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INCREASE OF WEAR RESISTANCE OF THE CRITICAL PARTS OF HYDRAULIC HAMMER BY MEANS OF ION-PLASMA TREATMENT

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The parts of a hydraulic hammer are subjected to wearing during the exploitation. This leads to the decrease of their service life. Many methods of surface strengthening are used in accordance with the literature and the practice, but they do not produce any significant effect. Therefore, it is currently important to develop the new methods of surface strengthening. Ion-plasma chromizing is one of such methods. To determine the influence of ion-plasma chromizing on the wear resistance and the mechanical properties of the hydraulic hammer on the basis of experimental researches and to analyze the structural changes in the material. Ion-plasma chromizing of the parts promotes the increase of their wear resistance in 1.75 times as compared to those which are not strengthened. The technology of ion-plasma chromizing secures the running of the strengthened parts without breaking off and chipping. The zones of structural changes are marked on the sections of parts damages, which are typical for the effects of the second hardening.

INTRODUCTION

The development of modern equipment imposes ever increasing requirements for the performance of the hydraulic hammer parts. Wear resistance issue holds a specific place in the range of problems as for the increase of their reliability and service life. Insufficient wear resistance limits the growth of hydraulic hammers efficiency and their operating life, increases the expenses for the repair and the spare parts.

More often the new methods of surface strengthening, in particular ion-plasma methods of coating, are implemented in order to increase the operational characteristics of the materials.

Publication analysis. The publication states that numerous methods are used to increase the wear resistance of equipment work surface, but they all do not provide significant increase of wear resistance [1–3]. Therefore, it was viable to implement ion-plasma technologies, which are directed to increase wear resistance of the parts work surface running in the conditions of cutting wear. The parts of hydraulic hammer belong to such objects.

Goals and objectives. To determine the effect of ion-plasma chromizing on the wear-resistance of hydraulic hammer parts on the basis of experimental research.

STATEMENT OF THE INFORMATION

The test results of the parts, strengthened by means of ion-plasma chromizing, showed that before the coating damage, satisfactory wear resistance of the strengthened parts is observed. Therefore, the choice of modes of ion-plasma chromizing allowing to increase wear resistance of the critical hydraulic hammer parts is currently important.

The strengthening treatment (ion-plasma chromizing) under advanced technology which excludes superheat of the parts in the coating process and its chipping under the test is conducted.

The high quality coatings from fine metals are obtained under the temperatures not less than 80…100 °C. The initial process materials for vacuum ion-plasma sputtering are cathodes from sputtering materials, chrome (BX-1) in this case.

A unit for ion-plasma sputtering “Bulat” was used (Fig. 1). It consists of a chamber, a vacuum pumping system, a vapor source, a rotator, a water handling and a seat.

The thickness of chromium plate made 50…60 μm. The roughness parameter of the strengthened surfaces – R_a 0.8…3.6. The roughness of the work surfaces after finishing reached within the limits R_a 0.4…0.8.

Wear of parts. The degree of damage to parts strengthened by means of ion-plasma chromizing using advanced technology is shown on Fig. 2. The initial signs of the coating damage in the form of scoring marks and tearings were detected at the peak in the zones “M” and “F” after 300 loading cycles, on the hammer head in the same zones after 450 cycles.

The scratch marks in the channel cavity of the bush appeared after 600 cycles, of the case after 700 loading cycles. Flaws along the axis of the parts were formed in the channels of the case and the bush (zone “B”) and their cut after 800 cycles. Due to the coating wear of the most loaded sections of the parts the test was stopped after 1730 cycles.

The measurements of the worn parts show that the equivalent diameter of the case and the bush channels in the cut zone increased to 125.5 mm. The hammer head is worn in the zone “N” to 0.2 mm, in the zone “M” to 0.5 mm. Correspondingly the peak – to 0.3 and 0.85 mm. The locations of the greatest wear zones and the nature of the damage to the parts are similar to those observed on the parts examined above.

Wear hardening and metal plastic working are observed in the zone “A” of the hammer head channel (the case) and the bush (Fig. 3). These effects are more intensive on the bush. The wear, surface coating plastic working and the formation of valley-tearing are seen in the zone “B”. The valley tops are smoothed, worn (to the base on some sections) on the bush, the valleys are rough, without wear features on the case. Even wear, wear hardening and surface coating scaling are observed in the zone “B”. The scaling on the case is major, on the bus is in the initial stage of the development. The small sections of remained strengthened layer are recognized on the case. The surfaces of zone “D” are characterized with artificial aging and scaling of the material. Coating wear on the case and the bush goes without signs of chipping or peeling.

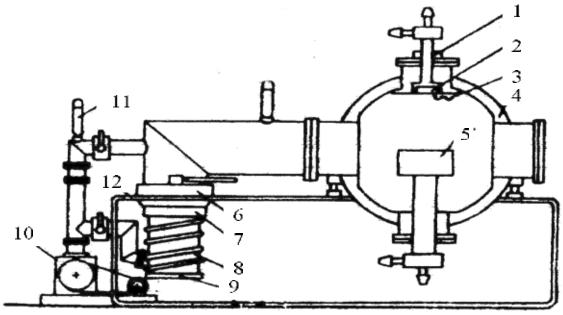

Fig. 1. General arrangement drawing of unit “Bulat”: 1 – focusing coil; 2 – cathode; 3 – ignitor electrode; 4 – anode chamber; 5 – supporter; 6 – liquid nitrogen trap; 7 – water trap; 8 – high-vacuum device; 9 – heater; 10 – backing pump; 11 – manometric lamp; 12 – unit water cool system

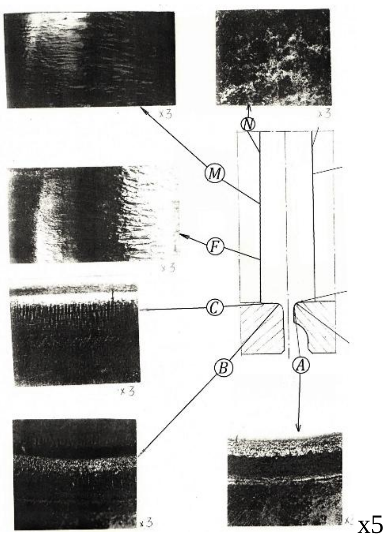

Fig. 2. Wear of the peak and the bush strengthened by means of ion-plasma chromizing (using advanced technology), x5

The damage nature of the hammer head and the peak is identical to the observed one on the parts tested earlier, strengthened by means of ion-plasma chromizing using initial technology. Smoothed spot is detected in the central section of the hammed head (zone “N”). The coating is less worn on the hammer head, than on the peak. There is a pattern of valley-tearing developed more on the peak in the zone “M”.

The pattern of valleys on the hammer head is significantly smoothed in the result of the wear. It is specified that the hammer head and the peak differ less as for the extent of valleys development than the hammer head and the peak of the strengthening variants tested earlier. Zone “F” is characterized with coating wear, wear hardening and smooth surface. The damage in this zone is even on the circle of the parts and practically identical on the hammer head and the peak.

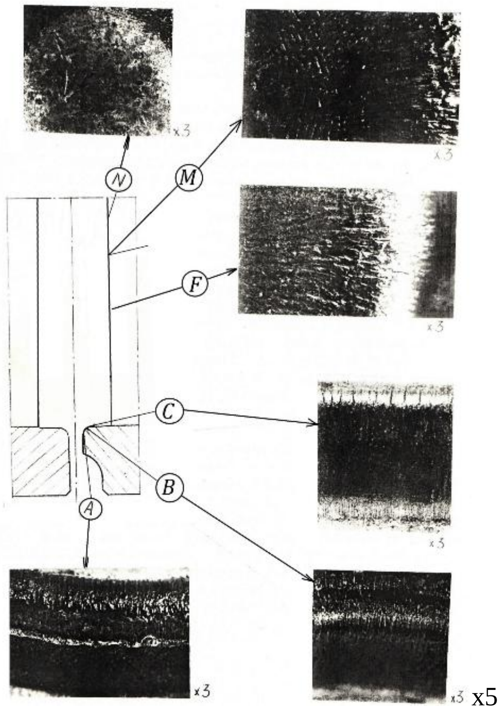

Fig. 3. Wear of the case and the hammer head, strengthened by means of ion-plasma chromizing (using advanced technology), x5

The marks of artificial aging and wear hardening of the coating are observed in the zone “E”. Galling to the arris of cylindrical surface is specified on the edges of the parts.

Flaws are observed on the tested parts of the examined variant (Figs. 4 and 5).

Flaws on the case and the bush are observed in the zones “A” and “B”. Their depth on the case reaches 0.55 mm, on the bush 0.4 mm. There are no flaws in the zones “C” and “D”. Flaws on the hammer head are found in the zone “N” of 0.3 mm depth and in the zone “M” – up to 0.6 mm. There are flaws on the peak only in the zone “M” of 0.6 depth.

Appearance of the flaws in the fractures is identical to the earlier observed on the other variants of strengthening (outlined contour, burning and smoothed surface).

On the case and the bush, the remains of the coating are observed in the zones “A” and “C”, the wear is insignificant in the zone “D”.

The depth of the remained coating on the bush in the zones “A” and “C” is 10 µm, in the zone “D” – 40 µm, on the case (channel) in the zone “C” up to 10 µm, in the zone “D” – 20…30 µm. The coating remained only in the zones “N” and “E” on the hammer head and the peak. The thickness of the layer on the hammer head is 10 µm, on the peak – up to 5 µm.

The structural changes are observed in the metal of the examined parts in the damage areas. The structural changes for the depth 0.25…0.30 mm on the bush are indicated in the zones “A” and “B”. The hardness of material in the structural changes zones is HV 510…645.

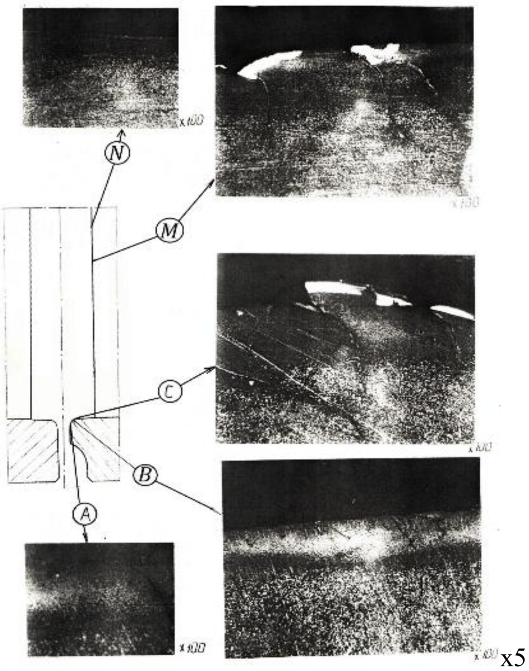

Fig. 4. Structural changes of the material of the case and the hammer head strengthened by means of ion-plasma chromizing (using advanced technology), x5

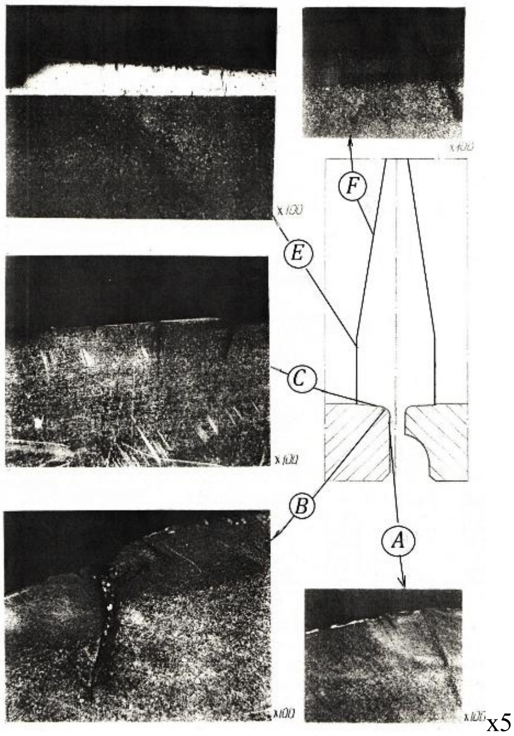

Fig. 5. Structural changes of the material of the peak and the bush strengthened by means of ion-plasma chromizing (using advanced technology), x5

The structural changes for the depth 0.25…0.30 mm are observed in the zones “N” and “M” on the peak material. On the hammer head in the same zones the depth of the structural changes is 0.15…0.20 mm. The hardness of material in the structural changes zones is HV 510…585. The hardness of the material of the examined parts: the bush – HRC 40…42; the peak – HRC 40…42; the case – HRC 40…42; hammer head – HRC 40…42.

The material microstructure of the parts is of sorbit type, with finely dispersed structure. The test results of the mechanical characteristics of the parts material for stretching is presented in the Table.

Mechanical characteristics of the parts material, strengthened by means of ion-plasma chromizing (using advanced technology)

Part name	Direction of samples cut	Mechanical characteristics			
		σ_B, Pa	$\sigma_{0.2}$, Pa	δ, %	ψ, %
Hammer head	axial	1390.0…1430.0	1310.0…1360.0	8.0	23.0
	tangential	1490.0	1400.0…1430.0	15.0	56.0
Peak	axial	1460.0	1380.0	6.4…8.0	3.0…15.0
	tangential	1450.0…1510.0	1360.0…1375.0	13.0	51.0…54.0

CONCLUSIONS

The tests results of the parts strengthened by means of ion-plasma chromizing using advanced technology show that the increase of their wear resistance in 1.75 times is guaranteed comparing to the initial (which were not subjected to special strengthening).

The damage of the work surfaces of the tested parts is identical to the parts examined earlier as for the nature and locations of the zones.

The damage of the details is characterized with the coating wear. Metal wear hardening. formation of valley-tearing and flaws. The strengthening coating was practically worn in the most loaded sections of parts (in the zone “B” and “C” on the hammer head case and the bush and “M” and “F” on the hammer head and the peak.

The advanced technology of ion-plasma chromizing provides the running of the strengthened parts without breaking off and chipping of the coating.

The feature of the tests results of this strengthening variant is lesser wear of the lower parts (the bush, the peak) as compared with upper parts.

On the sections of parts damage there are zones of material structural changes for the depth to 0.3 mm, typical for secondary hardening effects.

There are flaws on all parts: on the case and the bush in the zones “A” and “B” up to 0.55 mm, on the hammer head and the peak up to 0.6 mm. No flaws are identified in the other zones of parts damage.

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ПОВЫШЕНИЕ ИЗНОСОСТОЙКОСТИ ОТВЕТСТВЕННЫХ ДЕТАЛЕЙ ГИДРОМОЛОТА ИОННО-ПЛАЗМЕННОЙ ОБРАБОТКОЙ

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Детали гидромолота подвергаются в процессе эксплуатации износу. Это приводит к уменьшению продолжительности их работы. В соответствии с литературными данными и практикой используется много методов упрочнения, которые не дают существенного эффекта. Поэтому актуальным стало привлечение новых методов поверхностного упрочнения. К таким методам относится ионно-плазменное хромирование. На основании экспериментальных исследований необходимо установить влияние ионно-плазменного хромирования на износостойкость и механические свойства деталей гидромолота, а также проанализировать структурные изменения в материале. Ионно-плазменное хромирование деталей способствует повышению их износостойкости в 1,75 раза по сравнению с неупрочненными. Технология ионно-плазменного хромирования обеспечивает работу упрочненных деталей без сколов и без выкрашивания. На участках повреждения деталей отмечаются зоны структурных превращений, характерные для явлений вторичной закалки.

ПІДВИЩЕННЯ ЗНОСОСТІЙКОСТІ ВІДПОВІДАЛЬНИХ ДЕТАЛЕЙ ГІДРОМОЛОТА ІОННО-ПЛАЗМОВОЮ ОБРОБКОЮ

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Деталі гідромолота піддаються в процесі експлуатації зносу. Це призводить до зменшення тривалості їх роботи. Відповідно до літературних даних і практикою використовується багато методів зміцнення, які не дають істотного ефекту. Тому актуальним стало залучення нових методів поверхневого зміцнення. До таких методів відноситься іонно-плазмове хромування. На підставі експериментальних досліджень необхідно встановити вплив іонно-плазмового хромування на зносостійкість і механічні властивості деталей гідромолота, а також проаналізувати структурні зміни в матеріалі. Іонно-плазмове хромування деталей сприяє підвищенню їх зносостійкості в 1,75 рази в порівнянні з незміцненими. Технологія іонно-плазмового хромування забезпечує роботу зміцнених деталей без сколів і без викришування. На ділянках пошкодження деталей відзначаються зони структурних перетворень, які характерні для явищ вторинного гартування.