In Foreign Countries

Some Methods of Molding and Sintering Carbides

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In the manufacture of sintered carbides a variety of methods are used to mold the mixtures. In addition to classical methods, such as periodic or automatic pressing of powder mixtures in metal matrices, there is increasingly frequent use of other, special methods [1, 3-6]. The classical methods of pressing are widely used and will continue to be applied, but they possess a number of disadvantages which limit the use of sintered carbides. Among these are the difficulty of pressing large, intricately-shaped parts; the impossibility of making long, thin pieces, for example, pipes; and the lack of a technological procedure for pressing intricate shapes as well as thin-walled objects such as containers, crucibles and bottles. For such purposes, the production procedure for sintered carbides now contains a whole series of new techniques which pay for themselves even if they increase production costs, and effectively supplement the classic molding methods. In this paper, we would like to describe some of the methods of sintering and molding developed at Guta Baildon, namely, pressure sintering, core production, extrusion and slip casting.

Pressure Sintering*

Pressure sintering, also known as hot pressing, combines the operations of pressing and sintering. It is used for the production of parts of large size and intricate shape, particularly in cases where there is need for parts with improved mechanical properties and more exact dimensions [1, 2, 5].

At Guta Baildon powerful equipment is used for pressure sintering [2], enabling us to produce circular matrices with an external diameter of up to 350-400 mm. The equipment consists of a hydraulic press with adjustable pressure from 1.5 to 250 tons, a heating trolley containing an induction coil 236, 390, 540 and 670 mm in diameter, a graphite matrix, as well as an electrical section consisting of a medium-frequency generator with an output of 125 kW and frequency 2400 cps. Figure 1 shows the trolley, coil and matrix beneath the hydraulic press. The press is fitted with a set of high-pressure valves with which to vary the pressure continuously, at an adjustable rate, from 1.5 to 250 tons. The press is also fitted with an indicator making it possible to adjust the height of the part in accordance with the specification.

The temperature of the graphite matrix heated by the induction coil is measured by two Pt-PtRh-thermoelements; one of them measures the matrix temperature (external cylinder) while the other is situated in the middle of the graphite die close to the pressing point. This positioning of the thermoelements enables us to make exact measurement of both the temperature of the external matrix $T_z$, as well as the die $T_w$. Heating is effected as quickly as possible. The outer layer of the matrix is heated first, and this is shown by the difference between $T_z$ and $T_w$. It has been demonstrated that at the moment of sintering $T_z$ is approximately 80°C higher than $T_w$. At first, the pressing is conducted at a pressure $p_E$ half the theoretical value ($\frac{1}{2} p_E$). When the sintering temperature has been attained, full pressure is applied and maintained until the matrix cools down 100°C below the sintering temperature after the voltage has been switched off.

For carbides type G20 (89% WC, 11% Co) and G30 (85% WC, 15% Co) the following regime has been used: sintering temperature $T_w$ from 1300 to 1270°C, pressing pressure 100-75 kg/cm². The graphite used for the matrix has an electrical resistance of 10 $\Omega \cdot$ mm²/m, compressive strength 210 kg/cm², density 2.18 g/cm³, and bulk density 1.5 g/cm³.

Graphite matrices of various designs have been developed for pressing sintered carbides to make tractor wheels, roller casings, and there are also special ones for pressing of matrix blanks, and so forth. Figures 2 and 3 show a

* This section of the study was conducted by W. Missol [2].
Fig. 1. Heat-up car on hydraulic press table. 1) Indicator showing height of hole in die; 2) corundum; 3) graphite matrix; 4) asbestos; 5) ceramic linings; 6) hole in die and bisintered carbides; 7) heat-up car with coil; 8) machinery for pressure sintering.

Fig. 2. Design of graphite matrix for pressing one sintered carbide ring cross section.

Fig. 3. View of separate parts of the matrix. 1) Outside casing; 2) inside shell; 3) ejector; 4) clamping sleeve; 5) punch (die).

Fig. 4. Design of graphite matrix (cross section) for pressing two sintered carbide rings.

Fig. 5. View of separate parts of the matrix. 1) Outside shell; 2) ejector; 3 and 4) sleeves; 5) punch (die); 6) leveling ring.

In these graphite matrices it is possible to press flattening roller casings from sintered carbides with comparative ease. The matrices can also be used to make cylindrical parts of different heights by making some small adjustments to the design. The production of these matrices is of no great difficulty and they are manufactured by grinding.