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INCREASING OF DETAILS SURFACE QUALITY BY VIBRATING PROCESSING

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ПІДВИЩЕННЯ ЯКОСТІ ПОВЕРХНЕВОГО ШАРУ ДЕТАЛЕЙ МЕТОДОМ ВІБРАЦІЙНОЇ ОБРОБКИ

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The questions of surface quality increasing is considering in the article. An improvement of quality, increase of reliability and longevity of the produced machines and wares are among the major tasks of modern engineering. One of methods to increase the productivity and quality in metal-treatment is the vibrating finishing. The results of experimental researchers of vibrating treatment influence on details surface are presented in the article.
Key words: *vibrating treatment, surface quality, surface roughness, increase of productivity, microhardness*

Introduction. A modern world consumes vast amounts of power generated by engines and motors, transferred by gear boxes and drivetrains all of which have component parts that are subject to heat, abrasion, vibration, wear, combustion and accumulated deposits. A world of vehicles and transport systems operating in extremes of temperature, humidity, harsh salt and chemical environmental attack, causes corrosion, paint and coating deterioration and the seizing of component parts. The followings technological methods of increase of durability, wearproofness anf wear resistance of machine parts are most widespread:

– chemicothermal treatment: cementation, nitriding chrome-plating, cyanidation, silicification, alitizing, sulphurizing and others;

– heat treatment: flaming hard-facing, high-frequency tempering, hard-facing with heating in an electrolyte, laser work-hardening;

– chemical treatment: deep anodization, oxidizing, phosphating;

– superficial flowage: rolling by marbles and hard-alloy rollers, shot-peening, vibroabrasive consolidating treatment;

– diamond burnley, work-hardening, hydrofinishing, treatment of surface an explosive ladening a coinage;

– electric-spark work-hardening;

– galvanic coverages: chrome-plating, nickelage, borating, silvering, tinning, leading and coverage alloys;

– chemical coverages: nickelage, chrome-plating, coverage a cobalt and alloys a nickel is a cobalt;

– methods of giving the surface of anti-friction properties: graphitization, rolling (deepenings, ditches), overcoating in a vacuum, causing of molykote, friction brassing and bronzing, coverage plastics (vortical and gas-flame methods), metallization with evaporation;

– surfacing: electric arc, electro-slag, vibroarc.

Among the methods of flowage large interest is presented by vibroabrasive consolidating treatment. Vibrating treatment is made on machine-tools with U – shaped form of container. Containers make with a different size alongside, by volume of from 3 to 1000 l and more. Machine-tools provide possibility of work on the different modes (amplitudes from 0,5 to 7-10 mm and frequencies 33-80 Hertz). Thus in a container simultaneously load the far of details. Exactly universality of equipment for vibrating processing provides possibilities of realization with his help of a number of operations, such as cleaning, finishing, and including hardening.

The analysis of researches and publications. One of methods to increase the productivity and quality in metal-treatment is the vibroabrasive finishing. Its advantages consist in large technological possibilities. It allows to carry out the wide range of operations: from crude felling workmanships, removal of dross and welding burr, to polishing and decorative finishing. It provides a quick reconditioning, reclamation and renewal of dirty, corroded, worn machined components. And is of vital importance to mechanical engineers, in the process of maintenance, component re-claim, rebuilders and re-manufacturers. Maintenance, cleaning and refurbishment of private and commercial transport components for passengers and cargo. These include rockets, satellites, aircraft, trains, ships, cars, vans, trucks, buses and coaches. A modern world consumes vast amounts of power generated by engines and motors, transferred by gear boxes and drivetrains all of which have component parts that are subject to heat, abrasion, vibration, wear, combustion and accumulated deposits. A world of vehicles and transport systems operating in extremes of temperature, humidity, harsh salt and chemical environmental attack, causes corrosion, paint and coating deterioration and the seizing of component parts (fig. 1) [1, 2].

Fig. 1. Examples of details with complex surfaces, which can be treated in vibrating machine-tools

Vibrotreatment of steel plate, profiles, construction, and fabrications is a process to clean, descale**,** provide a specified surface profile and edge break as a surface preparation. This process takes place prior to a coating or paint application to maximise the adherence potential and corrosion control. High indexes on universality, productivity, quality of the got surface, firmly fastened the place of perspective methods of making of details of machines and devices after it, and also commodities of folk consumption.

Consolidating vibrotreatment improves operating properties of details, promoting wearproofness and tireless durability due to the increase of microhardness and creation of squeezing tensions in a superficial layer. The arrived at level of properties of material of the deformed details is related to the change macro - and microstructures. It is set that structure of material of details, exposed to the oscillation ladening, in the area of treatment more even and fine-grained [3, 4].

In literature these experimental influences of vibrating processing are widely presented on quality of superficial layer of details, got different researchers [1 – 5]. However, their failing is that they over are brought for different materials of details, workings environments, technological liquids, types of machine-tools, types of treatment (rough cleaning, polishing, polishing or work-hardening), that cause complication of analysis and comparison of these information [3, 4]. Thus possibilities of oscillation treatment as backer-ups of the required operating properties of details will be realized not to a full degree.

It ensues from the analysis of a priori information resulted higher, that to date contradictory results are present on research of vibrating treatment process, that is related above all things to that researches were conducted on a different equipment and different modes, with the use of different processing environments-instruments [1, 3 – 5]. The task of increase of the vibrating treatment productivity without the increase of power-hungryness of process is possible to decide by the choice of optimum parameters of instrument and amount of his loading depending on the form of workparts, their initial state, material which they are made from.

The real surface of solid is always rough. It has burries regardless of method of their receipt. It is explained: 1) by nature of physical surface, conditioned by the discrete, atomic-molecular structure of solid; 2) after tooling on-the-spot there always are tracks of instrument cutting edge action as ledges and cavities of different form and sizes.

Under the roughness of surface, ensuing treatment, the aggregate of burries is understood with relatively by small steps, formative relief of surface and examined within the limits of area length of which gets out depending on character of surface and equal to base length.

Roughness of surface after tooling – it is, foremost, geometrical track of toolpiece (metallic or abrasive), distorted as a result of plastic and resilient deformations and concomitant to the process of cutting of vibration of the technological system.

Results of experimental researches. The task of experimental researches is to establish the influence of vibrating processing on quality of details surface. The treatment of the parts was held on virating machine-tool *VMI-1003*, the parameters of which are resulted in a table 1.

Table1

Parameters of machine-tool of VMI-1003

Parameters of machine-tool	Range of size
1. Volume of container V, m^3	15
2. Amplitude of vibrations A, mm	0,5-2,0
3. Frequency of vibrations f, Hertzs	35, 63
4. Power N, kW	0,7
5. Mass m, kg	200

At researches an equipment and rigging of research laboratory of the V. Dahl East-Ukrainian national university was used. This laboratory has a row of operating oscillation machine-tools with the U-shaped containers of different volume and inertia vibroexciters the general of principle chart of which is presented on a fig. 2.

During carrying out tests the followings permanent terms were accepted:

a) filling of working chamber content on 75 % from his general volume;

b) simultaneous treatment of ten standards of the accepted material and size.

In order to determine micro hardness of the treated surface a metallography microscope MIM-7 was used. It consists of the optical, lighting and mechanical systems. On him it is possible to probe not only the structure of metal but also to get the pictures of microstructures. General view of microscope on a fig. 3.

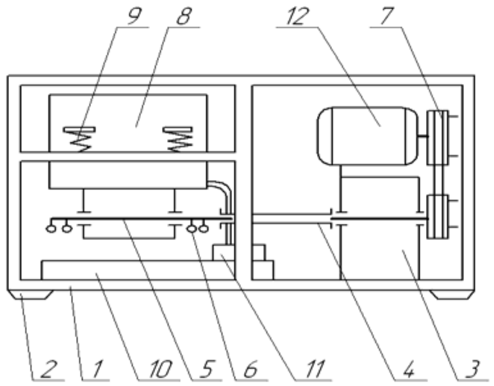


Fig. 2. A principle chart of machine-tool of model VMI-1003:
1 – framework with foundation; 2 – shock absorbers; 3 – an electromechanics drive; 4 – a flexible muff; 5 – a billow of vibroexciter; 6 – loads; 7 – a V-belt transmission; 8 – a container; 9 – a spring pendant; 10 – settler; 11 – an electromagnetic valve; 12 – is an electric motor

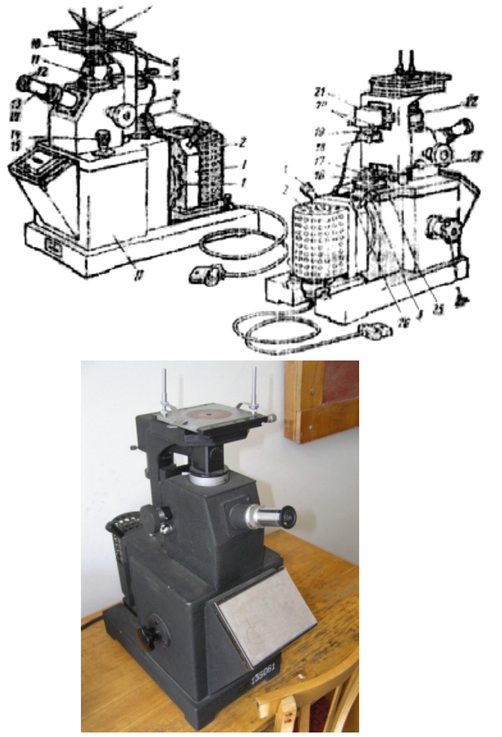


Fig. 3. General view of microscope MIM-7

A microsection is set on lining 7 (fig. 3) objective table 10 by the polished surface downward, preliminary making sure, that the ray of light, passing through a lens, gets in opening on an objective table. Aiming on a sharpness (focusing) is conducted at first by a macrometric screw 4, preliminary wringing out a stop screw 23. Looking after in an eyepiece 12, by the rotation of macrometric screw 4 to make the rough aiming, whereupon to clutch a stop screw 23.

The scopes of grains under a microscope look dark, because as in the places of deepenings the rays of light disperse.

In order to determine influence of vibrating processing on durability and wear resistance of details a machine of friction was used (fig. 4).

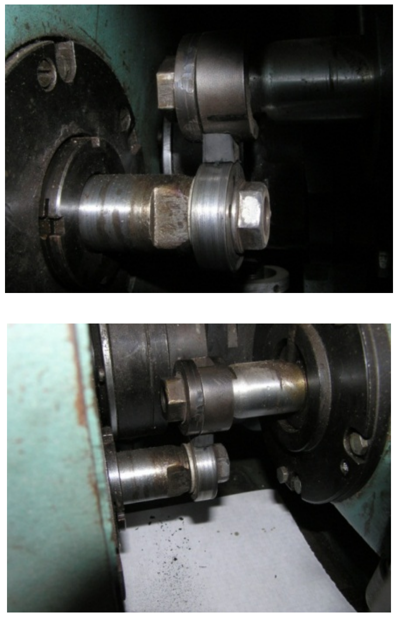


Fig. 4. Tests of materials on a wear at sliding and rolling friction with the pair of samples disk-rubber pad

The machine of model of SMC-2 is intended for the test of materials on a wear and determination of their anti-friction properties at sliding and rolling friction at normal temperatures with the pair of sample disk-disk, disk-rubber pad and hob-billow.

Determination of microstructure and hardening of material.

A purpose of treatment is study of macro- and microgeometry, diminishing of parameter of surface roughness, change of sizes of purveyance to possible, change of structure of material without his complete recrystallization (superficial peening), creation of the certain tense state (tense superficial peening).

A purpose of work is an estimation of possibility of receipt of peening on details without fixing. For this purpose next experimental researches were conducted with the use of microstructure method.

30 standards from steel 45 (table. 2) were selected. Their form was cylindrical with sizes: diameter d=16 mm, length L=50 mm, they were got from a bar with the diameter d=16 mm.

Table 2

Chemical composition of materials of the processed samples

Material	σ_B, N/mm^2	σ_{02}, N/mm^2	Chemical composition	Hardness	
				On-the-spot purveyance	On the cut line
Steel 45	600	355	0,45% With; 0,72% Mn; 0,29% Si; 0,020% S; 0,028% P	HB 234	HB 240

Steel 45 belong to the pearlitic class.

Treatment of samples was conducted during 3 hours on the machine-tool of VMI-1003: the volume of container V = 15 l, power N = 0,7 kWt, mass m = 200 kg. On the followings modes: vibrations amplitude A=1 mm, vibrations frequency f = 63 Hz; in an environment, consisting of the steel hard-tempered polished balls with the diameter of 3 mm and chemically active solution (a soda ash, triethanolamine, olein acid).

Treatment was conducted with weighing of samples before and after treatment on the analytical scales.

As is generally known, microanalysis allows to explain reasons of change of properties of metals and alloys depending on the change of chemical composition and terms of treatment, because between a microstructure and properties of metals there is certain dependence.

A task was put:

– determinations of form and size of crystalline grains which a metal or alloy consists of;

– establishments changes of internal structure, what be going on in the probed material under influence of different sort of influences at treatment pressure;

– exposures of nonmetallicss (sulfides, oxides et cetera);

– exposure of defects of metal – micro cracks, shells, pores et cetera

The microstructure method of research of metals and alloys consists of the followings; stages:

1. preparation of microsections;
2. etching of microsections;
3. study of structure and vices of metals and alloys under a microscope.

1) Preparation of microsections was conducted in the following order:

First, a selection of samples and his undercut. A sample got out from that part of metal, which most characterizes the structure of all detail. Samples were cut out standard sizes so that the structure of metal did not change (table 2); Second, sample was polished on sandpaper with grains of different sizes with a transition from more large grain to more shallow. Marks, which were left after polishing, retired with finishing. As is generally known, it is possible to apply the mechanical, chemi-mechanical or electrochemical methods of polishing. In this case a mechanical polish was made on thick felt circles, fastened on the circle of the special polishing machine-tool, on which inflicted the shallow particles of abrasive materials.

For the protection of samples' edges from heaping up, because in this case there was of interest a border layer, the following method was used: part of sample was placed in the ring of greater diameter and inundated epoxid rubber (TU-U 24.6–2558309112–004–2003) to the complete hardening, the repeated polishing and polishing of sample (fig. 5) was whereupon conducted on the machine-tool.

As is generally known [2], the special attention is required by an etch and cleaning of sample's surface after an etching. Samples were polished mechanically very carefully, that at a 500-multiple increase an optical microscope it was not visible scratches.

2) Etching of microsections. The turning out after polishing mirror surface of sample under a microscope has the appearance of light circle and does not allow to judge a metal or alloy about a structure. Only the nonmetallicss (for example, sulfides in steel, rules in cast-iron) due to their painting in different colors are selected on the light background of the polished microsection [2]. For the exposure of structure a microsections was exposed to the etching. Most widespread etches for steels and cast-irons is 4 % natal. An etch was carried out causing of reagent (4 % nital) on the polished surface of sample by a wadding tampon.

Fig. 5. Samples in steel rings

Under the action of reagent as a result of different intensity of dissolution of separate structural constituents and their scopes on-the-spot microsections relief appears. The scopes of grains take poison stronger than grains, because the superficial layers of grain are enriched admixtures, in connection, what galvanic pair appear with, a crystalline grate at scopes grains is in more distorted and tense state, than at back of grain. Therefore in places, proper the scopes of grains, deepenings turn out after an etch. Structural constituents with high electrode potential poorly take poison and come forward above the surface of structural constituents with more low electrode potential, which take poison stronger. Thus, numerous cavities and ledges appear on the microsection surface.

At illumination of microsection falling light on a metallography microscope the rays of light are variously reflected from the differently stainsed areas. That of them, which were etching poorly, reflect in sign of microscope more light and under a microscope will seem light. Other, stainsed strongly, will seem dark because of dispersion of light (the less rays of light will get in sign of microscope).

For research of microstructure of metals and alloys utillize optical and electronic microscopes. The choice of multipleness of increase of microscope depends on the size of the studied element of structure. The size of grains, size and location of nonmetallicss, is set at multipleness by increases in 100 times. The structure of separate grains is studied at an increase in 200 – 300 times, and sometimes and at greater multipleness [2]. This experiment was conducted on a metallography.

To estimate the size of the work-hardened layer after vibrating an experiment on determination of microhardness of material of that sample was conducted. An experiment was conducted on the device of PMT – 3 by pressing of diamond pyramid in the ferritic constituent of sample surface (fig. 6), on-loading

50 g. Measurings were conducted from the center of sample to the edge, on a radius.

A research purpose is an estimation of vibrating treatment influence on the microhardness of coating surface of sample.

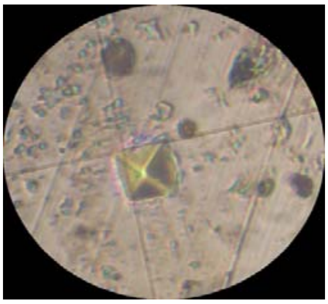


Fig. 6. Imprint of diamond pyramid at measuring of microhardness (×100)

The microstructure method of research was used to confirm the possibility to get high microhardness of coating surface.

As imitators of details were samples, made from flats, cut on plates with sizes 10×30×50 mm from materials: steel 3, steel 20 and steel 45 (fig. 7). The first group of samples were polished on the machine-tool model «ПШСМ-2», second – processed on the machine-tool «UVI-25» during 40 minutes in an environment, consisting of breakage of abrasive disc (AN-2), and then during 20 minutes on the machine-tool of «VMI-1003», in an environment, consisting of the steel chilled polished balls, 5 mm diameter.

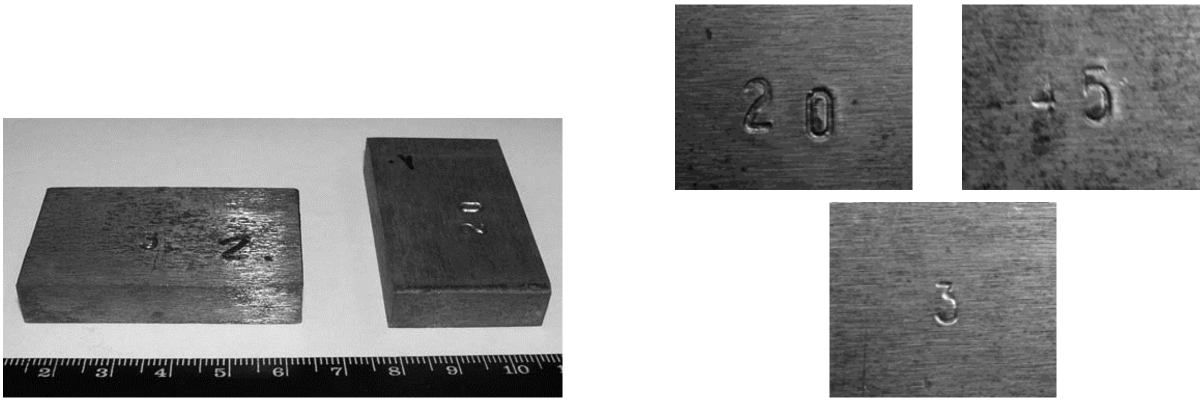
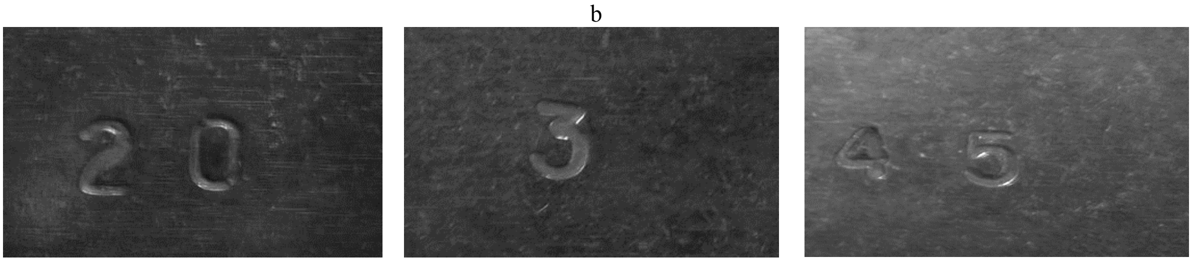


Fig. 7. Samples before treatment with pointing of brand

a

b



c

Fig. 8. Samples after the different methods of treatment:
a – after the traditional polishing; b – after the vibrating polishing in AN-2 (40 minutes);
c – after vibrating polishing in steel balls (20 minutes)

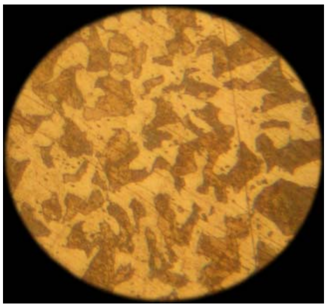
Quality of sample's surface before treatment, after the traditional polishing, vibropolishing (in AN-2) and vibropolishing (in steel chilled polished balls) is resulted on a fig. 8.

Tracks of corrosion, contaminations, and also local defects as pores and shallow scratches are obviously visible on the surface of sample before treatment.

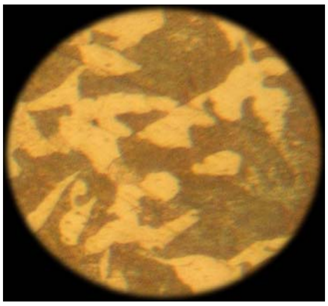
After the traditional polishing the surface of samples (fig. 8, a) is covered by even tracks from a polishing instrument as circular marks or furrows with the height of relief roughness from 6,3 to 25 mkm, wire-edge were saved.

The material changes on the details surface observed after the vibrating polishing. The treated surface is smooth, mat, without tracks of treatment with the height of burries of relief of Ra from 0,32 mkm to 6 mkm, nicks-and-burrs absent contoured, the directed tracks from an instrument are not observed (fig. 8, b).

The received structures of samples before and after treatment are resulted accordingly on a fig. 9.



a

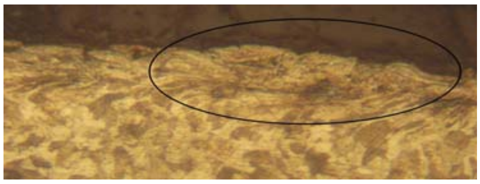


b

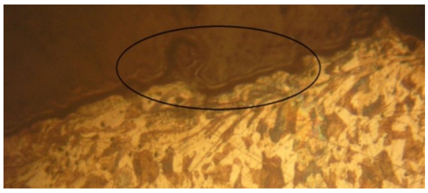
Fig. 9. Structure of metal:
a – before treatment; b – after vibrating (100)

As be obvious from a fig. 9, the structure of steel did not change substantially, remained even on all surface of samples. However much obvious changes happened in the structure of border-line layer. On a fig. 10 the border-line layers of samples are shown before and after treatment.

On the pictures evidently, that samples after treatment have a sharp-edged even border-line layer with the close-settled structure of grains. Oscillation treatment creates work-hardening of superficial layer (peening) the size of which makes 0,03...0,05 mm, that in 10 times there is a less size, offered by other authors [1, 5]. However necessary it is to take into account that vibrating treatment was conducted on the machine-tool of VMI-1003 with the volume of container 15 l, with amplitude 1,0 mm, that on the soft modes.



a



b

Fig. 10. Border-line layer of detail:
a – before treatment; b – after vibrating

To estimate the size of the work-hardened layer after vibrating treatment, an experiment on determination of microhardness of material of that sample was conducted. An experiment was conducted on the device of «PMT-3» by pressing of diamond pyramid in the ferritic constituent of surface of standard (fig. 11), on-loading 0,5 N. Measurements were conducted from the center of standard to the edge, on a radius. Estimation of microhardness of superficial layers was conducted before and after vibrating treatment (through 60, 240 and 480 mines). The results measuring presented in a table. 3.

Table 3

Surface microhardness of samples

Points	Hardness, MPa
1	927 – 929
2	927 – 929
3	927 – 929
4	927 – 929
5	927 – 929
6	927 – 929
7	927 – 929
8	927 – 929
9	929 – 933
10	930 – 933

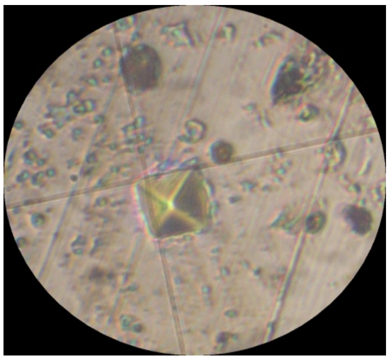


Fig. 11. An imprint of diamond pyramid at measuring of microhardness (×100)

By an experiment existence of the work-hardened border-line layer was well-proven even on the "soft" modes of treatment. Nearer to the border of sample large hardness was got, what in a center is talks about peening of superficial layer of metal, that corresponds to presentations in [1, 2]. For achievement of stable result it is necessary to produce the choice of the modes of this operation, and, exactly, to pick up frequency and main amplitude of vibrations of environment, and also sizes of instrument – steel balls.

Determination of durability and wear resistance of details.

Damage of details and workings parts of machines at normal external environments is investigation of physical wear of different kinds: tireless destructions, creep of materials, mechanical wear, corrosion, erosion, senescence of material and other Therefore the increase of his wear resistance is very important for the improvement of quality of good (it is property of material to offer resistance to the wear in the certain terms of friction, estimated a size, to reverse speed of wear or intensity of wear).

A microhardness Nm is very important making description of physic-machanical properties of superficial layer, and it is necessary to examine it as a result of elastoplastic deformations, shock wave processes accompanying oscillation influence caused an action [1].

Influence of working environment was also investigational on a change the microhardness of superficial layer of samples in the environment of steel hard-tempered balls of d=(3-4) mm (1), porcelain balls of d=(20-25) mm (2) and abrasive granules (AN-2) (3).

Mode and duration of treatment: A-1,5 mm, f = 63 Hertzs, t = 120 mins The processed samples had a rectangular form 10×20×5 mm and were made from hard-tempered and anneal steel 45. A microhardness was measured on the depth of 10 mkm for hard-tempered samples and on the depth of 20 mkm for anneal.

For determination of influence of vibrating treatment on wear resistance of details the row of researches was conducted.

Two complete sets of samples (fig. 12) were made from three types of material: steel 3, steel 45 and steel R9. The first group of samples after lathe clean treatment (Ra = 6,3 mkm) was precipitated polishing on the machine-tool (Ra = 3,2 mkm), second - after lathe clean treatment (Ra=6,3 mkm) processed on the vibrating machine-tool of VMI-1003 during 180 mines in the steel hard-tempered marbles of d=5 mm (Ra = 3,2 mkm).

Fig. 12. Samples for measuring of wear resistance of details

These samples in a form of rollers were used as a disk in the ground pair «disk-rubber pad». As pads samples from rubber were used. There hardness was (on Shoru – A = 65-80) GOST 7338-77.

An experiment was conducted in a few stages:

1. The prepared samples were weighed on analytical scales.
2. Samples were processed on the machine of friction dry-sand, without cooling, during 78 seconds (to the moment began melting of rubber) for 20 approaches for every sample.
3. After completion of treatment weighing was repeated.

During the hardness of samples was also certain on Brinell before and after treatment.

Hardness of material in a starting condition of samples from steel 3 was 170…187 HB. For steel 45 hardness had the followings values: 124…131 HB. For steel R9 hardness was 179…187 HB. An initial roughness of all samples was 6,3 mkm.

Steel 3 was not expose to heat treatment. Steel 45 exposed to tempering to the microhardness 270…320 HB. High-speed steel R9 was exposed to tempering with subsequent 4-th multiple vacation to HRC 63…66.

Further part of samples was exposed to the traditional polishing, and other part – to vibrating processing to the roughness of surface, equal 3,2 mkm.

After treatment on the machine of friction next results were got. For steel 3 after the traditional polishing the wear of material made ~0,0135 gr. After vibrating processing the size of material wear did not change and made also ~0,0135 gr.

For steel 45 after the traditional polishing the wear of material made 0,015 gr. After vibrating processing there was dimension of material wear to 0,0061 gr.

For steel R9 the wear of material after the traditional polishing not found out, and after vibrating processing there was an increase of mass of samples (due to sticking of rubber).

This experiment rotined that for steel 3 the wear of material does not depend on the type of treatment. For steel 45 the wear of material diminished in 2,46 time. For steel of R9 the wear of material not found out.

During the second experiment samples in a form of rollers with an internal diameter 15 mm, external – 50 mm and in 10 mm high from steel 40X were used. Tests with 80 rollers on the identical modes were made. Wear resistance was measured through every fifteen minute. Experimental samples after lathe treatment were exposed to cementation with the subsequent tempering to hardness of HRC = 52…56.

After heat treatment rollers were polished at the abundant cooling with taking to the required sizes and removal of allowance from an outward surface 0,3 mm on a side. The polishing modes were used V = 30 m/s, $S_{прод.}$ = 8 m/min, $S_{поп}$ = 0,02 mm, number of turns of detail of n = 175 rps at 15 passes. At polishing samples were set on mounting and polished from one setting, that provided the identity of terms of formation of superficial layer at every group of samples, subject to the test on a wear.

Further 60 samples from the 80 made was exposed to vibrating treatment. It consisted in the following. As an equipment the vibrating machine-tool of UVI-25 was used with the capacity of container of V=25 litres. The followings modes were set: frequency of vibrations n = 50 Hertzs, amplitude A = 2 mm. These modes it is suggested to use in future for treatment of row of wares, for example parts of valve of boring pump, cog-wheels of hauling reducing gear and other, as they allow for minimum time to get the enough low surface roughness. Samples were polished in a container during 90 minutes.

The breakage of abrasive disc was used as an instrument with the sizes of granules 20...30 mm, grittiness of 6 – 8 mkm.

Part of samples, passing vibrotreatment in the environment of abrasive disc breakage, and part of samples, not undergoing early to vibrotreatment, after exposed to the vibrating hardening. As an instrument-working environment – steel balls were used with sizes 5…6 mm. For providing of the vibrating hardening the followings modes of treatment were used: frequency of vibrations n = 50 Hertzs, amplitude A = 3,5 mm. Samples were consolidated during 30 minutes.

The further tested samples were set on a machine MI-1M, intended for the tests of metals on a wear and determinations of their corrosion resistances at the sliding friction and rolling friction.

The size of wear was estimated on the depth of ditch, leaved a hard-alloy roller on the surface of sample after 15, 30, 45, 60 and 90 minutes of wear. Thus every sample was tested three times to get average values of depth of ditch and taking to the minimum of percent of errors at measuring.

The sample, treated on a round-grinding lathe, was the first. After including of machine depth of ditch was measured through each 15 minutes of work.

Then sample, polished and hardened in the environment of steel balls, polished and treated on a vibromachine-tool in the environment of breakage of abrasive disc, polished and treated on a vibromachine-tool in the environment of breakage of abrasive disc and in the environment of steel balls, were set one after another, and measurings were accordingly produced. In this experiment as a criterion of wear resistance the change of depth of ditch was accepted from pressing of hard-alloy roller depending on time of rolling-off of him and sample.

Measuring is resulted in a table. 4 and on their results graphic dependences, resulted on a fig. 13., are built.

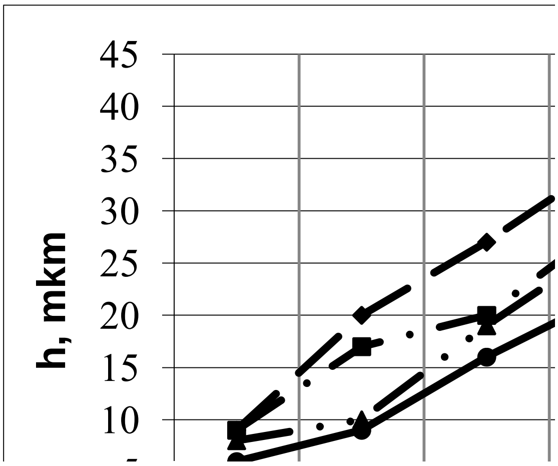


Fig. 13. Changes in samples' wear resistance depending on the method of their surface treatment

polishing;

polishing and vibrotreatment in the environment of steel balls;

polishing and vibrotreatment in an environment of AN-2;

polishing and vibrotreatment in an environment of AN-2 and in the environment of steel balls.

Table 4

Results of the experiment on wear resistance

Time, min	Methods of final treatment of specimens surface															
	Polishing				Polishing and vibrotreatment in the environment of steel balls				Polishing and vibrotreatment in an environment of AN-2				Polishing and vibrotreatment in an environment of AN-2 and in the environment of steel balls			
	Results of measuring of ditch depth h, mm															
	1	2	3	middle	1	2	3	middle	1	2	3	middle	1	2	3	middle
15	10	8	9	9	8,5	10	7,5	9	7,5	9	7	8	5	6,5	6	6
30	19	19,5	21	20	13,5	12,5	15,5	17	9	10,5	9,5	10	9,5	8	8,5	9
45	29,5	26	25,5	27	19	21	19,5	20	17,5	20	18,5	19	15,5	16,5	15,5	16
60	36	35	34,5	35	29,5	28	27,5	29	26,5	26	28	27	21	22,5	21,5	22
90	43	40	41,5	42	41	39	40	40	34,5	37,5	35	36	34	32,5	33	33

The analysis of graphic shows the stable increase of samples' wear resistance at additional introduction of vibrotreatment of surface after polishing.

Depth of ditch on sample, which was not exposed to vibrotreatment, at identical time of test and ladening of the tested sample made 25 kg to 0,042 mm.

Vibrotreatment in the environment of steel balls improved surface wear resistance (the depth of ditch h was 0,038…0,04 mm). Balls consolidated a superficial layer, but practically did not change the roughness of surface.

Treatment of surface in the environment of AN-2 considerably diminishes the roughness of surface and wearproofness of surface as compared to polished (h = 0,032…0,036 mm).

From the results of experimental researches evidently, that vibrotreatment in an environment of AN-2 with the subsequent hardening in the environment of steel balls considerably, to 15...20% increases wearproofness of surface. It is explained by that a roughness, stopping behind after polishing, diminishes at treatment in an environment AN-2, and here a few strengthened, and then strengthened at vibrotreatment in the environment of steel balls.

Test after 90 minutes of work rotined identical results on all samples, in connection with that a hard-alloy roller already passed the treated, hardened superficial layer and further the structure of metal on all samples was identical.

Conclusions. Experimental researches on wear resistance of samples' superficial layer allowed to make next conclusions:

1. The wear resistance of samples' surface rises to 15…20% after vibroprocessing of workings surfaces.

2. Both the size of surface roughness and depth of hardened layer influence on wear resistance of superficial layer.

3. Tests on wear resistance showed positive results on application of vibrating method of treatment of details as finish operation.

4. The analysis of results shows, that with growth of mass and hardness of granules of working environment, at the unchanging modes of treatment, there is a surface plastic deformation and increase of microhardness of superficial layer of details.

5. Structure of steel – one of basic parameters, influencing on quality of superficial layer, including his wear resistance:

– Steel 3. Structure of this steel: ferrit + pearlite, with predominance exactly of ferrit, loose, soft, that does not undergo and to work-hardening, what was approved by results (the wear of material is relatively permanent). There is a steady decline of surface roughness, therefore vibrating is recommended for treatment of details from this steel both on fellings operations and on a finish.

– Steel 45. Structure of this steel: ferrit + pearlite, easily exposed to hardening by vibrating, that is confirmed experimentally. Hardness of material rises after vibrating on 15...22%, and the wear of material diminishes in 2,46 time. Consequently, as finish operations for the receipt of low roughness and work-hardened superficial layer it is possible to recommend oscillation methods, and it is necessary to continue research on the choice of the optimum modes of treatment and optimum arrangement of structural parameters of equipment.

– Steel of R9. This steel possesses a high thermostability, that by ability to save a martensite structure and accordingly high hardness, durability and wear resistance at enhanceable temperatures. It saves a martensite structure at heating to 600…620ºC. Therefore in the area of contact (to the area of dry friction) at high speed of rotation of details a temperature rises and holds out exactly in a superficial layer (not spreading deep into). After vbrating the roughness of samples' surface diminishes, hardened comes, the area of contact of roller with rubber is increased on 26…34%, and as a result, there is the mutual grasping of surfaces, that sticking of rubber on a steel roller. For this reason there was an increase of mass of samples. Wear of detail here was not discovered. Taking into account hardness of steel and traced decline of roughness at vibrating, it is necessary to conduct research on the choice of optimum form and sizes of granules of working environment.

The wear resistance of samples' surface for construction steels rises to 15…20%. Both the size of roughness of surface and depth of hardened layer influence on wear resistance of superficial layer.

Preliminary tests on wear resistance approved positive results on application of oscillation method of treatment of details as that obligates a finish operation, complex making better the state surface, to continue research works in this direction.

Taking into account universality of oscillation equipment, this method it is recommended to use for the increase of operating properties of good, including wear resistance.

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Nikolaienko A.P. Increasing of details surface quality by vibrating processing.

The questions of surface quality increasing is considering in the article. An improvement of quality, increase of reliability and longevity of the produced machines and wares are among the major tasks of modern engineering. One of methods to increase the productivity and quality in metal-treatment is the vibrating finishing. The results of experimental researchers of vibrating treatment influence on details surface are presented in the article.

Key words: *vibrating treatment, surface quality, surface roughness, increase of productivity, microhardness*

Ніколаєнко А.П. Підвищення якості поверхневого шару деталей методом вібраційної обробки

У статті розглянуті питання підвищення якості поверхневого шару виробів машинобудування. Забезпечення якості поверхні є вельми актуальним завданням при виготовленні деталей машин. Приведено огляд наукових досліджень, в тому числі іноземних, присвячених дослідженню пливу параметрів якості поверхні деталей на їх зносостійкість, довговічність та інші експлуатаційні характеристики. Розглянуто вібраційну обробку деталей, як ефективний метод забезпечення якості поверхні. Представлені результати експериментальних досліджень впливу вібраційної обробки на показники якості поверхні та експлуатаційні характеристики зразків із різних марок сталі. В ході експериментальних досліджень вивчався вплив різних параметрів вібраційної обробки, а саме робочі середовища, початковий стан поверхні, параметрі вібраційного верстати, на отримання поверхні потрібної якості.

Ключові слова: *вібраційна обробка, поверхневий шар, якість поверхні, шорсткість, мікротвердість, експлуатаційні властивості.*

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