RAW MATERIALS

UDK 666.762.1

CURRENT TYPES OF IMPORTED HIGH-ALUMINA RAW MATERIALS FOR REFRACTORY PRODUCTION

V. A. Kononov¹ and V. K. Sturman²


Original article submitted June 24, 1996.

The major types of high-alumina raw materials used in Russian refractory plants are considered. The main principles in developing the supply of high-quality alumina raw materials to the world market are shown by the example of the Alcoa Company (US). Some information on materials little known in Russia is presented. Among the materials are tabular alumina, reactive alumina, high-alumina cement, etc. The basic requirements on the properties and parameters of high-alumina materials that are delivered to the leading refractory enterprises are given. The main areas of application of the materials to production at domestic plants of the metallurgy and refractory industry are defined.

The development of the present-day refractory industry is impossible without recourse to efficient kinds of raw materials. The lack of some kinds of refractory raw materials that should be available for refractory producers has adversely affected the production of modern articles and bodies, needed in particular for casting and out-of-furnace processing of steel.

Progress in the industrial technology of refractories is determined in many respects by the use of pure raw materials, such as tabular alumina, sintered spinel powders, high-alumina cement, and some kinds of special fired alumina, which are used extensively throughout the world.

Shiber Joint-Stock Company was concerned with the development of advanced technologies for plates for slide gates, seat blocks, ladle nozzles, and measuring sleeves. In this work, engineers faced the problem of the quality of such articles produced on the basis of domestic raw materials only. Articles of corundum or graphite-containing corundum compositions, with electrically fused corundum, did not comply with present-day requirements. By analyzing data on the behavior and service of imported refractories in casting units, some important distinguishing features were revealed in the structure of these materials. These features were due to the use of pure multifraction raw materials produced mainly outside Russia. It was decided to use in part new kinds of materials. As a result of cooperation between Shiber JSC, Alcoa aluminum company (US) and Vnukovskii Zavod Ogneuporykh Izdelii JSC, the necessary materials were obtained and modern high-quality refractories were produced. The refractories were tested successfully in service. The developed articles based on corundum and graphite-containing corundum compositions do not differ from imported refractories. The compositions make it possible to improve the stability of all components of the casting units significantly.

Using available information, extensive studies of imported high-alumina raw materials are conducted at the Institute of Refractories in St. Petersburg in cooperation with the Semiluki refractory plant and Link financial company.

At the present time, in manufacturing refractories Russian enterprises use mainly electrically fused white corundum made by a number of plants producing abrasive materials. Fired bauxites imported from China, fired and raw alumina of types GK and G-0 produced by plants of the alumina industry, and synthetic mullite powders.

To provide refractory enterprises with electrically fused corundum (electrocorundum), Kazogneupor plant was built. The productivity of this plant was 100,000 tons of fused electrocorundum per year. However, the plant is now outside Russia, and electrocorundum is supplied from abrasives plants, where the specific features peculiar to refractory production are not taken into account.

The Semiluki refractory plant uses fired Chinese bauxite with an Al₂O₃ content of about 88%. However, the bauxite has a relatively high content of iron and titanium oxides as compared to electrocorundum. Articles made from the bauxite show low durability under conditions of out-of-furnace treatment of steel.
Production of the highest-quality articles from a high-alumina composition was organized at the Borovichi refractory works. The technology provides for the production of mullite-corundum chamotte from service alumina and plastic clay. However, this production is unprofitable because of the high price of alumina.

High-quality corundum-based articles are produced by Snegirevskie Ogneupory JSC but the electrocorundum delivered from different abrasives enterprises varies in chemical and phase composition. Therefore, additional expenses are required to achieve the necessary quality of the products.

For more than 10 years, the leading refractory firms of the world have used tabular alumina and spinel powders for the production of articles and bodies for the most demanding applications in metallurgy. The use of these materials exhibits a tendency to grow.

On the world market, the enterprises that process raw materials are divided into several groups: plants related mainly to the mining industry, concentrating (refining) plants producing concentrates, and specialized plants for manufacturing starting materials to meet the customer's demands.

It is agreed that the best-known supplier of alumina materials is the Alcoa Company (US). The firm manufactures about 30% of the world alumina production for metallurgical and nonmetallurgical purposes. Nearly 90% of the alumina is delivered to produce primary aluminum, and the remaining 10% is used in nonmetallurgical branches of industry. Production and marketing in the nonmetallurgical branches are conducted by the Alcoa—Industrial Chemicals (AIC) business department, organized in 1990. The production strategy of the Alcoa Company involves three directions of activity:

1. Investments in mining and concentrating enterprises in different countries throughout the world to provide the firm's own specialized plants with raw materials. For instance, $42,000,000 was invested in the development of a plant in Queenane (Australia) in recent years.

2. Application of advanced technologies to processing raw materials delivered from throughout the world to the specialized plants, which produce high-quality calcined and tabular alumina, high-alumina cement, spinels, etc.

3. Accounting for individual demands of customers regarding composition, sizing, and other properties of the products at local processing centers.

The activity of the AIC department is supported by fundamental and applied research centers. Technologies, information, and promising ideas are introduced into a global electronic system that permits AIC workers anywhere in the world to access the latest information.

In Europe, the Alcoa Company incorporates specialized enterprises that produce several kinds of materials mainly for European refractory plants. This is illustrated by the following:

<table>
<thead>
<tr>
<th>Material</th>
<th>Producing plant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcined alumina</td>
<td>Ludwigshafen (Germany)</td>
</tr>
<tr>
<td>Polishing alumina</td>
<td>Moerdiek (Netherlands), Ludwigshafen</td>
</tr>
<tr>
<td>Tabular alumina</td>
<td>Rotterdam (Netherlands), Ludwigshafen</td>
</tr>
<tr>
<td>High-alumina cements</td>
<td>Rotterdam</td>
</tr>
</tbody>
</table>

In addition, special kinds of starting material for the refractory, ceramics, and abrasives branches of industry are manufactured. The materials belong to fired alumina: reactive alumina with a low soda content, medium-crystallite alumina with a low or intermediate soda content, and macrocrystallite alumina with a normal soda content.

The plant in Ludwigshafen manufactures more than 100 kinds of fired alumina of different crystalline (grain) size and different degree of purity, including unmilled, finely milled, and superfinely milled materials. The key parameters of the alumina are the primary size of the crystallites, specific surface, chemical and grain composition, grindability, reactivity, calcination loss, and density and shrinkage after calcination. Leading firms of advanced countries extensively use fired alumina, particularly reactive alumina, for the production of linings for casting ladles, ladle nozzles, seat units, plates for slide gates, etc.

Russian plants produce a limited amount of fired alumina (GK, GKIS, GLMK, etc.), which is used mainly for the production of special ceramics. Many refractory plants are experienced in the use of alumina GK. In the last few years, however, this kind of alumina went up sharply in price, and at the same time, it is inferior in quality to imported analogs.

Reactive alumina is specially developed for refractory mixtures for which certain rheological characteristics and very strong ceramic binding with other components are required (Table 1). Reactive alumina is of high purity (> 99%