United States Patent [19]

Blanke et al.

[11] **3,844,803**

[45] **Oct. 29, 1974**

[54] **ALUMINUM OXIDE MATERIAL FOR LINING THE FLOORS AND SKIDWAYS OF PUSHER-TYPE REHEATING FURNACES**

[75] Inventors: **Martin Blanke,** Ranzel, Troisdorf; **Karl Hass,** Niederkassel, both of Germany

[73] Assignee: **Dynamit Nobel Aktiengesellschaft,** Troisdorf, Germany

[22] Filed: **Mar. 5, 1973**

[21] Appl. No.: **337,793**

Related U.S. Application Data

[63] Continuation of Ser. No. 113,603, Feb. 8, 1971, which is a continuation of Ser. No. 761,392, Sept. 16, 1968, abandoned.

[52] **U.S. Cl.** **106/65**

[51] **Int. Cl.** **C04b 35/10**

[58] **Field of Search** 106/65

[56] **References Cited**

UNITED STATES PATENTS

2,154,153	4/1939	Easter et al.	106/65
3,247,001	4/1966	Alper et al.	106/65
3,378,385	4/1968	McCreight et al.	106/65

Primary Examiner—Poer: J.

Attorney, Agent, or Firm—Burgess, Dinklage & Sprung

[57] **ABSTRACT**

Cast refractory products comprising 97 – 99 wt-% Al_2O_3. 0.3 – 0.2 wt-% SiO_2, 0.2 – 0.4 wt-% TiO_2, 0.05 – 0.11 wt-% Fe_2O_3, 0.33 – 0.94 wt-% CaO or MgO or mixtures of this alkaline earth oxides and 0.22 – 0.24 wt-% Na_2O or K_2O or mixtures of this alkali oxides.

These products are suitable for use as materials for the lining of floors and skidways of pusher-type reheating furnaces.

4 Claims, No Drawings

ALUMINUM OXIDE MATERIAL FOR LINING THE FLOORS AND SKIDWAYS OF PUSHER-TYPE REHEATING FURNACES

This is a continuation of application Ser. No. 113,603 filed Feb. 8, 1971, which is a continuation of Ser. No. 761,392, filed Sept. 16, 1968, both now abandoned.

The invention relates to a new material based on aluminium oxide which in the form of fusion-cast refractory products is advantageously used for lining the floors and skidways of pusher-type reheating furnaces.

Pusher-type reheating furnaces are used in metallurgical operations for bringing metal ingots of great weight as for example a ton or more, or metal billets of considerable length, for example, of 6 meters or longer to the rolling temperature. The ingots or billets are moved by means of a pushing machine over the floor of the furnace, which is provided with a refractory lining, and are there heated to temperatures of over 1,200°C. The refractory lining on the floor of the furnace is thus, of course, subjected to exceedingly severe stress, not only by the fact that the workpieces mechanically attack the lining, but also by the action of the scale that falls from and is knocked off the workpieces and into contact with the lining materials. Another source of trouble is the casting crusts which flake off from the workpieces as they are passed through the furnace and which contain the compounds which melt at comparatively low temperatures and chemically attack the furnace lining. These low-melting compounds originate from the additives which are introduced into the ingot molds when the ingots are cast, so as to keep the runner gate fluid. Further, the bur on the top end of the ingot produced when the top of the ingot is sheared off to eliminate the "pipe" mechanically attacks the floor and the skidways. Lastly, it is conventional in many furnaces to move the ingot over a tripper so that the ingot is reversed, i.e., turned over and the dark spot formed on the ingot by the water-cooled skid is compensated for.

In addition to this mechanical wear-and-tear on the furnace lining there must be added the thermal stress on the lining, which also adversely affects the metal, as both when the furnace is charged with the ingots and billets and when they are removed, a door has to be opened through which the cold air flows into the furnace which suddenly chills the hot furnace lining. Accordingly, it is necessary that the material for the furnace lining have adequate resistance to thermal shocks and stresses.

The requirements which a material utilized as a furnace lining has to meet have hitherto been satisfied only partially or only by resorting to various and often expensive procedures. Thus, it is known in the prior art to reinforce furnace floors with rails made of heat-resistant metals, i.e., with the so-called sheet bars or plate bars. Further it is known in the case of uneven floors to use water-cooled steel skids. Both of these proposals have the disadvantage that they result in heat losses on the one hand, and on the other hand they produce dark spots on the ingots due to reciprocal action between the workpiece and the rails or skids. Although refractory materials do not have these disadvantages, they are not sufficiently resistant to mechanical attack and the considerable temperature variations to which they are subjected.

It is known in the prior art to use fusion-cast bricks composed of 72 – 75 weight percent aluminum oxide and about 18 – 21 weight percent silicon dioxide as a ceramic lining for floors and skidways in reheating furnaces. When such materials are used for furnace linings, these so-called Corhart bricks have, similarly to the Forsterite bricks also in the prior art, the disadvantage that, due to their comparatively high content of silicon dioxide, fayalite (Fe_2SiO_4) is formed from the SiO_2 with the FeO contained in the scale from the metal, which fayalite in the simultaneous presence of aluminum oxide, melts at temperatures as low as 1,200°C. Therefore, at the working temperatures utilized in reheating furnaces, which range between 1,240° and 1,300°C, the surface of the lining is softened to a viscous vitreous phase which is easily torn away by the movement of the ingots, blooms or billets, as a result of which the lining becomes completely useless in a relatively short time. Furthermore, the infiltration of FeO into the surface of Corhart bricks initiates the crystallization of trydimite and cristobalite, which are converted back and forth from one to the other as the temperature varies, their respective volumes changing abruptly in this transition. As the infiltration itself produces a change in volume and in the coefficient of expansion, the bricks have a markedly increased tendency to cracking on entry of cold air into the furnace, and this greatly reduces their useful life.

From the behavior of the fusion-cast bricks of the prior art, one might come to the conclusion that it might be advantageous to completely eliminate the silicon dioxide content of these materials intended for use as linings in reheating furnaces. This, however, is not desirable, a pure corundum brick is characterized by a coarse crystalline structure having long crystals which run from the outer areas toward the center, the same having a highly adverse effect on the strength of the bricks.

In accordance with the invention it has now been found that the disadvantages of the prior art materials can be avoided and that materials which can be advantageously employed as linings for the floors and skidways of reheating furnaces are provided by cast refractory products consisting of 97 – 99 wt-% Al_2O_3, 0.3 – 0.8 wt-% SiO_2, 0.2 – 0.4 wt-% TiO_2, 0.05 – 0.11 wt-% Fe_2O_3, 0.33 – 0.94 wt-% CaO or MgO or mixtures of this alkaline earth oxides and 0.22 – 0.24 wt-% Na_2O or K_2O or mixtures of this alkali oxides.

The special advantage associated with the use of this material consists in the fact that the eutectic point between Al_2O_3 and FeO is then situated above the operating temperature utilized in reheating furnaces, namely at 1,340° C. Further bricks having the composition according to the invention cannot be adversely affected by the formation of cristobalite, as they contain only an extremely small percentage of SiO_2. They are therefore more resistant to temperature variations than fusion-cast bricks having contents of approximately 20% SiO_2.

The products according to the invention, are not only more resistant to thermal variations, but also are more wear-resistant than the materials known hitherto and employed as linings for pusher-type reheating furnaces. As no infiltration of FeO occurs, the scale cannot get burnt into the bricks, even under the application of great pressure by the ingots. Even a possible fall of an ingot onto the draw floor does not harm the lining since

fusion-cast products having the composition of the invention have a cold compressive strength greater than 2,000 kg/cm² as compared with a specific loading of 1.5 kg/cm² on the floor of the pusher-type reheating furnace. When the material according to the invention is used, therefore, it is no longer necessary to reinforce the floor as hitherto required by means of heat-resistant sheet bars and plate bars which entails considerable cost and in the end is not very satisfactory.

Bricks and shaped bodies consisting of 98 percent by weight of Al_2O_3, 0.3 percent by weight of SiO_2 and the balance of TiO_2, Fe_2O_3 and the above alkaline earth oxides and alkali oxides, have proven valuable as materials for use in the lining of pusher-type reheating furnaces.

The cast refracting products as per the invention were melted and also shaped by an oxidising atmosphere at temperatures between 1,800°–2,600° C and at normal pressure. The cooling was effected by a good heating isolation and lasted various days.

EXAMPLE

12 tons of calcined alumina, 52 kgs of lime, 32.5 kgs of rutile, 19.2 kgs of magnesium oxide and 84 kgs of quartz sand were fed into an electric arc furnace and melted by an oxidising atmosphere (normal pressure) at 2,300° C. This received melt was casted into forms and therein cooled for 5 days by using heat insulators. The formed parts having the dimensions of at least 600 × 300 × 200 mm had — with the exception of the differences of 2 mm — the nominal values of the dimensions expected. A jointing therefore was not necessary. The compound consisted, among others, also of Fe_2O_3, Na_2O, and K_2O. The latter oxides partially came from the calcined alumina, and the iron oxide from the walls of the electric furnace and the forms. The formed parts were characterized by a considerably high resistance to pressure, by abrasiveness and resistance to temperature changes.

We claim:

1. A fusion cast refractory shaped body suitable for forming a protective coating on the floors and skidways of pusher-type reheating furnaces consisting essentially of 97–99 wt-% Al_2O_3; 0.3–0.8 wt-% SiO_2; 0.2–0.4 wt-% TiO_2; 0.05–0.11 wt-% Fe_2O_3; 0.33–0.94 wt-% CaO or MgO or mixtures of these alkaline earth oxides; and 0.22–0.24 wt-% Na_2O or K_2O or mixtures of these alkali oxides.

2. A fusion cast refractory body according to claim **1** in the form of a brick.

3. A fusion cast refractory body according to claim **1** in the form of a sheet or plate.

4. A fusion cast refractory shaped body according to claim **1**, containing 98 wt-% Al_2O_3 and 0.3 wt-% SiO_2.

* * * * *