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REFRACTORY FURNACE LININGS AND PROCESS FOR PRODUCING SAME

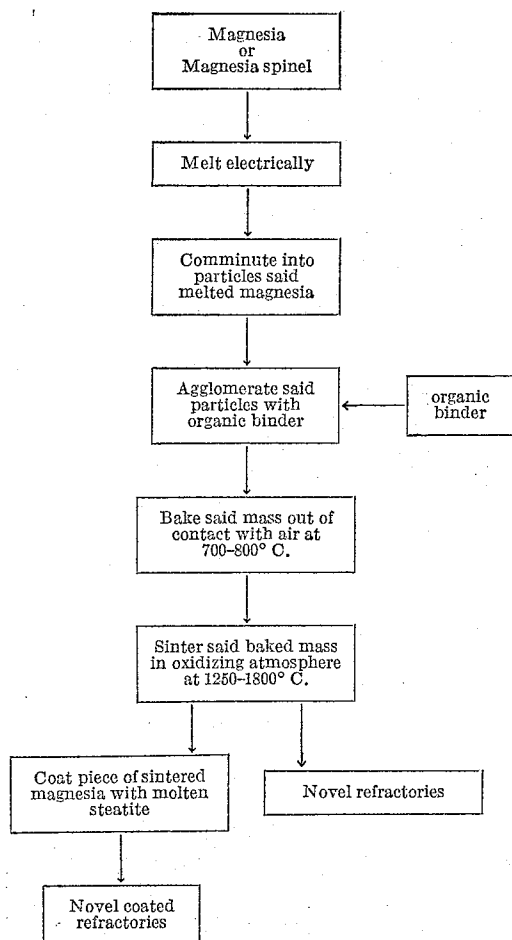
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Furnaces used in manufacturing operations which require a high temperature and a basic lining are frequently provided with an internal lining of magnesia bricks. The operating conditions are sometimes very severe from the standpoint of the temperature and the intensity of the thermal shocks to which the refractories are subjected and, therefore, the linings have but a limited life even when they are formed, for example, of bricks of magnesia of the best quality that can be found on the market. The necessity for frequently renewing these linings increases materially the cost of the products manufactured in such furnaces.

The present invention, which is based upon applicants' researches, makes it possible to produce basic refractory linings for furnaces the life of which is triple and, even, quadruple the life of the refractory linings used up till now.

In the interest of simplicity, references will be mostly made in the following description to magnesia linings; however, it will be understood that the invention is not limited to this type of lining, but is equally applicable to linings of magnesia spinel.

A simplified flow diagram of the process is as follows:



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The process of manufacturing refractory linings according to the present invention consists in agglomerating by means of an organic binder—preferably pitch—magnesia or magnesia spinel, preliminarily melted electrically (electrofused) and then ground.

The electrofused magnesia can be a very pure magnesia extracted from sea water; it can also be a natural magnesia which is melted in an electric furnace and then ground. The ground magnesia is then mixed either hot or cold with a quantity of pitch which should not exceed 7%. The pitch can be added in the liquid state or as a powder. The mixture thus obtained has the appearance of a dry paste or dough and can be shaped by any known means after having been poured into molds, for example, by compressing under a pressure ranging from 10 to 20 tons per square centimeter, tamping by hand, or by means of pneumatic tools, etc. There are obtained in this way agglomerates in the form of bricks or raw parts of larger dimensions; however, it is also possible to form the lining in the furnace itself, or to reconstitute a portion of a lining that has been accidentally damaged.

These agglomerates are then baked out of contact with air or in a reducing atmosphere at a temperature within the range of about 700° to 800° C., so as to coke the pitch and impart sufficient cohesion to the shaped parts or to the lining. The products thus obtained have a dark appearance and, if desired, can be machined, that is to say, cut, ground, sectioned, or rectified as may be necessary.

In a preferred embodiment of the invention, there is used a lining baked to about 700° to 800° C. and the furnace is then subjected to the temperatures that are used in the manufacture of the desired product, sometimes even up to 1800° C. and above, without resorting to a preliminary baking of the refractories to a higher temperature. When the furnace operates in an oxidizing atmosphere, the coke binder disappears little by little without affecting the cohesion of the refractory because the magnesia, which has been preliminarily electrically melted, begins to sinter (fritt) at a temperature of 1200° C. before the coke binder disappears, and this sintering is complete throughout the mass at 1400–1450° C. The lining, which is the object of the present invention, resists perfectly this rather severe treatment and has a long life. This particular embodiment is especially advantageous in the case of a lining or a portion of a lining which is tamped into the furnace itself.

When it is desired to use linings which are free of carbon, then the refractories, which have been preliminarily baked out of contact with air at 700° C., are heated in an oxidizing atmosphere at temperatures which can range from 1250°–1450° C. After heating for six to seven hours at 1350°–1450° C., all the carbon of the binder disappears. In this way, there is obtained, in a few hours, refractory parts which are perfectly white throughout their thickness. It is preferable to heat the parts to temperatures up to 1400–1450° C., if it be desired to obtain refractories possessing excellent cohesion.

This cohesion is, as will be well understood, even greater when the parts are heated to a higher temperature, for example, to 1600°–1800° C. in an arc furnace.

This invention also comprises as novel industrial products the refractory parts and linings manufactured according to the above described process.

The following example, which is not given by way of limitation, comprises the use of an especially pure, electrically melted magnesia.

Example I

There is used a pure electrically melted magnesia hav-

ing the following approximate granulometry (particle distribution):

Screen opening:	Percentage of particles
2 mm. -----	10
2-0.99 mm. -----	20.5
0.99-0.45 mm. -----	19
0.45-0.28 mm. -----	8.5
0.28-0.197 mm. -----	8
0.197-0.16 mm. -----	3
0.16-0.100 mm. -----	10
<0.100 mm. -----	21

This magnesia is intimately mixed at a temperature of about 120° C. with 7% dry pitch having the following characteristics:

Softening point ----- ° C.	75-76
Fixed or cokefiable carbon ----- percent	48
Volatile matter ----- do.	52
Ash ----- do.	0.2
Resins insoluble in benzene ----- do.	27
Resins insoluble in anthracene oil ----- do.	7

The mixture of magnesia and pitch is tamped by means of a pneumatic tamping device into sheet metal forms which have been preliminarily coated with tallow. There is thus formed, in several parts, a complete internal lining for a furnace.

The sheet metal forms filled with the mixture are placed in a coking furnace lined with bricks containing 42% alumina; the forms are carefully covered with ordinary powdered magnesia to prevent all contact with air and are heated for two hours to 700-800° C. They are then permitted to cool, but always out of contact with air.

They are then machined (worked) as may be required, and the lining is placed inside a rotating furnace provided with indirect arcs in which is manufactured a copper-chrome at a temperature of about 1800° C. Proceeding in this manner, it was possible to manufacture about 40 tons of this alloy without changing the lining whereas, with the best magnesia bricks on the market, it was necessary to replace the lining of the furnace after manufacturing only 10 tons of the alloy.

If the furnace be stopped while it is in operation, it can be seen that the magnesia in contact with the bath at 1800° is vitrified and possesses maximum hardness but high thermal conductivity. Back of this molten zone, there is found a zone which is sintered at its center and which assures the stability and resistance of the bath; finally, in contact with the walls of the furnace, the magnesia is imperfectly sintered and only slightly heat insulating.

By the use of the refractory lining produced according to the present invention, it is possible to obtain

Economy of energy;

A simplified construction, and

Lower production costs of the products manufactured in the furnace, especially, if there be used parts which were merely prebaked at a temperature of 700-800° C.

The above described process applies not only to electrically melted magnesia of high purity, but also to natural magnesias, that is to say, to calcined or sintered magnesias used in the manufacture of commercial magnesia bricks, provided that these natural magnesias be preliminarily melted electrically.

For example, Austrian magnesia even when preliminarily sintered, then ground, agglomerated with pitch and baked out of contact with air at 700-800° C., yields parts which are not at all sintered at 1250-1450° C. in an oxidizing atmosphere, and the magnesia particles remain separated following the disappearance of the coke binder by combustion.

By contrast, when this magnesia has been preliminarily melted electrically, there are obtained the results described in the following example:

Example II

A calcined Styria magnesia, containing 90-91% MgO, and 5 to 8% FeO as principal impurity, is melted in an electric furnace and is then ground. The resultant powder has the same granulometry as that of Example I.

It is intimately mixed at about 120° C. with 7% pitch. The paste is then tamped into sheet metal forms and the parts are then coked at 700-800° C. out of contact with air.

They are next heated in an oxidizing atmosphere at 1250-1450° C. Sintering starts at 1250° C.; however, the refractory parts attain their exceptional cohesion properties at about 1450° C. This cohesion is further increased when the parts are heated to 1600-1800° C. in the furnace wherein they are used.

In the refractory parts thus obtained, the magnesia retains its initial pyrometric properties because no impurity is added to form a binder. This magnesia, completely crystallized, resists better chemical attack and high temperatures than the magnesia bricks now on the market, of which only the base product has been sintered.

It is possible to line in situ with electrically melted crystallized magnesia the hearths of metallurgical furnaces operating at the highest temperatures, for example, those used for the treatment of baths which are decarburized with oxygen to obtain stainless steels having a very low carbon content.

These refractories have a certain porosity depending on the molding pressure, on the temperature and duration of the treatment. For example, in the case of parts of electrically melted magnesia, the apparent density varies between 2.56 and 2.80, whereas the real density of periclase is 3.79.

Parts which were molded but not compressed were found to have, for example, a porosity of:

27% following coking at 700° C., and 34% following oxidation at 1250° C.

Parts and lining produced in accordance with the present invention possess a high purity from the chemical standpoint, possess excellent internal cohesion, and exceptional resistance to thermal shocks; however, their porosity may be a drawback for certain applications, for example, as electric insulators.

The present invention also comprehends an improvement in the manufacture of refractory parts of electrically melted magnesia which consists in coating (covering, encasing) such parts by means of steatite preliminarily melted electrically.

There is preferably used an artificial steatite, because it is purer than natural steatite since it does not contain either iron oxide or titanium oxide; however, natural steatite is suitable in all cases where the electric insulation characteristics or very high purity are not indispensable.

The process of this embodiment of the invention is carried out in the following manner:

There is melted in an electric furnace a mixture of silica and magnesia—both of a very pure quality—in the proportion by weight of 2 of silica for 1 of magnesia. The parts of magnesia or of magnesia spinel are brought to a red heat (about 1000° C.) and are then dipped into the molten steatite. They are maintained in this position for about 10 seconds and there is obtained, following their removal from the molten bath, a covering layer having a thickness slightly in excess of 1 millimeter.

The covering thus obtained appears to consist of a superficial combination of silicate of magnesia, with the magnesia passing progressively from the exterior to the interior, from pure electrically melted steatite, into a silicate richer in magnesia and, then, into pure magnesia.

There are thus obtained refractory parts possessing both the electric insulating characteristics which are due to the steatite and those due to the electrically melted magnesia, but without porosity.

In lieu of pitch, other organic binders can be used, such

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as for instance: gels comprising carbohydrates, such as oses, holosides, heterosides, starch, cellulose, etc. and/or gels comprising proteins, such as gelatins, glues, etc.; natural or synthetic polymers, such as polyesters.

We claim:

1. Process of manufacturing a refractory lining for furnaces, comprising the steps of: melting electrically a refractory magnesia; comminuting the thus treated magnesia into particles; agglomerating the particles with an organic binder, consolidating the agglomerated mass; baking the consolidated mass out of contact with air at a temperature within the range of about 700–800° C., and thereafter sintering the baked mass in an oxidizing atmosphere at a temperature within the range of 1250–1800° C.

2. Process according to claim 1, wherein the sintering takes place within the range of about 1250° to about 1450° C.

3. Process according to claim 2, comprising the further steps of melting steatite electrically and coating the sintered magnesia with a layer of the molten steatite.

4. Process according to claim 1, wherein the magnesia

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is selected from the class consisting of substantially pure magnesia, natural magnesia, and magnesia spinel.

5. Process according to claim 1, wherein the agglomerated mass is tamped in situ in the furnace to be lined.

6. Process according to claim 1, wherein the furnace is lined with the baked mass, and the sintering is carried out during the normal operation of the furnace.

7. Process according to claim 1, wherein the comminuted magnesia comprises about 21% of particles passing through a screen opening smaller than 0.100 mm., and the amount of binder is not in excess of 7%.

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