RESEARCH

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SUGGESTIONS ON RESOURCE-SAVING REFRUCTORY TECHNOLOGIES

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Substantiated suggestions are made on the development of resource-saving technologies for a new generation of refractories and materials. Rapid organization of the production of the new generation of refractories will raise the refractory industry to a much higher level.

The main problem in the development of the refractory industry in Russia consists in organizing the production of a new generation of refractories. However, the attention to this problem is insufficient.

Only some concepts of the methods for creating the new generation of refractories [1], organizing the production of magnesia refractories [2], and modeling the development of the refractory industry [3, 4] have been considered; there are also some works that are indirectly related to the problem.

The present paper concerns some engineering solutions to the problem of the creation of resource-saving technologies for the new generation of refractories.

DEVELOPMENT OF SHS TECHNOLOGY FOR THE PRODUCTION OF MAGNESIA REFRUCTORIES

Under the conditions of a power crisis the saving of fuel and power resources acquires primary importance.

The greatest amount of fuel (0.5 - 0.6 ton per ton of articles) is required for the production of magnesia refractories, which are fired at a very high temperature (1580 - 1850°C). Therefore it is very important for the economy to reduce the consumption of fuel in the production of magnesia refractories.

The development of a technology for magnesia refractories using SHS (self-propagating high-temperature synthesis) technology solves the problem of cutting the consumption of fuel and widening the raw materials base.

The essence of the suggested technology consists in using the internal heat emitted due to the aluminothermic processes rather than the external heat of fuel combustion used in drying and firing of magnesia refractories in the conventional technology.

The advantages of SHS in the production of magnesia refractories compared to the existing technology are as follows:

- complete elimination of drying and a substantial reduction of the firing temperature; it seems that only a heat treatment at 400 - 500°C will be needed;
- considerable reduction of the production time, from 5 days in the case of the conventional technology to several hours in the case of SHS;
- formation of magnesia refractories with a high-quality structure and composition due to the high temperature (2400°C) of the aluminothermic processes. At this temperature the synthesis of compounds like aluminomagnesium spinel (its melting temperature is 2135°C and it occurs in the articles as if in a molten state) occurs with substantial acceleration;
- substantial improvement of the quality of magnesia refractories due to the formation of their binding part at a high temperature (2400°C);
- the possibility of using periclase powders with an elevated content of CaO and periclase-lime and lime-periclase powders for the production of articles, which is especially important;
- ecological safety when observing the specified conditions;
- the possibility of organizing the production of heat-insulating magnesia articles with elevated parameters of heat-insulating properties, which have not been produced in Russia earlier;
- the possibility of organizing the production of magnesia refractories using the equipment of any operating plant with minimum capital expenditure;

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competitive; the possibility of producing periclase-spinel, periclase-lime, lime-periclase, periclase-forsterite, and forsterite articles for linings of converters, electric steel-melting furnaces, rotary kilns, furnaces for nonferrous metallurgy, and steel-casting complexes.

Thus, SHS technology for the production of magnesia refractories makes it possible to decrease markedly the fuel consumption, use magnesia-lime powders, and organize the production of heat-insulating materials for many purposes.

DEVELOPMENT OF THE TECHNOLOGY FOR PERICLASE-LIME AND LIME-PERICLASE REFRACTORIES

Russia produces unfired periclase-lime and lime-periclase articles on tar or pitch binders for steel-melting converters.

In foreign countries magnesia refractories are developed by widening the production and improving the quality of unfired (on chemical binders) and fired periclase-lime and lime-periclase refractories instead of chromium-containing ones. In Russia such refractories are not produced.

A technology should be developed for organizing the production of unfired and fired periclase-lime and lime-periclase articles for roofs and walls of steel-melting furnaces, the steel-casting complex, rotary kilns, and furnaces for nonferrous metallurgy instead of periclase-chromite and chromite-periclase articles.

The suggested technology has the following advantages:

- ecological safety;
- use of a large number of initial materials: sintered metallurgical periclase-lime and dolomite powders, available binders and additives, etc.;
- the possibility of organizing the production of refractories at any refractory plant with low capital expenditures;
- improvement of the wear resistance of refractory linings of heating units by at least a factor of 1.5;
- reduction of the specific fuel consumption by at least 10%.

The capacity of the production of unfired and fired periclase-lime and lime-periclase articles is estimated at 100 - 150 thousand tons a year.

DEVELOPMENT OF THE TECHNOLOGY FOR MAGNESIA HEAT-INSULATING REFRACTORIES

Magnesia heat-insulating refractories are not produced in Russia at present. Since it is necessary to save fuel in the manufacturing and use of refractories it is expedient to begin the production of magnesia heat-insulating refractories to be used in the functional zones of linings and reconstruct existing linings with the use of heat-insulating refractories. Magnesia heat-insulating refractories can be used in linings of the steel-casting complex, rotary kilns, and furnaces of nonferrous metallurgy.

The technology of magnesia heat-insulating refractories has the following advantages:

- ecological safety;
- partial use of green magnesites, dolomites, and limestones as components of the initial material;
- the possibility of organizing the production at any refractory plant with a low capital expenditure;
- reduced consumption (by more than 30%) of materials for articles due to their porosity;
- decreased specific consumption of fuel (by at least 10%).

The capacity of the production of magnesia heat-insulating refractories is estimated at 30 - 50 thousand tons per year.

DEVELOPMENT OF THE TECHNOLOGY FOR PERICLASE-SPINEL REFRACTORIES

Periclase-spinel refractories are not produced in Russia. Only periclase refractories on a spinel binder (4 - 6.5% Al₂O₃) are produced.

An important direction in the development of magnesia refractories in foreign countries consists in increasing the production and quality of periclase-spinel refractories with 15 - 25% Al₂O₃ for steel-melting furnaces, steel-casting complexes, and especially rotary kilns for the cement industry instead of chromium-containing refractories.

For example, the use of periclase-spinel refractories in rotary cement kilns gives ecologically safe portland cement (the content of hexavalent chromium in portland cement is at most 0.0002%).

The technology of fired periclase-spinel refractories has the following advantages:

- ecological safety;
- the use of periclase powders, incompletely molten materials, caustic periclase, and alumina-containing materials as the initial components;
- synthesis of magnesia-alumina spinel in the process of firing of articles;
- the possibility of organizing the production at any refractory plant with a low capital expenditure;
- preparation of ecologically safe portland cement;
- increased wearability of the heating units (by at least a factor of 1.5).

The yearly capacity of the production of periclase-spinel articles is estimated at 50 - 100 thousand tons.

DEVELOPMENT OF THE TECHNOLOGY FOR HIGHLY STABILIZED PERICLASE-ALITE AND ALITE-PERICLASE REFRACTORIES

At present Russia does not produce highly stabilized periclase-alite and alite-periclase refractories for linings of heating units for various branches of industry. The need to