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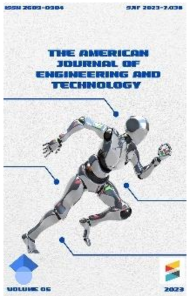

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Research Article

TECHNOLOGIES FOR PROCESSING WORKING PARTS OF DIES USED IN COLD VOLUME STAMPING

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ABSTRACT

This paper presents an analysis of the technical requirements for cold stamping, wear of their working zones, factors affecting wear and ways to increase wear resistance.

KEYWORDS

Cold stamping, bending, tool steels, alloy steels, carbon steels, strength, hardness.

INTRODUCTION

Metal pressure processing methods are very widely used in modern engineering industry. Among them, cold dimensional stamping is especially important. One of the relatively heavy-duty operations in cold dimensional stamping is the deposition operation. Dies designed for cold deposition work under the influence of complex stresses and high cyclic loadings of a relatively high speed shock loading nature.

MAIN PART

In the working zone of the stamps, a significant specific load with a value of 2500 MPa occurs. Stamping conditions are significantly more difficult in the local contact of the "metallzagotovka-tool" (applied wedge type) and its specific load in this zone can reach a maximum value of 3500 MPA. When heating the contact volumes of the tool, the temperature does not exceed 150-170°C in most cases. At the same time, at high intensity of stamping, the heating temperature of the tool can reach 300-400 °C due to the large volume of the deformable metal and the high degree of deformation.

Due to the limitations mentioned above and in a number of other cases, cold dip tools have been found to have limited durability.

The tolerance of stamps is characterized by a rapid decrease with increasing tangential (ring) stresses, which determine the mass of the die to be stamped [1].

As we noted above, the cost of tools is 20-35% of the cost of stamping.

Nevertheless, cold deposition is one of the progressive technological processes. In this method, obtaining the zagotovka in the state of precipitation in a state close to the shape, size and surface cleanliness of the finished product, the fact that the process has high productivity, and the loading scheme is close to all-round compression and is symmetric to the axis, determines the possibilities of increasing the basic physical and mechanical properties of the product.

The solution to the problem of increasing durability is the manufacture of tools from VK6, VK8 hard alloys. Hard alloy matrices are practically not used for roller deposition matrices, especially for large-sized ones, in cases related to the occurrence of significant local loads in the contact zone of "metal zagotovka - engraving" at the first stage of deposition.

To solve the above problem, information on the basic laws of corrosion of cold-pressed tools and the causes of failure is needed. We emphasize that a comprehensive approach is needed to solve the problems of increasing the durability of the tool. According to the literature, the collection of data in the operation of cold-dip stamps with different nomenclature (for obtaining cylindrical and conical rollers, balls, bolt-rivet type details, and the like) is carried out for three reasons: the fact that the deformation of the engraving is irreversible, the integrity of the working zone on tampering and displacement of stamps.

Local or general irreversible changes in the shape and dimensions of the working zones of the tool occur as a result of plastic deformation and abrasive wear. The dominant mechanism of changes in the geometric dimensions of the working surfaces of stamps has not been developed by researchers from a single point of view. Cold forming tools attribute the irreversible deformation to the abrasive action of the workpiece material and, in part, to fatigue cracking of the tool workpiece [2].

Research shows that the dimensional stability of the tool depends on the yield strength of the material from which the stamps are made. In general, the intensity of irreversible deformation of the engraving depends on its configuration, the temperature-force conditions of stamping and the strength characteristics of the stamp material. At the same time, it has a great influence on the hardness and depth of penetration of the stamping material [3,4].

An increase in the hardness of the toiled zone on the one hand leads to an increase in bending strength and resistance to plastic deformation, on the other hand, it causes a decrease in viscosity and migration. A decrease in hardness leads to an acceleration of crushing and deformation of the contact zone. Inadequate indentation depth and significant contact stresses in the transition zone and working surfaces of the dies can cause local plastic deformations due to insufficient strength in the layers. And on the contrary, an excess of the specified zones leads to a decrease in the viscosity of the working volume of the stamp, and as a result, the cracking and grinding of the macro sections of the tool occurs.

The degree of resistance to bending under cold deformation conditions depends on the type of carbides, their amount, dispersion and uniform distribution in volume. High bending resistance results in a fine and uniform distribution of carbides in the structure. Carbide particles, which have entered the working surfaces in the form of large accumulations or strips, or their excessive amount, play an additional abrasive role in this case, cracking and breaking due to acceleration of bending can be observed.

It is known that the state of the phase of carbides is determined by the conditions of crystallization, plastic deformation and, to a significant extent, the scheme and regimes of thermal treatment. However, the directional control of the carbide phases during the final thermal treatments (with deposition and release) is much less studied and therefore relevant. These possibilities are explored in the current research work.

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Violation of the integrity of the working zone of the stamp, occurrence of micro and macroscopic breaks (cracks) occurs as a result of various reasons. The occurrence and subsequent acceleration of cracks during the early service phase of cold forming stamps is not considered typical and is associated with defects of a metallurgical, technological, or structural nature, and under multi-cycle loading, high-intensity-low-cycle fatigue. The occurrence of cracks is caused by the effect of high specific forces, and in most cases, by the resistance of the steel to temporary rupture, which occurs during cold sintering. The presence of microcracks accelerates the processes of irreversible deformation, retention and abrasive wear. In the localized areas of cracks, stress concentration occurs, strength and viscosity characteristics decrease sharply, which leads to voids and microdiscontinuities in overlapping contact retention processes.

Crack acceleration kinetics depends on the properties of tool steels under operational conditions and is manifested by the mechanism of slow wear of the tool and immediate wear - the splitting of stamps into small pieces. Stamping into small pieces is known to us at some specific stages of tooling due to serious technological process disturbances or fluctuation phenomena (having rough scores on carbide and mirror inclusions, fiber compression, presence of cracks of hammering or thermal origin, high residual tensile stresses level, etc.) is based on the strength limit and impact toughness of the stamp material, which is considered one of the important characteristics when evaluating the tool's resistance to embrittlement.

Thus, the leading mechanisms of distortion for cold-deposition stamps are the irreversible deformation and size changes of the working zones of the tool (mainly due to plastic deformation and deformation) and the formation of cracks (the division of the stamps into small pieces). Accordingly, stamps designed for cold deposition should be characterized by high plastic deformation resistance and creep resistance properties combined with as high a viscosity as possible. At the same time, according to these requirements, the stamping steels intended for tools intended for cold deposition should be characterized by satisfactory technological properties at all limits (having a sufficient level of malleability, depth of penetration, hardness and satisfactory machinability, cutability, grindability, etc.).

The issues of controlling the stress state of the tool in the constructive and surface finishing methods are considered in the work.

According to a number of researchers [2,3], the level of physico-mechanical properties of the material for cold stamps is one of the factors that determine tolerance. Changing the physical and mechanical properties of relatively alloyed steels, high-strength and bending-resistant coating methods (plasma coating, ion-plasma thin coating coating, laser processing methods, chemical-thermal processing methods, melt coating of working surfaces with bending-resistant alloys) can be implemented [6]. Significant results in solving the problems of increasing the long-term durability of cold working stamps can be achieved by traditional optimization of thermal treatment schemes and modes. This engineering oriented solution is relatively the most convenient and doable solution. However, it is not practical to increase the durability of cold-deposition stamps by known heat treatment methods. New opportunities in this direction are associated with research and development of new schemes (respectively and modes) of volumetric or local thermal processing.

Tools designed for cold deposition are made of carbon and alloy steels. Carbon steels are characterized by a small depth of penetration and not great properties. Therefore, U10, U11 steels are used only for small-sized stamps (diameter 30 mm) intended for sinking with a small force. The application of these steels is very limited [7,8].

CONCLUSION

The selection of a tool steel grade for a specific technological process is primarily based on the properties of the material to be deformed (mainly

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hardness) and the size of the zagotovka in the shape changes, which together determine the stresses that will occur in the tools. A large number of different grades of steel are recommended for tools intended for cold deposition, which differ significantly in the degree of alloying, the combination of alloying elements, and the level of final structure and properties. Complex alloyed steels with relatively high mechanical properties are among them. However, many of these branded steels have serious disadvantages: low technological level, the fact that the final property and operational tolerance of the brand composition are significantly important, their high level of alloying, which reduces the technical and economic efficiency of their use, etc.

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