A covering block for furnaces of the suspended roof type and process for the manufacturing of such block

This invention relates to a covering block (1) for furnaces of the suspended roof type, characterised in that it comprises a plurality of superposed layers having different refractory and insulating properties. In particular, the block comprises a first layer (3a) having high refractory properties and at least a second layer (4a,4b), superposed to the first one, having high insulating properties. The desired level of refractory and insulation of the furnace is ensured in any case by a plurality of blocks of easy manufacturing and contained cost, so as to reduce the amount of the investments that are to be provided for the manufacturing of such roof.
The invention relates to a covering block for furnaces of the suspended roof type and to a process for the construction of said block.

Today, furnaces of the suspended roof type are well known and widely utilised in various fields of the industrial sector, in the place of conventional arches-furnaces, with regard to which they provide known functional advantages.

In furnaces of the suspended roof type, the covering wall is comprised of a plurality of refractory elements that are kept - through suitable metal means - in a suspended condition relatively to a supporting frame. Such elements are then approached to one another and adequately pressed against one another, so as to reduce the air spaces between adjoining elements, through which spaces the heat generated in the inside of the furnace may disperse towards the outside.

The above requirements are satisfied by paying much attention, in the design stage, to the choice of the materials that will form the walls of the furnace. Additional care must be paid afterwards to the methods according to which such elements are mutually associated during the assembly of the furnace.

Typically, the walls of the furnace are made from materials having a high level of refractory, possibly by carrying out special workings (for instance, application of special covering paints) on the surface that will face the inside of the combustion chamber.

However, such a wall does not ensure high insulation levels. This is due to the structural characteristics of refractory materials which, unlike the typical insulating materials (characterised by high porosity levels), have a high density.

Therefore, the insulation level desired is usually achieved by increasing the thickness of the furnace walls, and by applying an external additional insulation. As the thickness of the individual blocks is limited by the need of ensuring, during the construction of the same, an adequate and homogeneous burning of the base material, the increase in thickness of the furnace wall is achieved by placing several vertical refractory elements near to one another.

The additional insulation consists of suitable material, provided on the wall of suspended blocks. Typical materials used for this purpose are insulating concrete and ceramic fiber mats.

A suspended roof furnace obtained according to the above method has the drawback of a high installation cost, especially because of the high number of refractory elements (which are particularly expensive) that are necessary to obtain a wall having such a thickness as to ensure a good thermal insulation during the running.

In fact, in suspended roof furnaces the problem of insulation is particularly important because of the presence of metal means for the support of the elements. Such presence involves the need of limiting the temperature in the area adjoining said means and therefore the creation of an adequate thickness between the combustion chamber and such area. Otherwise, the supporting frame could be damaged.

The technical problem which is at the basis of this invention is that of contriving a covering block for suspended roof furnaces having adequate refractory and insulating properties and, at the same time, a contained cost, so as to reduce the amount of the investments that are to be provided for the construction of said furnace.

According to a first aspect, the invention relates therefore to a covering block for furnaces of the suspended type, characterised in that it comprises at least a first and a second superposed layers having different refractory and insulating properties.

In the following of the description and the appended claims, the term "refractory" is intended to mean a material that can withstand, without remarkable structural alterations, the high temperatures of a furnace (at least 1000 °C and more) and, possibly, the direct action of the flame; instead, the term "insulating" is intended to mean a material having a low thermal conductivity, and therefore a material that can provide a high resistance to the heat flow.

According to the invention, it is advantageously possible to construct, to relatively a low cost, a covering block having good refractory properties and able to ensure at the same time a good thermal insulation. Reduction in costs is achieved by reducing the overall percentage of refractory material (more expensive) in the block; by limiting the presence of such material in given layers suitably located in the inside of said block, and by providing further layers of insulating material: in this way it is possible to achieve the refractory and insulation levels desired. Such reduction in the percentage of refractory material (material having a high specific weight) involves also a reduction in the weight of the resulting block, with remarkable advantages for the installers of the various blocks and the resulting wall.

Preferably, the first and the second layer comprise respectively a first and a second brick independent as concerns construction. This allows to realise the covering block in a particularly simple manner.

Advantageously, the first layer has higher refractory properties with respect to the second layer. More advantageously, the second layer has higher insulating properties with respect to the first layer.

This allows to provide, for the block portion adjoining the furnace combustion chamber, a layer of a material...
that can withstand the high temperatures and possibly the direct action of the flame, and for the upper block portion, a layer of a material that can oppose the heat flow from the furnace towards the outside, so as to minimise heat dispersion (energetically disadvantageous and in any case dangerous for the attending personnel), and to keep the temperature of the external portion of the wall (where the means for the support of the block are mounted) relatively low.

Also, it is possible to optimise the construction costs of the covering block, placing the refractory material (expensive) only where its presence is necessary, i.e. only in the lower layer of the block. In this way, the lower layer performs prevalently a refractory activity towards the heat present in the inside of the furnace, without however markedly opposing the heat flow towards the outside. Such flow will be opposed afterwards by the insulating material placed in the upper layers of the block.

Preferably, the first and the second layer are mutually fixed by high fixing strength glues. In this way, it is possible to ensure the structural integrity of the block, indispensable both in terms of safety and in terms of thermal efficiency of the furnace.

Advantageously, the second layer comprises seats intended for housing means suitable to support the above block relatively to a supporting frame. Therefore, such seats are obtained in a relatively colder block portion, where the presence of insulating material is provided; this ensures during the running the structural integrity of the metal support means that are to be mounted in such seats.

According to a second aspect, the invention relates to a covering wall for furnaces of the suspended roof type, comprising a plurality of blocks of the above described type, such blocks being suspended on the assembly on a supporting frame and being approached to one another and kept in a condition of close adherence. Therefore, this wall is very efficient from the thermodynamic point of view and at the same time particularly simple from the point of view of construction.

According to a third aspect, the invention relates to a furnace of the suspended roof type, comprising a covering wall of the above described type.

According to a last aspect, the invention relates to a process for the construction of a covering block of the above described type, characterised in that it comprises the following steps:

- preparation of a first layer of a material having specific refractory and insulating properties,
- preparation of a second layer of a material having different refractory and insulating properties relatively to the first layers,
- superposition of said second layer on the first layer,
- fixing of said second layer to the first layer.

Advantageously, the first and second layers are independent from one another as concerns construction, and the aforesaid fixing step comprises the step of placing between the first and the second layer a high fixing strength glue.

Such process allows to obtain a covering wall thermodynamically efficient by means of a sequence of simple and quick operations.

Further characteristics and advantages of a block and a process according to this invention will be better understood through the following description of a preferred embodiment of the same, made with reference to Figure 1 showing a perspective view of such block.

In such figure, a covering block for furnaces of the suspended roof type is indicated by 1. Block 1 comprises a plurality of superposed layers, indicated on the whole by 2. In a preferred embodiment of this invention, the layers 2 comprise a plurality of superposed products, independent on one another from the point of view of construction and having an essentially parallelepiped form. Such products are in practice refractory insulating bricks, manufactured according to techniques known per se, so as to have the refractory and insulating properties as desired that will be shown in the following.

Layers 2 comprise a first layer 3, having high refractory properties, and at least a second layer 4 (two layers 4a and 4b in the example shown, superposed to one another) having high insulating properties, superposed to the first layer 3.

More particularly, the first layer 3 has refractory properties higher with respect to the second layers 4a and 4b which, in their turn, have insulating properties higher with respect to the first layer 3.

The first layer 3 has a lower surface 3a which faces the inside of a furnace combustion chamber (not shown). The second layer 4a is fixed on the first layer 3 through an in-between high fastening strength glue 5. In the same way, the second layers 4a and 4b are fixed to one another.

The second layer 4b has, on its upper surface, seats 7 suitably shaped to house metal or ceramic means (not shown) suitable to keep block 1 suspended relatively to a supporting frame (not shown).

During the running, block 1 will be mounted suspended on the supporting frame by means of the aforesaid metal means. To block 1 a plurality of other blocks 1 are approached and kept in close adherence by suitable pressing means (not shown) provided in the opposite ends of the covering wall so realised. The lower surface 3a of each block
1 forms in this way a refractory surface of the aforesaid covering wall. On the installed blocks, additional insulating materials (not shown) may be provided, around the suspension means.

[0035] During the running, the furnace generates heat at a given running temperature thanks to the heat generated by the flame supplied by the burners of the same furnace. Such running is ensured by the capability of the refractory lower surfaces of block 1 to withstand the high temperatures of the inside of the furnace.

[0036] The thermal flow generated and directed from the inside of the furnace towards the outside, passes through the first refractory layer 3a and is subsequently opposed and minimised by the subsequent insulating layers 4a, 4b, so as to achieve a high thermal efficiency and an upper surface 6 having a relatively low temperature.

[0037] This invention, as described above, allows to achieve several advantages compared to the known technique, comprising following ones. Firstly, the presence of separate refractory and insulating layers allows to markedly reduce the costs of installation of the furnace roof. In fact, the possibility of placing the refractory material (expensive) only where its presence is necessary (i.e. only in the lower layer of the block) and the insulating material (less expensive) in the remaining portion of the block, allows to provide a covering wall which, thickness being the same, requires an amount of refractory material much lower than the known technique.

[0038] Such reduction in the refractory material also allows a reduction in the weight of the resulting wall. In fact, the specific weight of a good insulating material is about between a half and a third of the specific weight of a good refractory material.

[0039] Besides, while in the known technique the insulation function is performed to a great extent by refractory materials (from which the need ensues of creating a wall of a certain thickness to prevent the support means from metal from being affected by the high temperatures), in the present invention such performance is carried out by suitable insulating materials, with the ensuing advantage of having to realise smaller wall thicknesses, the dispersed thermal flow being the same.

EXAMPLE

[0040] The aforementioned advantages have been demonstrated by computer-simulated tests (according to ASTM G640 specifications) on heat conduction on walls constructed respectively with the construction methods of the known technique and those of the present invention. All materials that are mentioned in the following are commercially available from the Applicant, under their respective trade names.

[0041] Such tests were based on a furnace in the following conditions:

Ambient temperature: 25°C
Furnace temperature: 1200°C

[0042] There was first constructed a covering wall model according to the known technique, having the following dimensions:

Heat-exchange surface: 130 * 260 mm
Wall thickness: 295 mm

and composed as follows:

<table>
<thead>
<tr>
<th>Material</th>
<th>Thickness (mm)</th>
<th>Density (kg/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BLOCK</td>
<td></td>
<td></td>
</tr>
<tr>
<td>refractory JM26 CASAL 58% Al₂O₃</td>
<td>230</td>
<td>780</td>
</tr>
<tr>
<td>ADDITIONAL INSULATION</td>
<td></td>
<td></td>
</tr>
<tr>
<td>insulation CERABLANKET 128</td>
<td>25.4</td>
<td>128</td>
</tr>
<tr>
<td>ADDITIONAL INSULATION</td>
<td></td>
<td></td>
</tr>
<tr>
<td>insulation FIR BM 0-3 mm CASAL</td>
<td>40</td>
<td>400</td>
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</tbody>
</table>

[0043] The latter two are insulating materials superposed on refractory materials: the first is a mat of ceramic fibres, the second is an insulating concrete.

[0044] Temperatures were measured at the interface surfaces between the layers and within the single layer of the block (at a height of 50 mm from the top of the block, such height corresponding to where the suspension means are typically engaged with the block), obtaining the following results:
[0045] Afterwards, a covering wall model was constructed according to the invention, having the following dimensions:

- Heat-exchange surface: 230 * 260 mm
- Wall thickness: 220.4 mm

and composed as follows:

<table>
<thead>
<tr>
<th>Material</th>
<th>Thickness (mm)</th>
<th>Density (kg/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BLOCK refractory JM26 CASAL 58% Al₂O₃</td>
<td>64</td>
<td>780</td>
</tr>
<tr>
<td>BLOCK glue BLAKITE</td>
<td>1.5</td>
<td>1950</td>
</tr>
<tr>
<td>BLOCK insulation JM23 CASAL</td>
<td>64</td>
<td>480</td>
</tr>
<tr>
<td>BLOCK glue BLAKITE</td>
<td>1.5</td>
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<td>ADDITIONAL INSULATION insulation CERABLANKET 128</td>
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<td>128</td>
</tr>
</tbody>
</table>

[0046] Also in this case, temperatures were measured at the interface surfaces between the layers and within the upper external layer of the block (at a height of 50 mm from the top of the block), obtaining the following results:

<table>
<thead>
<tr>
<th>Material</th>
<th>Hot face (°C)</th>
<th>Intermediate (°C)</th>
<th>Cold face (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>JM26 CASAL 58% Al₂O₃</td>
<td>1200</td>
<td>738</td>
<td>596</td>
</tr>
<tr>
<td>BLAKITE</td>
<td>1038</td>
<td>1038</td>
<td></td>
</tr>
<tr>
<td>JM23 CASAL</td>
<td>1038</td>
<td>747</td>
<td></td>
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<tr>
<td>BLAKITE</td>
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<td>746</td>
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<tr>
<td>JM23 CASAL</td>
<td>746</td>
<td>676</td>
<td>396</td>
</tr>
<tr>
<td>CERABLANKET 128</td>
<td>396</td>
<td>78</td>
<td></td>
</tr>
</tbody>
</table>

with:

- Heat loss: 838 W/m²
- Heat storage: 49.2 KWh/m²

[0046] Also in this case, temperatures were measured at the interface surfaces between the layers and within the upper external layer of the block (at a height of 50 mm from the top of the block), obtaining the following results:

<table>
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</tr>
<tr>
<td>CERABLANKET 128</td>
<td>396</td>
<td>78</td>
<td></td>
</tr>
</tbody>
</table>

with:

- Heat loss: 859 W/m²
- Heat storage: 31.3 KWh/m²
[0047] By a comparative examination of the results obtained, there may be concluded that in the wall made with blocks according to this invention, similar values of heat loss and temperature of the external surface are achieved with:

- a smaller wall thickness,
- a lower number of insulating material layers,
- an overall lower quantity of energy stored by the wall,
- a lower temperature where the suspension means engage the blocks,
- less additional insulation material.

Claims

1. A covering block for furnaces of the suspended roof type, characterised in that it comprises at least a first and a second superposed layers having different refractory and insulating properties.

2. The block according to claim 1, wherein the first and the second layers comprise respectively a first and a second brick, independent from the point of view of construction.

3. The block according to claim 1, wherein the first layer has higher refractory properties with respect to the second layer.

4. The block according to claim 1, wherein the second layer has higher insulating properties with respect to the first layer.

5. The block according to claim 1, wherein the first and the second layers are fixed to one another by high fixing strength glues.

6. The block according to claim 1, wherein the second layer comprises seats for housing means suitable to support said block relatively to a supporting frame.

7. A covering wall for furnaces of the supported roof type, comprising a plurality of blocks according to any of the preceding claims, said blocks being mounted suspended on a supporting frame, and being approached to one another and kept in a condition of close adherence.

8. A furnace of the supported roof type, comprising a covering wall according to claim 7.

9. A process for the manufacturing of a covering block according to claim 1, characterised in that it comprises the following steps:

- preparation of a first layer of a material having specific refractory and insulating properties,
- preparation of a second layer of a material having different refractory and insulating properties with respect to the first layers,
- superposition of said second layer on the first layer,
- fixing of said second layer to the first layer.

10. The process according to claim 9, wherein the first and the second layers are independent on one another from the point of view of construction, and the above fixing step comprises the step of placing between the first and the second layer a high fixing strength glue.

11. The process according to claim 9 or 10, wherein a material having high refractory properties is provided in the first layer.

12. The process according to claim 9 or 10, wherein a material having high insulating properties is provided in the second layer.

13. The process according to claim 9 or 10, wherein in the first layer a material is provided having higher refractory properties with respect to the second layer.

14. The process according to claim 9 or 10, wherein in the second layer a material is provided having higher insulating properties with respect to the first layer.
properties with respect to the first layer.

15. The process according to claim 9 or 10, wherein in the second layer seats are obtained for housing means suitable to support the aforesaid block relatively to a supporting frame.
The present search report has been drawn up for all claims.

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document with indication, where appropriate, of relevant passages</th>
<th>Relevant to claim</th>
<th>Classification of the application (Int.Cl.)</th>
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<td>US 2 908 157 A (C. BLISS) 13 October 1959 * claims; figures *</td>
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<td>F27D1/06</td>
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<td>A</td>
<td>EP 0 534 267 A (EUROIMPIANTI) 31 March 1993 * claims; figures *</td>
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<td>F27D1/02</td>
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<td>A</td>
<td>DE 15 58 579 A (GOTTFRIED LICHTENBERG) 9 April 1970 * claims; figures *</td>
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<td>A</td>
<td>US 1 448 684 A (M.F. BEECHER) 13 March 1923</td>
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<td>A</td>
<td>DE 460 763 C (SPENNEMANN &amp; LINDEMANN)</td>
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<td>US 3 134 199 A (K.D. SCHEFFER) 26 May 1964</td>
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The present search report has been drawn up for all claims.

Examiner: Coulomb, J.

The Hague, 3 November 1998.