



Cleaning Car Propeller Shaft from Operational and Industrial Dirt by Vibration Wave Machining

Guteta Kabeta Weyessa ^{a*}, Ambachew Maru Woubou ^b

^{a,b}PhD Student of DSTU, Rostov on Don State Technical University, 344000 Russia

^a uni100@yahoo.com

^b ambexmaru@gmail.com or ambex_45maru@yahoo.com

Abstract

The experimental studies presents the results of vibration wave surface cleaning of parts and propeller shaft (PS) on the car performance and industrial dirt pollution in terms of repair and recycling, including when performing car balancing. Proposed equipment modernization of working chamber optimum implementation conditions of process flow sheet.

Keywords: vibration machining; vibration wave machining; process fluid; technological scheme; working chamber; abrasive granular medium; working medium.

1. Introduction

Vibration machining (VM) of parts in the free abrasive medium is widely used in all branches of machine building engineering's because of its broad technology opportunities and manufacturing of parts of finishing operations [1,2]. techno-economic advantages of wide range in

A number of studies [1,2], a thorough description of the physical nature and scheme of the vibration machining, so this work is limited to brief summary of the process.

*Corresponding Author.

The workpieces are loaded into the working chamber filled ($2/3$ volume of working chamber) with the desired characteristics of the working medium. Working chamber is mounted on springs and having the ability to vary in different directions, according to the vibration of the inertial vibrator with a frequency (f) in the range of 15-50 Hz and amplitude A of 0.5 to 5.9 mm. In the process of vibrating parts and the working medium is continuously exposed to varying the sign of acceleration. Workpieces and working medium come to the intense relative movement, making two kinds of movements; swings and slow rotation of the entire mass (circular motion) of the walls of the working chamber; vibration is transmitted to the adjacent layers of the working medium, which convey it to the next layers, etc.

During machining, parts occupied different positions in the working medium and different zone of the working chambers, which ensure sufficiently uniform treatment of all surfaces contacting the working medium.

Under the influence of vibration, processing occurs in all areas of the working chamber. Several processing efficiency is attained at the bottom, where the fluid pressure is high. As the distance is away from the walls of the working chamber, amplitude of oscillations of the particles of the working medium, the intensity of the treatment is reduced. -

VM process is a complex mechanical and physico-chemical phenomenon that has a significant impact on the entire surface and the surface layer of the machined. Most machining operations carried out with the use of process fluids. Certain physical technological features although inherent vibration workpiece, depending on the characteristics of the processing medium and process fluid (PF) treatment as a method of machining in a freely oscillating working medium, effects of general laws of liquid media technology on the deformation and destruction of the material in the contact area of the particle fluid to the surface of the items are stored for this process.

Most of the operations of the vibration machining are carried out with continuous and periodic submission of PF. It provides the removal of wear products (metal and abrasive particles) from the surface of parts and fluid particles, wetted parts and medium, helps their separation and even distribution of parts in a production environment. The intensity of machining can be adjusted by changing the liquid level in the chamber. The composition of the PF can be introduced various types of chemical additives with special properties, which also allows you to adjust the intensity of the process, and the quality of machining [3, 4, 6].

VM using vibratory effect, by superimposing the low-frequency vibration, combined with chemicals [5], electrochemical and thermal processes provides high performance processing parts.

VM techniques have been widely used in wastewater treatment, finishing and grinding and polishing operations [1, 2, 6, 7]. They are intended to deburring, cleaning, grinding and polishing the surface to prepare it for electroplating operation, decoration and hardening of surfaces.

Intensification and productivity of processes and methods of operation is one of the central problems in the research process orientation. This equally applies to the VM and vibration-wave machining (VM and VWM). Finding ways of intensification carried out on a number of fronts: optimizing mode and trajectory oscillations

characteristics and dimensions of processing (instrumental) medium, changing its density, the use of transients and inharmonic vibrations characteristics and composition of the process fluid, applying a magnetic and electric fields, change the size of the working chamber design. Among the structural elements of the equipment (machines) vibratory processing the working chamber (object, where the process of interaction of a vibrating medium and machined parts) play an important role. During operation of the vehicle, on the surface of the cars propeller shaft formed oil mud dirt, corrosion, which in time become dense and difficult to remove. The need of cleaning arises for repair, recycling, and periodic balancing.

The design parameters of car propeller shaft: shape, size (relatively long) creates certain difficulties in choosing a method of cleaning (MC). Application of methods for elemental and consistent treatment is associated with increased complexity and the use of manual labor. The use of MC requires appropriate fencing work area; purification by washing with immersion in a bath of the PF does not ensure removal of dirt solids without additional mechanical action [8, 9].

Nevertheless, the technological scheme of processing all surface parts is preferred. These conditions correspond to VWM in granular medium with the modernization of the shape and size of the working chamber [8, 10, 11, and 12].

For this purpose, experimental studies were carried out on the process of surface cleaning from operational dirt and experimental development of construction modernization shape and size of the working chamber of the equipment.

2. Materials and methods

Research was conducted on samples coated with mud contamination, scale, corrosion in process of dirt cleaning of parts. Complex clearing made on field samples in the form of fragments (clippings) of car propeller shaft after prolonged use taking into account, the results obtained in special samples (removal of soil, scale, corrosion). Along with fragments subjected to PF treatment, fork and fragments (clippings) of car propeller shaft. Processing carried out in the working chamber volume of 40 dm³. in the free state. Used as working medium abrasive granules (PT 10x15 - triangular prism) with grain size 8 - 10, vitrified hardness ST. was adopted.

Regime and duration of treatment: A = 3.5 mm, f = 33 Hz, t = 30 min.; used as PF aqueous detergent solution (car shampoo). Test results of processing done visually. Accepted treatment conditions are to provide removals of dirt from PS a dense soil layers, corrosion, oil stains. Fig. 6 shows the fragments before and after the PS treatment.

3. Results

Research made on the influence of the characteristics of the work medium on the process of firmly adhering soil dirt. The working medium used:

1. Broken abrasive wheels;
2. Metal steel balls $d = 5\text{mm}$;
3. Porcelain balls $d = 12\text{mm}$;
4. The abrasive granules KCH40 (KЧ40) bonded polymer in the form of a cone 15×15 .

The PF used is a 10% solution of soda ash. Machining regime: $A = 2.5 \text{ mm}$, $f = 25 \text{ Hz}$. Results are given in Fig. 1 and Table 1.

Table 1

Number of working medium	Time to clean fully the ground t, min.	Average percentage of cleanness in 30min Q (%)	Surface condition after machining
1	120	25	Smooth, steel color
2	140	21	Smooth, steel color
3	300	10	Smooth, steel color
4	330	9	Smooth, steel color

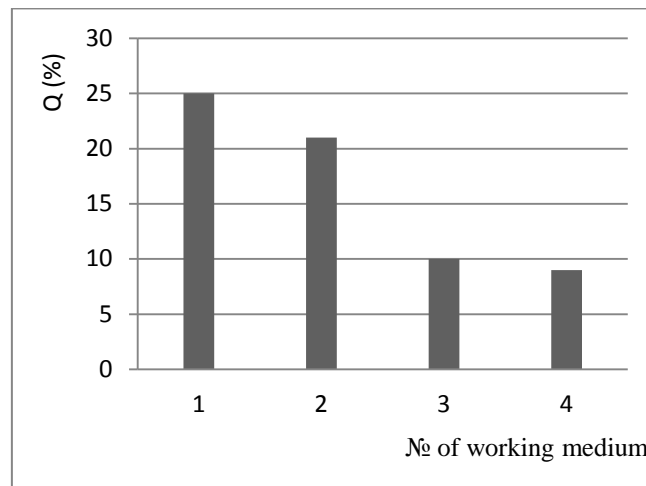


Figure 1: Effect of the characteristics of the work medium on samples cleaning process from the soil.

Taking into account the effect of chemical cleaning process experiment was performed in the following solutions:

1. Water + 5% of old paint removers (TU 00-00210051-96 6);

2. Water + 2% sodium hydroxide;
3. 10% solution of soda ash;
4. Running water.

The research results are shown in Figure 2 and Table 2.

Table 2

Number of solution	Time to clean fully the ground t, min.	Average percentage of cleanness in 30min Q (%)	Surface condition after machining
1	30	100	Smooth, steel color
2	40	75	Smooth, steel color
3	120	25	Smooth, steel color
4	120	25	Smooth, steel color

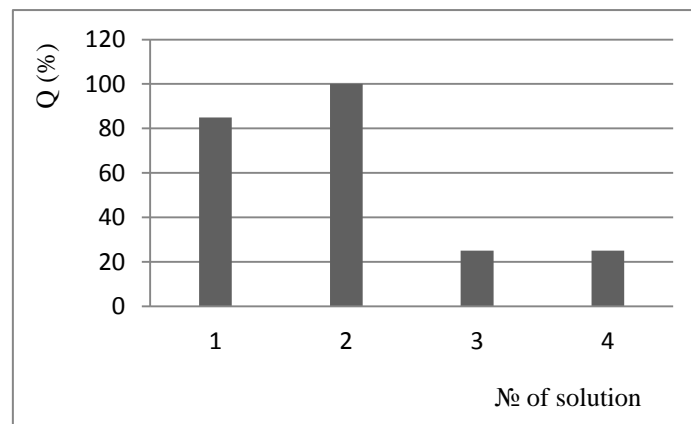


Figure 2: Effect of the characteristics of the PF on sample cleaning process from the surface

The process of cleaning scale from the surface

In view of significant impact characteristics of the work medium on the process of cleaning samples from scale experiments were performed in the following working mediums:

№ 1 - Abrasive pellets PT 15x15 (triangular prism) EB8ST1K;

№ 2 - Abrasive granules on the polymer-bonded, KCHM40 (R) cone 15x15;

№ 3 - Porcelain balls Ø12 mm;

№ 4 - Crushed grit "Baikal", grain 4-6; granules 15-20mm.

In all cases, the use of chemical etching solution with the following composition (g / l):

- Sulfuric acid 400 g / l;
- Hydrochloric Acid 250 g / l and
- Kata pin 3 g / l

Room temperature was taken for Solutions.

Steel ring 15 with SH-dense layer scale is taken as samples, weight 70g. Experiment results are shown in Figure 3. and Table 3.

Table 3

Number of working Medium	Time to clean fully the ground t, min.	Average metal removal (Q) within 15 min, g.	Surface condition after machining
1	15	0,21	Smooth, steel color
2	20	0,185	Smooth, steel color
3	20	0,18	Smooth, steel color
4	25	0,168	Smooth, steel color

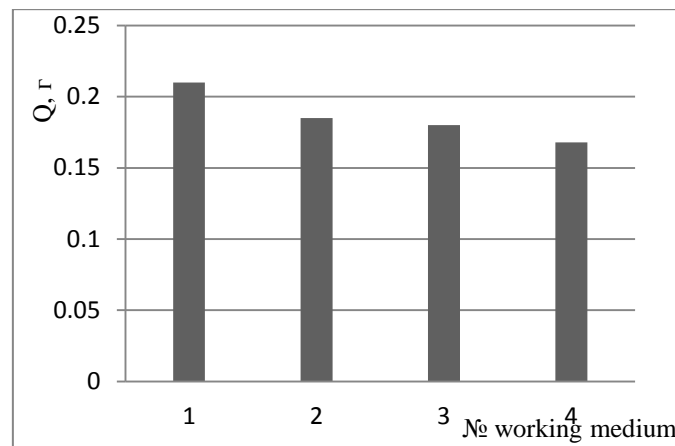


Figure 3: Effect of fluid characteristics on descaling process

Taking into account the substantial effect of chemicals on the surface cleaning process to remove scale after the heat treatment experiment were conducted on rings of rolling bearings in the following solutions:

1. Composition for pickling (g / l)

- Sulfuric acid 400 g / l
- Hydrochloric Acid 250 g / l
- Katapin 3 g / l

2. PF - 2-5% solution of soda ash;

3. Running water.

In all cases used the working medium - abrasive granules PT15h15. Room temperature was taken for Solutions. The samples from the ring rolling bearing steel ShKh15 with a dense layer of scale; weight 70g. Results of the fluid composition on descaling are presented in Figure 4 and table 4.

Table 4

Number of solution	Time to clean fully the ground t, min.	Average metal removal (Q) within 15 min, g.	Surface condition after machining
1	15	0,21	Smooth, steel color
2	35	0,12	Smooth, steel color
3	50	0,10	Smooth, steel color

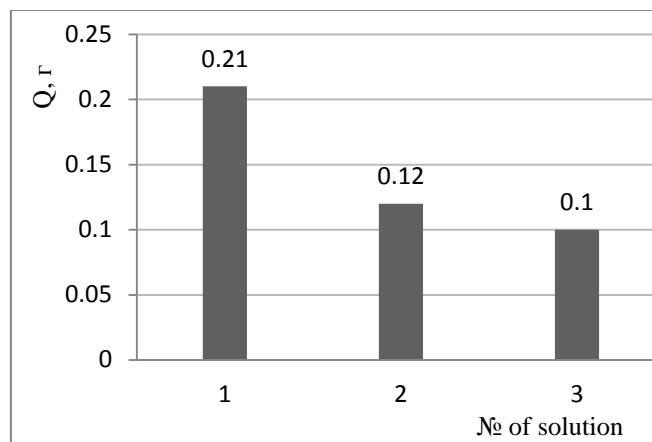


Figure 4: Effect of solution composition on the descaling process

Cleaning of samples in a corrosive environment (condition) was performed by abrasive granules bonded polymer in the form of a cone 15x15 mm (KЧ40) KCH40, continuously supplying PF of an aqueous solution of 2-5% soda ash. The results are shown in Figure 5 and table 5.

Table 5

Processing time, t min.	10	20	30	40	50	60
The degree of cleanness from corrosion, Q%	30	50	65	80	90	100

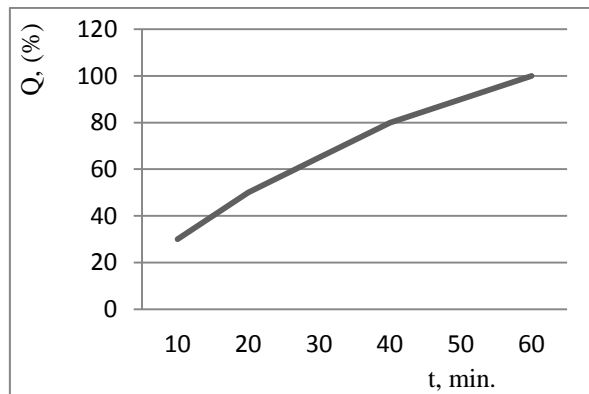


Figure 5: Effect of machining time on the cleaned surface from corrosion.



a) Before machining

b) After machining

Figure 6: PS fragments before and after machining

4. Result Analysis

Analysis results of table 1 and figure 1 shows that, the effective cleaning takes place in the medium of granules – broken abrasive wheels. These granules are characterized, by very good self-sharpening ability that provides intensive destruction and removal of soil.

Analysis results of table 2 and figure 2 shows that the most effective cleaning process from the soil takes place

in media alkali PF (caustic soda (2%) + water). This basic solution is characterized by a good capacity to destruct pollute contact surface between parts, and provides intensive removal of soil.

Analysis results of table 3 and figure 3 shows that, the most effective cleaning process takes place in a medium abrasive granules PT 15x15, made from corundum white vitrified. These granules are characterized by good self-sharpening ability that provides intensive removal of scaling.

Based on the analysis of the results essence cleaning is as follows: removal of scale from the treated surface is the result of complex effects of numerous micro particle strikes the working medium offering scarring (shear) and the grinding action and chemical substances introduced into the PF promoting chemical degradation of the film scale.

5. Conclusion and Recommendation

Identified conditions for the implementation of effective surface cleaning of propeller shaft from the operational and industrial contamination in the form of dense layers of soil, oil, corrosion; regimes and duration of operation, the characteristics of the tool medium (abrasive granules); the composition of the PF.

This study is subjected to some limitations, which can be further developed. During cleaning process the movement of samples, work medium PF in a vibration machine is random. Due to this, the effect of cleaning varies from operation to operation. The following are some of the main factors:

1. medium size, quality and type;
2. type of PF;
3. vibration machine chamber size;
4. the degree of operational and industrial contamination of sample and others.

Proposed technological scheme of modernization of the working chamber in view of the design features of the workpiece (size, shape, technology requirements). Equipment for processing PS recommended vibrating machine model VU350 with upgrading design (figure 7).

Proposed technical characteristics of the machine:

Number of chambers	1
The volume of the working chamber, dm ³350
oscillation amplitude, mm.	0 - 5
oscillation frequency in Hz	20; 25; 30.
maximum weight load, kg	1000

power kW 7

Dimensions:

Length, mm.....2150

Width, mm1800

Height,mm1500

Weight, kg 1800

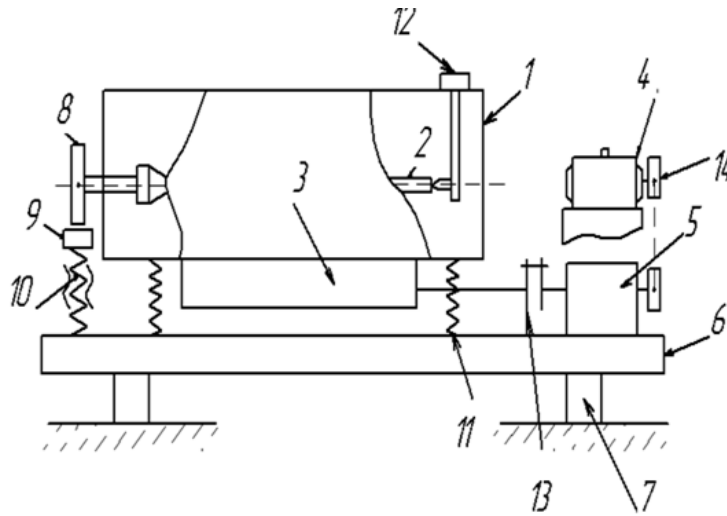


Figure 7: Technological modernization scheme of the working chamber.

1- housing of the working chamber; 2- The workpiece; 3 - vibrator; 4 - electric motor; 5 - intermediate support; 6 - base; 7 - shock; 8 - drum; 9 - adjustable block; 10 - adjustable support; 11 - spring; 12 - immovable support;

13- flexible coupling; 14- pulley.

Acknowledgment

This research is made possible through the support and guidance of our Scientific advisor A.P. Babichev Dr. of technical sciences, prof. of DSTU. We are thankful to our prof. for his expertise that greatly assisted us to produce this research. We have to express our appreciation to machine building technology experts for sharing their pearls of wisdom with us during the course of this research. We are also immensely grateful for their comments on earlier versions of the manuscript, although any errors are our own and should not tarnish the reputations of these esteemed professionals.

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