PRODUCTION

PRODUCING COMPLICATED ARTICLES WITH
FOAM POLYSTYRENE INSERTS

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In a range of production processes in nonferrous, ferrous, and other sections of industry it is necessary to use refractories of complex and very complex configuration with internal straight-through or blind-alley cavities. Great difficulties are encountered in making such articles.

The shaping of hollow refractories by casting is well known; this is done by fitting a core in the mold and placing on it a rubber shell corresponding to the required shape. After casting the refractory slip the core is removed, air is sucked through the aperture on the face, and the shell is compressed and then removed.*

It is possible to use metallic components for the inserts to shape the internal cavities in the articles, but this method is labor intensive.

A better method involves the use of combustible inserts prepared from friable, powdered (refractory or combustible) materials with a thermoplastic bond [1, 2]. A disadvantage of this method is the need for the additional operations of burning out the bond with subsequent cooling and removal of the filler for the insert (alumina, sand, graphite, etc.) or ensuring combustion of the insert during high-temperature firing. During combustion of the bond or insert a certain amount of gaseous products is formed, contaminating the atmosphere; sometimes the articles crack, which is due to the different thermal expansion insert and article.

In the present article results are presented of an investigation leading to the production of articles with complex cavities of any configuration, practically excluding loss and the emission of gaseous products. The basis of the method is vibration casting, using bodies of different composition [3-5]. The cavity-forming agents consist of foamed polystyrene inserts. Since they have a low strength they can be rationally used only for vibration casting, and with other methods of shaping the inserts are deformed and damaged.

The inserts are made from foamed polystyrene using a two-stage technology: the granules are first partly foamed, and then they are sintered in a press mold by the autoclave method. Foamed polystyrene inserts possessed a much lower apparent density (17-57 kg/m$^3$) than those made of alumina, graphite, or sand with a thermoplastic bond (density respectively 2610, 1270, and 2140 kg/m$^3$). Moreover, such inserts during drying (practically without mass loss) vary sharply in volume. Taking account of the necessary configuration of the cavity we developed the production of various inserts (Fig. 1).

Specially complicated items (diffusors, burner blocks, T-pieces, etc.) were prepared by vibrocasting from corundum-mullite bodies based on fused corundum, fused mullite, and alumina [6]. Foamed polystyrene inserts were established in the gypsum, wood, or metallic mold (Fig. 2). Corundum-mullite body with a moisture content of about 6% was poured from the hopper into the vibrating mold. After the necessary holding time the green articles with the inserts were released from the mold. The T-piece, dried out at 70°C with the foamed polystyrene insert, is shown in Fig. 3.

It is known that foamed polystyrene melts at 164°C, and at 316° it decomposes; and at 576°C it burns and forms hydrogen and carbon [7]. Analysis of the thermal destruction products at 700, 1300, and 1550°C showed the evolution of styrene, benzol, toluol, ethane, methane and other products [8]. Therefore, firing articles containing this foam is undesirable.*

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The method developed specifies that the greenware containing the foam inserts be predried at 100-150°C before firing. The drying time depends on the mass of the article and the apparent density of the foam. In the above conditions, there is a marked reduction in the volume of the insert (2-32 times), and it is easily removed from the green article. Foamed polystyrene inserts before and after heat treatment are shown in Fig. 4. With such a substantial change in the volume of the insert the mass remains almost constant (a reduction of 0.2-1.4%), which indicates the absence of thermal breakdown. The use of inserts made of alumina with a thermoplastic bond showed that during drying of the greenware, the bond is impregnated by the melt, and after drying it is impossible to extract the insert from the mold. Only after biscuit firing and combustion of the thermoplastic bond is it possible to remove the alumina and carry out high-temperature firing.

Refractory articles made with foamed polystyrene inserts are shown in Fig. 5. At the experimental factory of the Ukrainian Institute we made very complicated articles (T-pieces) with the use of the foam and composite metallic inserts. Forming the internal cavities and gaps in the lock joints with the metal inserts requires, in addition to assembly and splitting of the molds, the installation and subsequent removal of the T-pieces of the insert parts from the channels. This operation should be completed by a highly skilled operative with careful observation of the sequence of operations; slight deviations cause increased losses [9]. With the new technology the process is greatly simplified; we need only to assemble and dismantle the mold, and then to remove the inserts before firing. Using foamed polystyrene inserts, the yield of satisfactory articles is high (see Table 1).