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PROCESS FOR MANUFACTURING BASIC REFRACTORY BRICKS

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ABSTRACT OF THE DISCLOSURE

The invention relates to a process of making basic refractory bricks containing an organic binder such as tar which comprises heating coarse basic refractory particles larger than 0.1 mm. in size to a temperature between 100 and 200° C., the coarse material being separated into fractions and separately heated, combining the heated coarse grain fractions, mixing the combined coarse grain fractions with an organic binder which itself has been heated to a temperature of from 100 to 200° C., heating fine basic refractory grain materials less than 0.1 mm. in size to a temperature of from 100 to 200° C., subsequently mixing the heated fine grain with a previously made mixture of binder and coarse grain and then shaping the resulting mixture into the desired shape. Basic refractory grain material is of a sinter grade of at least 90%.

This invention relates to a process for manufacturing basic refractory bricks, blocks and tamping mixtures containing tar as a binder suitable for lining industrial furnaces and metallurgical vessels.

Tar-bonded refractory bricks, blocks and tamping mixtures of basic material such as dolomite, magnesite or chrome ore are widely known and commonly used to a considerable extent for the lining of metallurgical furnaces and vessels. They have been more recently used for the lining of oxygen-blowing converters.

In the conventional process for manufacturing such products, the basic refractory materials consisting essentially of coarse particles greater than 0.5 mm. in size and fine particles of the same material below 0.5 in size are mixed with an organic binder such as tar in a heated pug mill, the refractory materials having been sintered prior to the mixing. The mixture is then given the desired shape by pressing, vibrating or ramming it into the proper mold.

In the prior art methods of manufacturing these basic refractory bricks, difficulties were encountered in the combining of the various ingredients resulting in products with unsatisfactory properties. It was important in making such bricks to control accurately the amounts of ingredients used and to thoroughly to mix them to achieve a uniform mass. If the binder was not uniformly distributed the brick would contain unbonded areas giving it a susceptibility to crumble or disintegrate when used within a furnace.

During heating up, the temperature of the furnace passes through the range in which the binder will become soft and fluid before it is coked. If there is an excess amount of binder, this may result in a slipping of the layers up to a thickness of 50 mm. on the hot side of the lining of the furnace or the total collapse of the entire lining. Even if a high proportion of hard pitch was used, the difficulty encountered could not be eliminated as it merely displaced the temperature range in which the tar would flow toward a higher temperature.

Therefore, it was extremely important not only to thoroughly mix all the refractory materials with a sufficient amount of binder to produce a uniform mass, but

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it was equally important to very accurately control the amount of binder used, especially when highly sintered refractory material was used. Thus, the slightest amounts of binder under or over the desired percentage rendered the brick unsatisfactory for use as a liner in a furnace. Since it is difficult to so accurately control the proper percentage of binder, it was therefore, uneconomical to produce satisfactory bricks on a large scale.

Accordingly it is an object of this invention to provide a process for the manufacture of basic refractory bricks which will not only have a high resistance to slag, by the use of highly sintered materials, but which bricks will also have a greater uniformity of distribution of binder thus resulting in a more stable product.

It is an additional object of this invention to achieve this greater uniformity while eliminating the necessity of accurately controlling the amounts of binder to be used, thus making it easier and simpler to produce satisfactory bricks within a greater margin of error.

These objects are accomplished by individually preheating each and every fraction of the coarse component of the refractory materials to approximately a temperature of at least 100° up to 200° C., preferably around 150° prior to mixing them with the organic binder which has also been preheated to the same temperature. The coarse component in this new process comprises all particles above 0.1 mm. in size. The mixture of coarse particles and binder is then mixed with fine particles of a refractory material consisting only of those less than 0.1 mm. in size, which particles have in addition been preheated to the aforementioned temperatures with the subsequent shaping of the mixture into the desired shape.

This process of manufacture has decided advantages over the prior art methods as will be apparent from the following detailed discussion of the invention wherein the use of the term bricks is intended to mean all forms and shapes of refractory material containing objects including blocks and tamping mixtures.

It is known to make refractory mixtures from organic binders and refractory base material consisting of dolomite or magnesia by disintegrating the materials into various particle sizes and separating them into two main components, namely, a first component containing the coarse particles e.g. above 0.5 mm., and a second component consisting of those below of fine particles. In this process the coarse component is first treated by the surplus of binder or admixed in a bath of binder so that the coarse particles are thoroughly impregnated with the binder. The fine component is then mixed with the impregnated coarse component. Further binder could be added to the mixture of the two components and the refractory material and/or the binder may be preheated.

In addition, it is also known to manufacture basic refractory linings consisting substantially of a small amount of a non-aqueous, cokable, carbonaceous binder, and two components, a major component consisting of non-acid particles having a considerable dolomite content and a particle size above 0.41 mm. and a minor component consisting of magnesia in a particle size below 0.41 mm. In this process the coarse and fine refractory components could be mixed with each other and then with the binder, or the coarse component could first be mixed with the binder with the subsequent addition of the fine component. In both of these cases the refractory material and binder could be preheated.

It is desirable in making refractory bricks to use a refractory material of a high sinter grade as this gives a high resistance to liquid slag which will attack the bricks during the operation of a furnace. The sinter grade of refractory particles is obtained by deducting the percentage of the particle porosity or grain porosity from

100% so that a grain porosity of 5-10% corresponds to a sinter grade of 95-90%, which is considered a high sinter grade refractory material. Investigations have shown that there is a direct correlation between the sinter grade of the refractory grains, the grain size distribution and the amount of binder. At lower sinter grades such as from 80-90%, the amount of binder used is not critical and may vary within wide limits between 2 and 9% because a surplus of binder will be absorbed by the porous grains, but in cases of high sinter grade, those exceeding 90%, the amount of binder must be very exactly controlled and may generally vary only by about 2%, e.g. between 3 and 5%, if every good results are to be obtained. In this case, an excess of binder would result in the brick having the dangerous properties of slipping in the furnace as aforementioned. Thus to avoid these dangers of too much binder, heretofore smaller amounts of high sinter grade material or low sinter grade material were used and thus the bricks were not highly resistant to the attack of liquid slag.

It has been found that by using particles of a size less than .1 mm. and preferably less than .06 mm. a higher sinter grade refractory material desirable for high resistance to slag can be used, without the complicated proportioning of the binder within small limits. While porous refractory material would overcome this difficulty, the porosity of the particle gave the brick poor properties with respect to slag resistance. If fine particles below a particle size of .1 mm. and preferably below .06 mm. are used, the binder need not be so exactly proportionated and may vary anywhere between 2 and 6%; it is preferably 3 to 5%. Thus by using fine particles below 0.1 mm., desirable properties in the bricks can be achieved without the necessity of accurately controlling the amount of ingredients.

By lowering the level of division between coarse and fine particles to the level of 0.1 mm. more particles will be subjected initially to the binder at a high temperature with the result that a more uniform mixture is obtained. Each fraction of the coarse component is individually preheated in the process of the invention and the individual coarse fractions are then mixed in the desired proportions with each other and then brought together and thoroughly mixed with the entire binder which has also been preheated. The fine or powder component below 0.1 mm. is not admixed until a uniform distribution of the coarse component and the binder has been obtained. The formation of lumps by the powder portion can thus be avoided, whereas such lumps would frequently form when fine refractory materials were mixed directly with the tar. The addition of the preheated binder to the components above .1 mm. is preferably not effected at once but the binder is sprayed or injected onto this component in a running mixture. This results in a particularly uniform distribution of the binder on particle surfaces. The mixture used is an impeller type mixer. As the refractory material and binder are fed in a preheated condition into the mixer, the mixer need not be heated. It is emphasized, however, that a proper preheating of the material is essential for a good effect of the binder because the cold crushing strength of the resulting shaped bodies is poor or unsatisfactory when the refractory material and the binder are too cold when fed into the mixer.

The refractory grain material contains suitably about 15-35% fines below 0.1 mm., preferably even below 0.06 mm. as mentioned above. In a specific composition the refractory material may contain the following particle size fractions expressed as a percentage of the total amount of refractory grain material present:

	Percent
Below 0.1 mm., preferably below 0.06 mm.	15-35
0.1-1 mm.	15-35
1-3 mm.	10-20
Above 3 mm. up to 10 or 15 mm.	20-40

Thus, each fraction listed above having a particle size greater than 0.1 mm. is individually preheated before they are mixed with a preheated binder. Thus, it has been found that highly desirable refractory bricks containing material sintered to a grade of above 90% and having optimum distribution of organic binder can be achieved by separating coarse particle grains, as those above 0.1 mm., into fractional amounts according to size in the quantity desired and heating each of these fractions individually to a temperature of 100-200° C., preferably to 150° C. The fractions are then combined in the desired proportions and mixed with the entire binder which has also been preheated to a temperature of 100-200° C., preferably 150° C., subsequently mixing this mixture with the fine refractory component (having a grain size smaller than 0.1 mm.) consisting of at least 15% of the total mixture, which component has also been preheated to the same temperatures with the subsequent shaping of the mixture into the desired shape.

Suitable refractory materials include magnesia as well as dolomite or mixtures of magnesia and dolomite. All may contain additions of chromite, alumina and the like. A material specially suitable for converters may have the following composition:

	Percent
SiO ₂	Less than about 0.5.
CaO	About 2-20.
Fe ₂ O ₃	About 4-6.
Al ₂ O ₃	About 1.
MgO	70-95.

For special purposes, it is sometimes recommendable to use low-iron material containing less than 1% Fe₂O₃.

The bricks according to the invention may be metalclad. In a manner known per se, the cladding elements or metallic plates may be co-molded with the brick material, or subsequently applied to the finished bricks.

The term "tar" is intended to include anhydrous steelwork's tar containing 70-90% hard pitch, or pure hard pitch and bitumen.

The use of tar which has this high content of hard pitch, or pure hard pitch as a binder is desirable because it increases the amount of fixed carbon. The content of fixed carbon is significant because it varies the wetting angle of the slag and thus the ability of the slag to attack the refractory particles, and because the fixed carbon in the form of carbon lamellae disposed between the periclase crystals reduces the rate of coalescent crystallization so that the compacting and the disorganization of the particle structure on the hot side of the refractory materials is delayed or even prevented.

Another factor which is of decisive significance for the process according to the invention is the temperature at which the mixture of refractory material and binder is pressed, vibrated or rammed. It has been found that during these shaping operations, particularly during pressing, the temperature must not exceed about 110° C. because the viscosity of the binders is so low above this temperature that cracks may form in the refractory products. On the other hand, the operations should not be carried out at a temperature below about 70° C. because this would reduce the compressibility of the mix to be shaped, and the compacted mix would have a lower bulk specific gravity and would give rise to the appearance of binder-free, crushed particles of the refractory material on its outside surfaces. Particularly in the presence of free lime, the hydrating attack may begin at such crushed particles.

In view of our invention and disclosure, variations and modifications to meet individual whim or particular need will doubtless become evident to others skilled in the art to obtain all or part of the benefits of our invention without copying the process shown, and we, therefore, claim all such insofar as they fall within the reasonable spirit and scope of our claims.

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Having thus described our invention what we claim as new and desire to secure by Letters Patent is:

1. A process for the manufacture of basic refractory bricks, bricks and tamping mixtures containing an organic binder which comprises sintering basic refractory grain material to a sinter grade of at least 90%, heating coarse grain material of said basic refractory grain material greater than 0.1 mm. in size to a temperature of from 100° to 200° C., said grains being separately heated in fractional amounts according to grain size, combining said heated coarse grain fractions, thoroughly mixing therewith an organic binder which has been heated to a tempertaure of from 100 to 200° C., heating fine grain material of said basic refractory grain material less than 0.1 mm. in size to a temperature of from 100 to 200° C., subsequently mixing the heated uncoated fine grain with the previously made mixture of binder and coarse grain and shaping the resulting mixture into the desired shape.

2. A process according to claim 1, wherein the fine grain material comprises at least 15% of the total amount of refractory grain material present.

3. A process according to claim 1, wherein a substantial amount of the fine grains are less than 0.06 mm. in size.

4. A process according to claim 1, wherein the fine grain material comprises 15 to 35% and the coarse grains 85 to 65% of the total amount of refractory grain material present.

5. A process according to claim 1, wherein the total

basic refractory grain material has the following particle size fractional distribution:

	Percent
Grains less than 0.1 mm. -----	15-35
Grains from 0.1 to 1 mm. -----	15-35
Grains from 1.0 to 3.0 mm. -----	10-20
Grains above 3.0 mm. -----	20-40

6. A process according to claim 1, wherein the refractory grain materials are magnesia and the organic binder is a tar.

7. A process according to claim 1, wherein the heated binder is injected into the combined heated fractions of the coarse grains in a running mixer.

8. A process according to claim 3, wherein fines below 0.06 mm. are used and the binder amounts to 2 to 6%.

9. A process according to claim 1, wherein the binder amounts to 3 to 5%.

10. A process according to claim 1, wherein the shaping is effected at a temperature of 70 to 110° C.

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