HYDROSTATIC PRESSING OF POWDER MATERIALS IN RUSSIA —
A 50-YEAR-LONG HISTORY

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A brief survey of the 50-year long history of the development of hydrostatic molding technologies in Russia is given. Types of hydrostats and major manufacturing processes used in the refractory industry are described.

The early experiments with hydrostatic pressing of powdered materials into components and preforms started in the Soviet Union in the mid-1950s. By that time, at the Luga Abrasive Plant (Leningrad Region), a new technology was developed that later became known under the name “dry bag” method. A development shop was organized where crucibles of diameter up to 700 mm and tubes and molds of height up to 2000 mm were manufactured by this method (until now in service). A schematic of the pressing chamber of an early “dry-bag” hydrostat designed for molding crucibles from chamotte-graphite materials is shown in Fig. 1. The pressing chamber looked like a thick-walled cylinder. The axial load of 10 MN is transmitted in the top section through a bayonet gate to the to the bottom which is closed with a conical plug. The elastic pressing shell (rubber) was a dead-end tube with a wall thickness of 5 mm. A shortcoming of the hydrostat was the rather low pressure \( p = 20 \text{ MPa} \), which was not sufficient for high-quality products.

Simultaneously, at the I. P. Bardin Central Research Institute for Ferrous Metallurgy (CRIFM) (Moscow), a hydrostat was designed for pressing refractory powders of tungsten and molybdenum by the “wet-bag” method. A schematic of the pressing chamber for hydrostat is shown in Fig. 2. The inner diameter of the working chamber was 600 mm, and the height was 1100 mm. The pressing chamber was a frame-like structure composed of four columns and two stationary cross-arms. The container was a double-layer cylinder equipped with an inner bushing onto which rings were mounted in interference fit. An intermediate plate moved by means of a special cylinder was installed between the top plug and the cross-arm. The high-pressure hydraulic drive was a pump operating at a pressure \( p = 100 \text{ MPa} \).

Based on CRIFM results, a shop was put in service at the Novo-Tul’skii Metallurgical Plant (Tula, Russia) designed for production of preforms from tungsten and molybdenum powders. The shop had three hydrostats with working chambers of diameter 230, 400, and 700 mm and height 1200 mm. The pressing chamber was a thick-walled cylinder (Fig. 3). The axial load was taken up by a bayonet gate in the top sec-

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tion and by a bottom in the bottom section. A total of eight hydrostats of this type were manufactured at the Obukhovskii Engineering Plant (St. Petersburg) for the aerospace industry in the early 1960s. Further technological problems to be resolved were concerned with the production of polyurethane, a basic material for elastic pressing shells.

Since the early 1960s, basic research in the area of technology and equipment for hydrostatic pressing was conducted at the VNIImetmash (All-Russia Research and Design Institute for Metallurgical Engineering) (Moscow) under the guidance of Academician A. I. Tselikov and Prof. B. V. Rozanov. The output industrial-scale hydrostats was preceded by a large amount of experimental and laboratory research. Basic technological relationships between performance parameters (molding pressure, grain composition, types and amount of bonds used, sintering temperature, etc.) were established essential for hydrostatic pressing of powdered material for use in refractory, ceramic, electronic, electrode, nuclear, and other sectors of industry.

The first three industrial hydrostats (designed at VNIImetmash) were fabricated by the Izhorskii Zavod Production Association (Kolpino, St. Petersburg) for the Russian nuclear industry. A schematic diagram of the UGS200/700-type hydrostat (working chamber diameter 200 mm, height 700 mm, \( p = 300 \text{ MPa} \)) designed for molding components from silicon carbide is shown in Fig. 4. The UGS350/1000-type hydrostat (working chamber diameter 350 mm, height 1000 mm, \( p = 300 \text{ MPa} \)) was designed for shaping preforms from metallic beryllium and beryllium oxide. Both types of hydrostat were equipped with a hydraulic jack mounted above the top plug capable of generating an axial load higher than the operating axial load in the container during pressing. A booster was used to generate high pressure. The two hydrostats were of frame-type construction in which the axial load during pressing was taken up by a frame (made of steel sheets), and the radial liquid load — by the walls of the container; the container may be designed as a single-layer or multilayer block. The third hydrostat UGS250/500 (likewise intended for the nuclear industry; working chamber diameter 250 mm, height 500 mm, \( p = 600 \text{ MPa} \), operating temperature 200°C) was of frame type; the frame was composed of two forged columns positioned vertically and two cross-bars fastened with a high-strength steel ribbon. This type of hydrostat heralded the advent of a new class of press-forging equipment (hydropresses, hydrostats, and gasostats) with a frame and a container, both fastened with a high-strength ribbon (Fig. 5).

Using the frame structure, VNIImetmash jointly with the Izhorskii Zavod Production Association and the Kolomna Heavy Engineering Industry Plant JSC have manufactured a total of 23 hydrostats (G2000, UGS150/1000, G8000, YaO6023, G63, G31.5MN, G120MN, G30MN) for different sectors of industry. Hydrostats of various design were available, in particular: a stationary container and a traveling frame; a stationary frame with a traveling container; a detached high-pressure hydraulic drive, or a high-pressure hy-

![Fig. 2. Schematic diagram of a hydrostat (designed at CRIFM).](image)

![Fig. 3. Frameless hydrostat with a bayonet gate.](image)

![Fig. 4. Schematic diagram of a UGS200/700 hydrostat: 1) low-pressure inlet; 2) frame; 3) hydraulic jack; 4) plunger; 5) intermediate plate; 6) top plug; 7) container; 8) bottom plug; 9) stationary beam; 10) roller; 11) high-pressure inlet.](image)