EQUIPMENT

ON FABRICATION OF REFRACTORY ARTICLES BY INJECTION

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A principally novel technology for molding and compacting articles from low-moisture powder materials by continuous zonal injection directly into open molds is suggested. The method excludes air inclusions, the elastic aftereffect, the inaccuracy of the sizes of the articles, and other defects typical for cyclic semidry pressing. The use of the new technology in the production of refractories makes it possible to increase their density, decrease the forces acting on the material by 1 - 2 orders of magnitude (i.e., to the ultimate strength of the greenware), increase the accuracy of the sizes, decrease the expenses per unit product, and increase the output of the molding equipment.

Refractory parts are predominantly fabricated by semidry pressing from low-moisture (from 5 to 9%) powder mixtures. A shortcoming of the existing regimes of semidry pressing of refractories is the pressed-in air that markedly deteriorates the quality of the products, causes open porosity, and decreases the density and the corrosion strength of the refractories. Air is pressed-in because the bulk density of the mixture poured into the mold is 1.5 - 2 times lower than the density of the pressing, and the punch introduced into the mold forms a closed space from which it is impossible to remove all of the air through the minimum clearance between the punch and the walls of the mold. In addition, this pressing regime does not provide close packing of the particles with a maximum area of contact between them, because the relative motion of the particles is hampered when the volume decreases.

Another disadvantage is the insufficient accuracy of the sizes of the articles, which influences the service life of the lining. This occurs because of the considerable vibrations of the poured powder mixture, which hamper exact proportioning. It should be mentioned that the two pressing problems that consist in providing a high and uniform density of the articles and their precise geometry cannot be solved in an optimum way simultaneously, because when the pressing pressure is controlled by a manometer it is impossible to provide a constant height of the pressings, whereas when the pressing is performed to a specified height the density of the article can be highly nonuniform.

The third disadvantage is the necessity for high pressing pressures (200 - 1000 MPa). This requires the use of super powerful hydraulic presses for fabricating large refractory blocks or the use of laborious manual tamping. Paradoxically, it is possible to compact the articles successfully by 10-kg tampers, whereas their pressing in closed press-molds requires a force of 1000 kg/cm² [1].

This paradox makes us doubt the correctness of the universal opinion that the density of the pressings depends on the pressure only [2]. A worker with a tamper creates a denser structure in the article acting on the poured mixture with a force an order of magnitude less than that of a press. Consequently, what is important is the mechanism of compaction of the material and not the high pressure.

Various processes of self-organization of compact structures from friable sediments including materials resembling refractory powders occur in inorganic nature permanently. For example, such sedimentary rocks as sandstones or aleurolites initially represented by a loose nonequilibrium physical system densify strongly in the late stages of diagenesis, and their porosity does not exceed 2% (note that all of the free water and then the bound water is squeezed out) [3]. This occurs without powerful presses and pressures in the upper layers of the ground.

Some geologists assume that the sediments first compact locally and by spots (in the stage of diagenesis) and later (in the stages of catagenesis and metagenesis?) undergo continuous compaction [4]. One of the authors of the present paper (N. E. Korolev) has discovered for the first time that the natural effect of self-ordering (self-compaction) of friable me-
The "flowing wedge" effect has been reproduced repeatedly for various powder media, for example, for low-moisture concrete mixes of various compositions, loams, sand loams, soil mixtures, glass ceramic and ceramic mixtures, molding sands of casting production, coal dust, and metallic powders (aluminum, iron, cobalt, copper, etc.). The mechanism of formation of dense ordered structures has been about the same in all the tested media. However, in order to provide the transformation of various powder materials to a state corresponding to the "flowing wedge" effect, the injecting organs should differ in their power and rigidity.

The technology involving the "flowing wedge" effect has passed full-scale tests in the production of parts from dry-concrete mixes in the form of plates and pipes, for which various molding machines with injecting working organs have been created. The most universal variant is that of the "Russian swing" type (RF Patent No. 2085400).

Such an injecting organ has been used in a principally novel casting molding machine (RF Patent No. 2077136) created by the MASHMIR company for compacting molding sand in boxes. The machine is intended for replacing the Foromat machines. The tests performed by the Ukhtomskii plant in Lyubertsy have proved the efficiency of the compaction method that provides the requisite degree of compaction.