calcareous material, provided with burners (10, 11), characterised in that it comprises, at said calcination zone, at least a first group of said burners (10) positioned, with the respective outlets (14), substantially at a same first distance (A) from said central axis (6) and at least a second group of said burners (11) positioned, with the respective outlets (14), substantially at a same second distance (B) from said axis (6), said first group of burners (10) being overlapped to said second group of burners (11) relative to the dropping direction of the calcareous material and said second distance (A) being smaller than said first distance (B) .

2. Furnace according to claim 1, comprising a third group of burners (12), positioned underneath said second group of burners (11), placed at a same third distance (C) from said axis, said the third distance (C) being smaller than said second distance (B) .

3. Furnace according to claim 1 or 2, wherein said burners of said first group (10) are coplanar to one another.
4. Furnace according to any one of the previous claims, wherein said burners of said second group (11) are coplanar to one another.

5. Furnace according to any one of claims 2 to 4, wherein said burners of said third group (12) are coplanar to one another.

6. Furnace according to any one of claims 2 to 5, wherein said first group of burners (12) and said third group of burners (12) are axially equally spaced from said second group of burners (11).

7. Furnace according to any one of claims 2 to 6, wherein said burners of said first group (10) and/or of said second group (12) are equally spaced from one another.

8. Furnace according to any one of the previous claims, wherein said container (2) has a substantially cylindrical shape.

9. Furnace according to the previous claim, wherein said burners of said first group (10) and/or of said second group (12) and/or of said third group (12) are angularly equally spaced from one another.

10. Furnace according to any one of the previous claims, wherein the number of burners of said second group (11) is at least half the number of burners of said first group (10).
11. Furnace according to any one of claims 2 to 10, wherein the number of burners of said third group (12) is at least half the number of burners of said second group (11).

12. Furnace according to any one of claims 2 to 11, wherein the burners of said first group (10) and/or of said second group (12) and/or of said third group (12) are inserted in respective through holes (13) in said container (2).

13. Furnace according to one of the previous claims, comprising at least one axial burner (21) placed at the base of said container (2).

14. Furnace according to claim 8, wherein said burners of the first group (10) are operating in a first zone (18) of the baking chamber (5) which, in section, consists of a circular rim concentric to said central axis (6).

15. Furnace according to claim 14, wherein said burners of the second group (11) are operating in a second zone (19) of the baking chamber (5) which, in section, consists of a circular rim concentric to said central axis (6), substantially circumscribed by said first zone (18).

16. Furnace according to claim 15, wherein said burners of the third group (12) are operating in a
third zone of the baking chamber (5) which, in section, consists of a circle, concentric to said central axis (6), substantially circumscribed by said second zone (19).

17. Furnace according to any one of the previous claims, wherein the burners of said first group (10) are inclined by a first predetermined angle (a) relative to said first plane (15).

18. Furnace according to any one of the previous claims, wherein the burners of said second group (11) are inclined by a second predetermined angle (β) relative to said second plane (16).

19. Furnace according to any one of the previous claims, wherein the burners of said third group (12) are inclined by a third predetermined angle (γ) relative to said third plane (17).

20. Furnace according to claim 18, wherein said second angle (β) coincides with said first angle (a).

21. Furnace according to the previous claim, wherein said third angle (γ) coincides with said second angle (β) and with said first angle (a).
### INTERNATIONAL SEARCH REPORT

**PCT/IB2010/051146**

**A. CLASSIFICATION OF SUBJECT MATTER**

| INV. | F27B1/00 | F27B1/08 | F27B1/10 | F27D99/00 | C04B2/12 |

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) |
| F27D | F27B | C04B |

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

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

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**Date of the actual completion of the international search**

15 November 2010

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