

Technology for Designing Dies and Stamping Equipment for Cold Stamping

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Annotation

The paper presents The durability of stamps largely depends on the conditions of their operation; a significant role is played by factors that determine the temperature regime of the stamp and the condition of the surface of the working tool of the processed surface, lubrication, and the removal of scale during the stamping process.

Keywords: forging, stamp, scale, heat, blank, hammer.



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The durability of stamps depends largely on the conditions of their operation. The most significant role is played by the factors determining the temperature mode of the stamp (heating, stamping rate, cooling system) and the condition of the surface of the working tool (roughness of the machined surface, lubrication, scale removal during stamping, timely repair). Before starting work, stamps made of high-alloy stamping steels must be heated to a temperature of 250-400 °C and maintain this temperature in the inductor built into the stamp block. To prevent excessive heating of the working surface of the stamp (above the tempering temperature during heat treatment) and the resulting decrease in its strength properties, the stamp must be cooled during operation. External and internal cooling of stamps is used. External cooling of stamps (with air, emulsion, etc.) contributes to the appearance of variable dangerous tensile thermal stresses in the surface layer, leading to the occurrence of thermal fatigue cracks. The best type of cooling is internal, which is carried out with air and water using a cooling system built into the stamp package.

To reduce the specific stamping force and improve the thermal mode of the stamp, its systematic lubrication is necessary. The efficiency of the entire technological process and the quality of forgings depend on the correct choice of lubricant and the method of applying it to the surface of the stamp and the deformed workpiece. Recommended lubricants for stamping forgings from stainless, alloyed steels, heat-resistant, aluminum and titanium alloys.

The service life of stamps depends on the wear of their grooves. A distinction is made between the stages of natural wear of stamps: running-in, established wear and progressive wear. The running-in stage occurs during stamping of the first tens or hundreds of forgings and ensures further operability of the stamp. The stage of established wear of a well-run stamp corresponds to 80-90% of its service life. The stage of progressive wear is accompanied by the appearance of grooves, chipping of larger than usual metal particles, deepening and widening of individual cracks. The groove quickly loses its size, and stamping must be stopped to avoid defects.

Wear of dies largely depends on the stamped material, the equipment used, the die surface heating temperature, the die material and the configuration of the forging being manufactured. Thus, when manufacturing thin-walled machines on KGShP and impact machines, there is a significant difference in the values of specific forces: when stamping cup forgings from steel 45 on VSM, the specific forces are within 80-90 kgf/mm² · when stamping on steam-air hammers they are 115 kgf/mm² · when stamping on KGShP they reach 135-140 kgf/mm² · When stamping forgings with a ribbed rod from steel 45 and alloy AK6 on dynamic action machines, the specific forces are 40-60 kgf/mm² · and when stamping on KGShP-25-30. Clear design of stepped forgings made of grade 45 steel during stamping on VSM was achieved at specific forces of 80 kgf/mm² · while during stamping on a steam-air hammer and KGShP, corner filling could not be achieved even at specific forces of 160-180 kgf/mm² · When manufacturing forgings from difficult-to-deform materials (alloyed and stainless steels, heat-resistant and titanium alloys), specific forces increase and amount to 100-200 kgf/mm² · and in some cases reach 250 kgf/mm² · The greater the degree of deformation and the more highly alloyed the stamped material is (more difficult to deform), the lower the durability of the dies, since the average specific forces on the die increase. Specific forces on the dies during closed stamping are higher than during open stamping, and, consequently, the durability of the dies during extrusion will be lower.

Typical causes of wear and failure of stamps during stamping on high-speed hammers are destruction, edge crushing, and wear. Destruction is a consequence of improper stamp design (the presence of stress concentrators - sharp corners, undercuts, etc., insufficient tension to create compressive stresses on the working surface of the matrix, etc.). Edge crushing is associated with a long time of residence of the stamped forging in the die cavity. Insufficient durability of stamps during high-speed stamping in some cases is explained by overloading of the tool due to excessively high (incorrectly selected) impact energy.

The durability of stamps when stamping on high-speed hammers generally corresponds to their durability with conventional stamping methods, although it is often lower or higher, depending on the material and shape of the stamped forging. There are data when the stamp was suitable for further work after 4,000 forgings had been stamped on it (only after stamping 1,800 forgings did minor cleaning require). Durability of a stamp made of domestic material grade 4X3VMF [1] amounted to 1000 forgings, and after a small cleaning it could be used for further stamping. The durability of the dies can be increased by plating the matrices with zirconium. The overall durability of the die is made up of the durability of the new die and the durability of the die after its repair. With extrusion stamping, the number of repairs is less than with open stamping, since during repair (regrinding or cleaning) the gap between the punch and the matrix increases, therefore the end burr becomes thicker and can cause jamming and breakage of the die. The durability of the die also depends on the tolerances for the forging. The tighter the tolerances and

the smaller the allowances for the forging for mechanical processing, the lower the durability of the die.

When producing forgings from difficult-to-deform materials, the temperature of the surface layer of the die is 550-570 °C and on the projections -620 °C, and in some cases reaches 720 °C [2]. Typical causes of stamp failure, as indicated above, are thermal fatigue, wear (abrasion) and edge removal. Thermal fatigue, to a greater extent than mechanical fatigue, affects the reduction of stamp service life due to the occurrence of structural transformations accompanied by cyclic stress. When stamping heat-resistant alloys and steels, the removal of the shaping parts of the grooves is one of the main causes of stamp failure.

The problem of increasing the durability of hot-forming dies is complex. In the metallurgical aspect, in order to successfully solve it, in addition to optimizing the technology of processing die materials at all stages of processing (smelting, casting, forging, heat treatment), rational alloying remains the most effective method. The main directions for increasing the durability of hot-forming dies are the following:

- 1) the use of new heat-resistant, wear-resistant and high-strength stamping steels (EI958, EI959, DI22, DI23, DI32, 40XCHMΦ, 3X3M3Φ, 4X5MΦC, etc.);
- 2) the use of stamp steels of high metallurgical quality (electroslag and vacuum arc remelting);
- 3) application of chemical and thermal treatment: cementation, azoping, aluminizing, chromium plating, boriding, beryllization, nickel plating, carbonitriding;
- 4) surfacing with dispersion-aging materials of grades 65Kh3V10 MFGT, Zh-70M or hard alloys of the stellite type of pressing and cutting dies;
- 5) application of differentiated leave;
- 6) the use of stressed-structure stamps with inserts made of a more heat-resistant grade of material or hard alloys such as VK8, VK15, VK20, etc.;
- 7) application of progressive methods of stamp manufacturing: electrical discharge (electric pulse and electric spark), electrochemical, hot and semi-hot extrusion, casting;
- 8) improving the operating conditions of dies: introduction of an automated cooling and lubrication system, introduction of dies with intensified internal water cooling, use of a cutting fluid (CFL) and heating of dies;
- 9) introduction of the hot pressing method [3].
- 10) introduction of a new method of heat treatment for different hardness across the cross-section of a stamp made of deep-hardening heat-resistant stamp steels of the EI958 type;
- 11) use of preparatory and roughing streams in order to reduce wear of the numerical stream;
- 12) improving the design of stamps by strengthening rapidly wearing parts, wearing parts, changing the size of stamping slopes and rounding radii, using ejectors and pullers, changing the shape of grooves and flash grooves, improving the quality of groove processing [4];
- 13) application of low-oxidation and non-oxidation methods of heating blanks for stamping;
- 14) use of protective and lubricating coatings made of enamels of the EVT-24, EVT-10A, EVT-10A, EVT-52, EVT13-11 brands, glass No. 209, etc., applied to workpieces before heating;
- 15) clear organization of the stamping industry (certification of stamps, control over the quality and technology of their production, strict accounting and storage, timely repairs).

Implementation of any of the above mentioned directions allows to increase the service life of dies by 1.5-4 times on average. Implementation of the whole complex of measures will allow to

significantly increase the service life of tooling and reduce the share of the cost of the tool in the cost of forgings. Thus, when stamping a body and a quadrant with unprocessed surfaces with deviations of ± 0.5 mm from difficult-to-deform materials (12Kh18N9T, 20Kh13, 12Kh17G9AN4), VT3, VT5-1, etc.) on KGShP with a force of 1500 tf and 2500 tf, the service life of dies made of DI22 materials before renewal is twice as high as the service life of dies at the 5KhNM stage and four times higher if the stamping grooves are made by the electrochemical method instead of mechanical processing [5].

Nitriding and chromium plating increase the hardness, strength and wear resistance of stamps. This chemical-thermal treatment is more effective than carburizing and cyaniding, the thickness of the nitrided and chromium-plated layer is 0.2-0.3 mm. The surface of the stamp before chroming and nitriding should be brought to a roughness of $Ra = 2.5 \div 0.32$ μm . The initial hardness is retained when heated to 525 °C. The durability of the stamps in this case increases two to three times. Aluminizing prevents the formation of boiling cracks and is recommended for stamps operating under a relatively calm load, in particular for stamping on presses.

Conclusions

The application of the above recommendations will have a positive effect on the production and operation of stamps. As a result, the production of forgings and parts in the mechanical engineering industry will improve.

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