THE PREPARATION AND USE OF PLASTIC MOLDS

M. B. Borisov

UDC 666.5:666.3.032

Plaster molds are widely used for casting wares in the ceramics industry. Apart from certain advantages, they have a low mechanical strength and short working life due to wear of the work surface under the action of water and electrolytes in the body. Besides this, the temperature in the dryer cannot be higher than 65°C as above this temperature the plaster is destroyed.

The necessity of finding a substitute for plaster was increased when the porcelain industry began installing semiautomatic machines for molding and drying, with intensified drying conditions. The search for a substitute for plaster began in our factory in 1967, and to this end a group was organized containing the following workers: A. V. Savel'eva, P. S. Polyakov, T. A. Pashkova, V. A. Kholkin, A. V. Sarichev, F. I. Lisov, and others.

At the start of their work the research group were guided by data from the State Ceramics Research Institute [1]. However, this did not answer a number of questions arising from the working of the plant, such as: how to design and make press molds so as to avoid cracking in the plane of intersection of two surfaces, what batch to take per unit volume of mold, what schedule to use for the heat treatment, how to obtain uniform distribution of pores and increase general porosity, and how to avoid adhering by the body, etc.

Following on the results of their research, in 1969 the group began developing the preparation of PVC molds, and converting the production line of the factory to their use.

At the present time there are in the factory five production lines for plates, three of which are for shallow 200 mm plates and two for deep 200 mm plates, as well as seven lines for cups. Using the plastic molds a total of 24,000 plates and 35-37,000 cups are produced per day (24 h). The provisional annual saving accruing from the introduction of only one production line is 2500 rubles.

The working life of the plastic molds in cup production reaches 4000 cycles and can still be increased. The life of the molds in plate production has still not been determined.

A section for preparing the molds was organized in the factory in 1969 (Fig. 1). The raw material was domestic polyvinylchloride latex, grade L-5, or emulsified polyvinylchloride, grade E-62. Polyvinylchloride is the product of polymerization of vinyl chloride.

It is a white finely dispersed (no residue on No. 0056 sieve) powder of density 1.41 g/cm^3. At a temperature of 170-180°C and under slight pressure (specific pressure 0.05 kg/cm^2) the polyvinylchloride particles melt and cohere.

The first stage in the preparation of the molds is a preliminary vibromolding (on the vibrotable) which ensures uniform porosity. The vibrotable performs 50 oscillations/sec with an amplitude of 0.5 mm. The vibromolding is carried out for 15-20 sec.

This preliminary vibromolding is an essential part of the process for making the molds, since, during molding, internal stresses are generated which are concentrated near the points of contact of molecular cohesion of the fine particles. This internal stress is especially dangerous during the process of sintering. It can be removed by vibration, which almost completely breaks all connections between particles and ensures their uniform distribution.

The basic piece of equipment in the preparation of the plastic molds is the metal press-mold (Fig. 2) which is made from grade 45 or St. 3 steel. Its internal surface must be chromium plated.

Dulevo Porcelain Factory. Translated from Steklo i Keramika, No. 3, pp. 7-9, March, 1972.

© 1972 Consultants Bureau, a division of Plenum Publishing Corporation, 227 West 17th Street, New York, N. Y. 10011. All rights reserved. This article cannot be reproduced for any purpose whatsoever without permission of the publisher. A copy of this article is available from the publisher for $15.00.

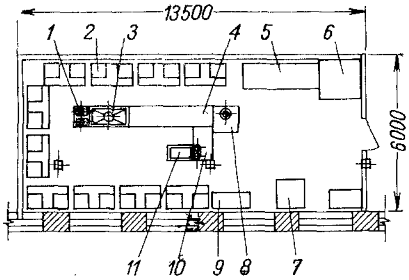


Fig. 1

a

b

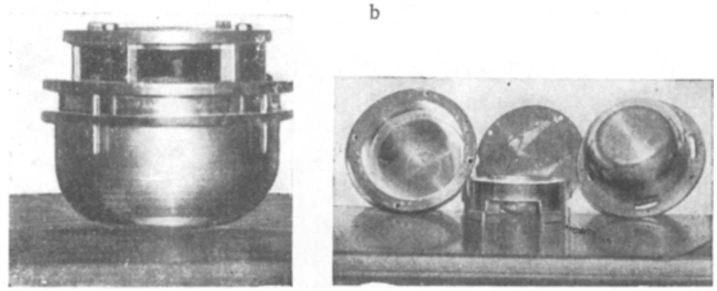


Fig. 2

Fig. 1. 1) Hand press; 2) SNOL electrically heated cabinet for heat treatment of the molds; 3) cabinet for cooling the molds; 4) table for assembly and dismantling; 5) stand for prepared molds; 6) storage for the plastics; 7) electrically heated cabinet for drying; 8) stand for finishing the molds; 9) table for packing plastics; 10) table for measuring out plastics; 11) vibrating table.

Fig. 2. Press-mold. a) Assembled; b) dismantled.

The process of filling the press-mold for making flat ware (plates) plastic molds is shown in Fig. 3.

L-5 powder, which has previously been dried in the electrodrying cabinet at 110°C and then screened through a No. 05 sieve, is charged into the matrix of the press-mold and leveled with a special tool. The amount of plastic depends on the type (volume) of the mold. For shallow 200 mm plates it is 600 g, for deep 200 mm plates 660 g, for saucers 400 g, and for cups 500-515 g. The press-mold punch is then inserted into the matrix in such a way that it enters under its own weight until it is in contact with the plastic. To check the correctness of assembly at this point, the punch is rotated relative to the matrix.

The assembled press-mold is placed on the vibrotable and compacted for 15-20 sec. After compacting, the gap between the matrix flange and the punch flange should be 8-10 mm.

The press-mold is next inserted into SNOL electrocabinet for the heat process and a weight is placed on the top so as to give a pressure of 0.05 kg/cm^2. To monitor the temperature, a thermometer is inserted so that it touches the center of the punch. A small amount of the plastic is heaped on the punch flange, and its change in color is used to assess the readiness of the mold. The heat process continues for 2-3 h and at its completion the temperature of the press-mold is 170-175°C.

After the completion of the heat process, the thermometer is removed and the press-mold taken from the cabinet and placed into the ventilated cabinet to cool. The press-mold is then dismantled using an extraction screw. The prepared plastic mold is removed, trimmed smooth at the edges, and after inspection is ready for use.

The molds for the hollow wares (cups) were prepared according to the following schedule. The correct amount of PVC plastic was put into the matrix (Fig. 4) and leveled off. Two 22-24 mm thick spacers were placed on the flange of the matrix 1, and the matrix 2 lowered onto it so that the ring flange was resting on the spacers. The punch 3 was then lowered into the ring so that its flange was level with the ring flange.

The assembled press-mold was then turned over and placed flange down on the vibrotable, with the punch flange standing on a 50 × 50 mm block. The spacers were then removed from under the ring flange, and a weight of 8-10 kg placed on the bottom of the matrix, positioned to that its center lay on the axis of the press-mold. The vibrator was turned on and the ring held behind the flange vibrated the plastic for 15-20 sec. After vibrating the clearance between the flanges of the matrix and punch should be about 5-7 mm, and between the punch flange and the ring about 10 mm. The press-mold was then turned over, and 5-6 mm thick packing laid on the punch flange, and then the weight placed on this which gave the pressure of 0.05 kg/cm^2 for the heat process.

The press-mold, with the weight, was placed in the electrodrying cabinet on a fireclay base 6-8 cm thick. The heating process was carried out according to the graph (Fig. 5) for 1.5-2 h up to a temperature of of 180-185°C. The temperature was monitored by a mercury thermometer. At the end of the heat treatment the load was removed and the press-mold taken from the electrocabinet and pressed on the hand press until

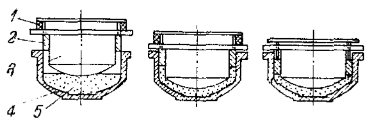


Fig. 3

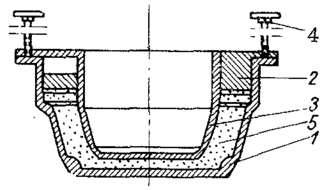
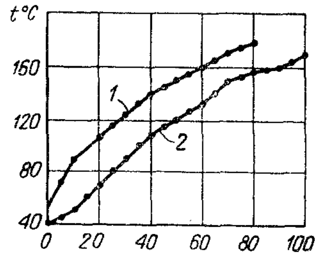


Fig. 4



Time, min

Fig. 5

Fig. 3. 1) Stop washer; 2) ring; 3) punch; 4) die; 5) polyvinylchloride.

Fig. 4. 1) Matrix; 2) ring; 3) punch; 4) screw; 5) mold.

Fig. 5. Heat treatment graphs for processing plastic molds. 1) For cups; 2) for shallow 200 mm diameter plates.

the ring and punch flanges made contact with the matrix flange. After retaining under the press for 10 min the press-mold was removed and placed in the ventilated cabinet to cool down to 40-45°C. The press-mold was dismantled and the prepared plastic mold extracted. After trimming it was ready for use.

Experience in the preparation of these polyvinylchloride molds and in their use in the factory has shown that deviation from the above preparation schedules leads to the appearance of various faults in the molds which show up during the process of forming wares with them: underpressing, porosity of the material under the shoulders of the hollow mold, ring cracks on the stem of the hollow mold.

Constant control of the electrodrying cabinet by means of the thermoregulator ensures a uniform temperature in the chamber during the heat treatment of the pressings, and ensures uniform heating of the plastic for all section thicknesses. The resultant uniformity of sintering prevents the production of a mold with different coefficients of thermal expansion between the edges and center of the plastic. This greatly reduces the occurrence of cracks in the working surface of the mold during use and increases its working life.

Accumulated experience in the use of the molds in the factory has shown that it is necessary to pay attention to: careful adjustment of the mold holder under the pedestal of the semiautomatic machine; selection of the molding schedule; avoiding sudden lowering of the roller at the moment of contact with the body; the selection of the correct speed for the molding roller (500-550 rpm for cups and 250-275 rpm for plates) and for the mold holder (750-800 rpm for cups and 300-500 for plates) in order to avoid the production of scrap in the form of "humpers" and "whirlers." Failure to observe these requirements can also lead to damage to the mold (chipping off the shoulder, and digging out the bottom with hollow ware).

The molds when produced vary in color from rose to dark brown, according to the duration of the heat treatment at constant pressure and the final temperature in the electrocabinet. The dark brown ones have low porosity, and in practice cannot be used. The rose colored ones have adequate working properties, but their low mechanical strength significantly reduces their working life.

Obtaining the normal working porosity of 31-35%, with uniformly distributed pores, and at the same time retaining the necessary mechanical strength, was one of the most difficult problems in the production of the molds. If the heat treatment was forced, this rapidly led to the appearance of a surface crust with a raw interior in the mold. If the final temperature was raised above 210°C, in order to speed up the heat treatment, this led to decomposition of the plastic with the evolution of gases which destroyed the surface of the mold. After extensive investigation, the optimum heating schedule for the plastic in the press-mold, which gave molds of the desired quality, was found and is shown in Fig. 5.

From experience in the preparation and use of the molds, the correct amount of plastic per unit volume of mold was established as 0.9 g/cm^3. This enables, with other factors remaining constant, to maintain a constant density for the molds.

The technical criteria for acceptance of the molds were established in the factory. They must have a smooth dense working surface and a homogeneous color matching the established standard. Dimensional variations must not exceed ±0.05%. The molds must have no deformations. Their porosity must fall within the limits 31-35%. Their rate of water absorption is determined by a method developed in the factory.

The surface of wares made in these molds requires no further treatment, which is a commercial advantage. The consumption of gypsum by the factory is reduced by 500 tons per year. The labor requirement on heavy loading/unloading work is reduced, the work of the laborer/molders is relieved, and transport is released.

The factory team continue to work on the introduction of more progressive methods of preparing plastic molds, on speeding the heat treatment process to give increased output of molds per press-mold, and on increasing their mechanical strength whilst preserving a high porosity.

LITERATURE CITED

1. S. M. Tsenter et al., Steklo i Keram., No. 1 (1969).