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Research of the polymer casting process under pressure and design of the working body of the casting unit

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ABSTRACT: This article describes the study of the polymer injection process under pressure and the design of the working body of the casting unit, as well as the main working bodies and the principle of operation of the casting unit.

KEY WORDS: injection molding, casting unit, plasticization of material, injection of plasticized material, plasticization temperature, softening temperature of the polymer.

I. INTRODUCTION

The injection method has been used in the leather and shoe industry since 1955, when, according to the patent of the French engineer R. Wucher, Foster (England) began to manufacture FW700 injection machines for the production of all-molded beach shoes. The polyvinyl chloride mixture was melted in the working cylinder of the machine and injected into a cold mold in which the mixture cooled. The bottom and top of such pantolets are obtained from the same material. Then, CEFOM (France), in partnership with R. Boucher, created the W700 SMT machine for casting only soles of polyvinyl chloride onto the tightened shoe upper (leather or textile). Both cars consist of an injection unit and a rotary table, on which there are 10 molds.

There are four ways to cast various materials under pressure:
-thermoplastic materials (PVC plastic compounds, thermoplastic elastomers);
-polyvinyl chloride pastes;
-rubber compounds;
-polyurethanes ("liquid casting").

II. SIGNIFICANCE OF THE SYSTEM

Currently, not only PVC compounds and pastes, but also rubber compounds are used to make the bottom of shoes by injection molding. This is caused by insufficient frost resistance of the soles made of polyvinyl chloride. Molding rubber compounds because of the need to cure them is very difficult, but gives the soles the necessary frost resistance.

Recently, thermoplastic elastomers, which are block copolymers of thermoplastics (e.g. polystyrene) and rubbers, are beginning to be used for casting. When casting, such a material behaves like a typical thermoplastic, and in products it is flexible, frost-resistant and durable without vulcanization or crosslinking.

III. LITERATURE SURVEY

Of great interest was the molding of polyurethanes. Liquid polyurethane components are poured into the mold. As a result of the reaction, an elastic polyurethane foam material (bottom of the shoe) is formed, which immediately adheres to the long edge of the workpiece. Depending on the components of the mixture, both a porous and non-porous bottom

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of the shoe can be obtained. In this case, a number of operations disappear: the synthesis of rubber, the manufacture of rubber soles or granules, the use of glue is not required. Polyurethane molding is the most promising.

The injection method can also be widely used for the manufacture of heels, soles, aggregated units, and accessories.

IV. METHODOLOGY

An interesting method is the deposition of toes onto a vamp, which eliminates the need to manufacture special materials for toes. The scoop face down is placed on the extended carriage of a special machine. The carriage is shifted to the working area. The profiled matrix “prints” the molten thermoplastic resin (or resin composition) on the bakhtarmany side of the vamp. The thickness of the toe cap is V3 the thickness of a conventional toe cap, which ensures the elasticity of the work piece in the forefoot. Productivity - 480 toes per hour.

Molding of thermoplastic elastomers is also being introduced for the manufacture of leather goods, for example, handles of briefcases, suitcases and bags, accessories, and halves of suitcases.

Injection molding allows the manufacture of products with a high degree of accuracy, with low costs and high productivity.

Injection molding of thermoplastics can be defined as a simple cyclic process consisting of the melting of material granules, injection of the melt into the mold, after cooling in which the material hardens and forms an article of a given geometric shape. Injection machines allow casting products weighing 0.016-20 kg.

According to the principle of action and design, piston, worm and worm-piston injection machines are distinguished.

Schemes of the LPGV-0 piston injection machine (USSR) before and after casting are shown in Fig. 1. The granules of the material are poured into the hopper 1, in the lower part of which there is a dispenser 2 and a cutter 5. The granules are heated in the feeder 4 and fed into the injection cylinder 5 with heaters. In the cylinder, the granules are heated to a viscous state. During the movement of the piston 6 downward, the molten material 7 is injected through the gate into the mold 8. The injection time is 5-10 s.

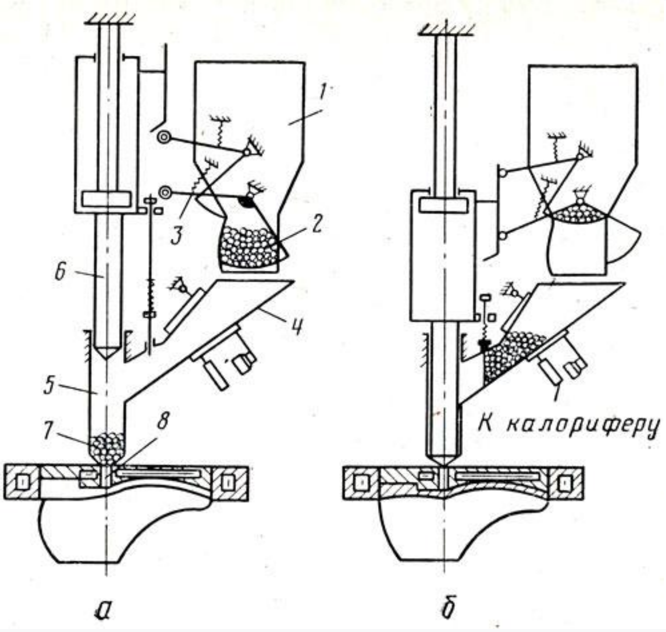

Fig.1.Schemes of the piston injection machine LPGV-0 before casting (a) and after casting (b)

Piston machines are effective in the casting of small-volume products from easily flowing thermoplastics. It is difficult to process high viscosity melts, such as polyvinyl chloride.

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The injection process is called injection, or extrusion. Therefore, injection machines are called syringe machines, or injection machines, and the working unit of the machine is injection machines. The injection cylinder of the machine can also be called injection.

As injection molding can be used and worm machines - extruders. Extrusion is the process of continuously extruding a material in the form of a tape, sheet, pipe, or some other profile. However, if the nozzle of the extruder has a tap, then the molds can be filled intermittently, and the extruder starts to work as an injection machine. The operation scheme of such an extruder is shown in Fig. 2.

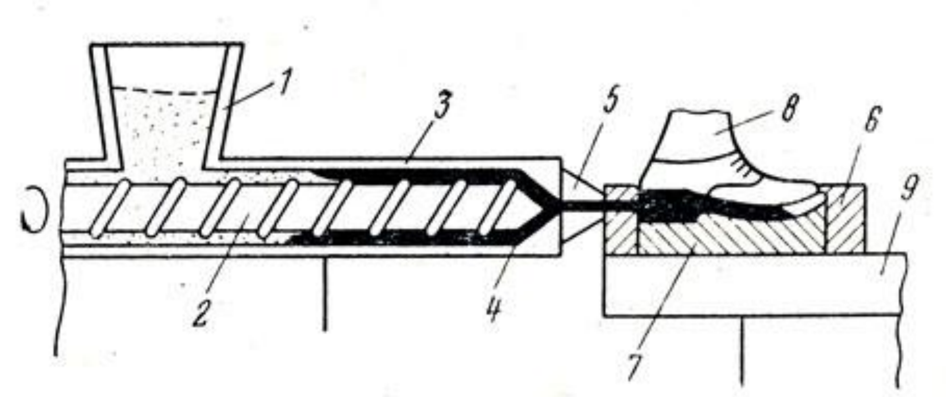

Fig. 2. Extruder circuit

The polymer material from the loading hopper 1 is captured by the screw surface of the worm 2 and carried away when it is rotated to the front of the cylinder 3. Heaters are mounted in the cylinder walls to ensure the thermoplastic 4 is heated to its melting temperature. The transition of the thermoplastic into a viscous flow state is facilitated by vigorous mechanical mixing of the material by the worm and friction against the walls. The inner surface of the cylinder is usually roughly treated to increase the friction of the material. The surface of the worm is trimmed very carefully to reduce the friction coefficient of the melt. Due to the difference in these friction coefficients, an intense flow of the melt occurs along the cylinder.

Fig. 3 shows a diagram of an injection nozzle with a tap. When the gate of the mold is pressed against the nozzle, the front sleeve of the nozzle is pressed in and opens the gate channel. The mold is being filled with the mixture. When separating the mold and nozzle after casting, the sleeve is again fed forward and clogs the gate channel.

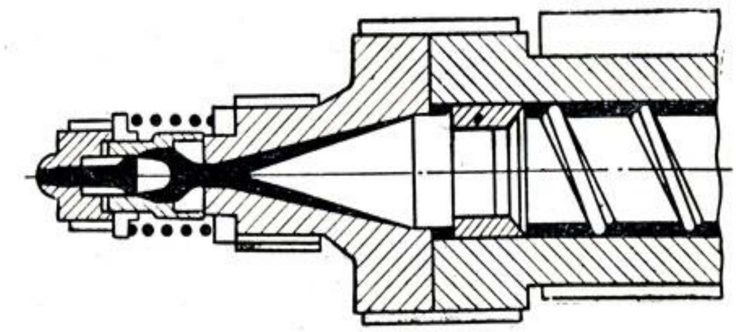

Fig. 3. Scheme of injection nozzle with tap

When the valve 5 (see Fig. 2) is open, during the rotation of the worm 2, the melt of the thermoplastic material is extruded through the channel into the mold. The mold is filled in 5-20 s, depending on the fluidity of the material in the molten state, the size and design of the mold. The mold is cold or slightly warmed up, which prevents the material from solidifying until it is completely filled.

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V. EXPERIMENTAL RESULTS

True, this delays the subsequent cooling of the product and lengthens the overall cycle of work. The mold for casting the bottom on the shoe consists of a matrix 5, forming the side surfaces of the sole and heel, a punch 7, forming the running surfaces of the sole and heel, and pads 8. The molds are mounted on the rotary table 9.

After filling the next mold and closing the valve, the worm pumps molten material into the front of the cylinder (prechamber). If the gaps between the two fills are large, the worm can stop.

Compared to a piston machine, the extruder has a relatively low mold filling speed: the piston machine provides an injection time of 1-2 s, while the extruder - 5-20 s.

Therefore, in machines of later designs, the advantages of worm and piston machines are combined. Fig. 4 shows a diagram of the injection unit of a worm-piston machine with axial movement of the worm. Thermoplastic material is loaded and plasticized in the same way as in an extruder.

The molten material accumulates in the front of the cylinder chamber and presses the worm to its extreme rear position by increasing pressure. The back flow of the melt is prevented by a piston check valve mounted on the end of the worm and provided with channels for supplying the melt to the prechamber.

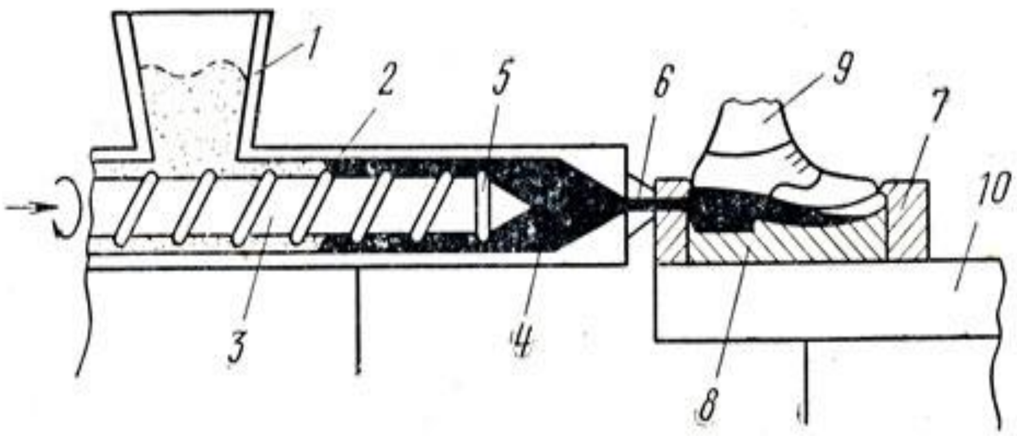

Fig. 4. Scheme of the injection unit of the worm-piston machine: 1 - hopper; 2 - a working cylinder; 3 - a worm; 4 - polymer; 5 - check valve; 6 - gating channel; 7 - matrix; 8 - a punch; 9 - block; 10 - rotary table

When the nozzle sleeve abuts against the sprue sleeve of the mold, the valve opens and the worm starts to move forward, working like a piston. The melt is rapidly (1-2 s) and under a pressure of 150 MPa (1500 kgf / cm2) is injected into the mold.

Compared to an extruder, a worm-piston injection mechanism with axial movement of the worm provides not only a high filling speed of the mold, which increases productivity and quality of products, but also allows to obtain thin-walled products. Worm-piston injection mechanism allows you to get the soles of any thickness and any pattern.

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