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ANALYSIS OF CONDITION CHANGES OF ROTOR COMPRESSORS CONTACT SURFACES.

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Abstract: *The rotors of screw type compressors are the most important details, which make influence on running efficiency. Scientists of engineering solve problems, which relates to the changes of mechanical properties of screw type compressors rotors surface and possibilities to increase lifetime of rotors without diminishing his efficiency in action.*
The main task of this work is analysis and solutions for these problems.
Changes on contact surface roughness and surface mechanical properties, which substantially make influence on lifetime of rotors, are explore in article.
The analysis of material microstructures shows change of structure in the various cross-section points of rotors. Influence of processing tracks on their structure of screw type compressors rotors are explored with the analysis of macro structure using the Heine reagent.
In conclusion gives recommendation on extension of the lifetime and influence results of various processing technologies on main material parameters of compressors rotors.
Keywords: Rotors, hardness, stability, structure, changes, surface

1. INTRODUCTION

By increasing of query, what extend industrial production volumes, many of companies more frequently use excelsior technologically fashionable, economic and the safe equipment. A very important catch not only in the engineering, but also in other developed production industries, in general, pay large attention on lifetime of the instruments, machines, tables of work, and also their complete parts, including rotors of screw type compressors.

A screw type compressor is one of the simplest mechanisms, which is useable for production of the compressed air. Screw compressor is rotary positive displacement machine, which is compact and have few moving parts, and it operate at high efficiency over a wide range of speeds and pressure differences [2]. Already long time scientists of engineering solve problems, which relates to the changes of mechanical properties of rotors surface of screw type compressors and possibilities to increase lifetime of rotors without diminishing his efficiency in action. The rotors of screw type compressors are the most important details, which makes influence on running efficiency [1]. During exploitation time, screw type compressors operate at various dynamic loadings, different moment of rotations, what increase wear out of rotors, change mechanical properties, what reduce compressor running efficiency and their lifetime also.

Using of various material verification types of rotors, for example, analysis of topography parameters of surface, analysis of macro and microstructure, analysis of mechanical property, gives to us ability to make analysis of

structures and mechanical properties of rotors and give recommendations for saving of compressor rotors running efficiency to all lifetime. The productivity and lifetime stability of compressor rotors is function, which depends from various parameters of the states of surfaces.
Mechanical properties (strength, hardness, plasticity, and roughness of surface) of materials substantially influences on lifetime of rotors.
Researches are executed for a one type of oil flooded screw type CE55RW compressor with the asymmetric profile rotors.

2. INFORMATION

2.1. Analysis of surface roughness

The change of surface roughness is one of the most important pointers of oil-flooded compressors, which makes influence on hermetic of axis in the pair apartment of screw, together with it also pointer of productivity and action.
Rotors of screw type compressors are manufactured accordingly to technical terms. The roughness of their surface must be in scopes Ra=0.32...0.63 μm, what provides effective and continued action of compressors.
During exploitation, various foreign particles reach surface of rotors contact (dusts of air, abrasives particles, product of wear), what in time create substantial damages of rotors, for example, wearing of contact surface, changes of roughness.
A megascopic crack between rotors substantially reduce compaction, air pressure, productivity and in generally running efficiency of compressor.
The parameters of topography of surface are measured with the Taylor Hobson 3D measuring device.
Surface roughness measuring of new rotor is shown in figure1.

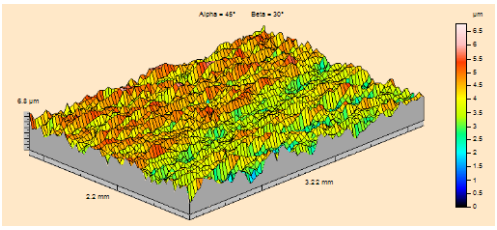


Fig .1. Surface roughness of new rotor

Parameters of surface Sa=0.738μm and parameters of profile Ra=0.409μm are conforms to primary technical requirements.
In time of exploitation, various foreign bodies what reach in space of rotors contact are creating substantial damages of surface contact (figure 2).
This wear not only increase crack sealing, but also in generally change geometry of surface, what reduce running efficiency of compressor.

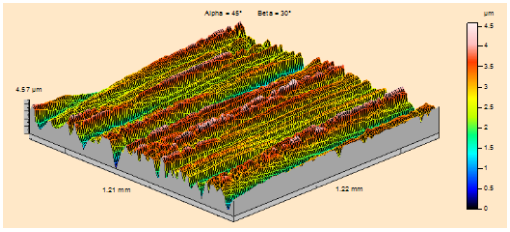


Fig.2. Surface roughness of worn out rotor

The purpose of research is to find out possibilities to decrease the wear of rotors and decrease particle of foreign bodies, exceptionally abrasive, penetrated in the working area and method as to improve wearing resistance of rotor surface. It would allow increase high efficiency running of compressor.
Results of analysis show laving tracks of abrasive particle, what change the parameters of surface roughness and reduce running efficiency of compressor.

2.2. Analysis of macro structure with Hein reagent

The research of macro structure on cross-section enables to define influence of manufacturing technology

on the material structure of screw type compressors rotors and their properties.

Wear endurance of rotor surface is stipulated by surface quality and structure of material and mechanical properties. Semi-finished manufacture production technology is playing large role. The semi-finished manufacture production of such details can extract with the various ways, for example, rolling and casting in forms with the next tooling.

Macro model is prepared to find out semi-finished manufacture of rotors production type. Macro model of rotor polished and subordinated to pickle with Hein reagent (35g $CuCl_2$, 53g $NH_4Cl + H_2O$). It allows research after macro structure of rotors in various cross-section points. Picture of macro structure (figure 3) shows, that refined pillar crystals are established on overhead layer, which are characteristic for the overhead layer of moulding surface.

Fig.3. Analyze of macro structure

Here liquid steel come into contact with cold material of form, quickly cools off and forms the fine-grained area of structure. Farther on middle, speed of metal cooling diminishes and dendrite form structure is developing what are characteristic of moulding steel [4]. The analysis of macro confirms that the semi-finished manufacture production of rotors obtained in casting way.

The greatest producers of screw type compressors semi-finished manufacture production of rotors obtain with casting technology. Using this technology, the losses of material diminish, that is why that we obtain the sizes of semi-finished manufacture, what is equivalently of manufacture detail size.

The structure of semi-finished manufacture were saved in the prepared rotor, what specifies, that exact form, dimensions and proper quality of surface is obtained by processing with cutting. Structure changes of moulding from part of core on an overhead layer, certainly, will change its hardness and other properties.

2.3. Analyze of microstructure

The materials microstructure of rotors is explored with a metallurgical microscope, using 100x/0.9 increases. Microscope from Meiji Techno IM 7000 Inverted metallurgical microscope series together with a digital photo camera, allows in direct way to obtain a microstructure of rotor material. The microstructure of steel is explored in various cross-section points.

In foundation the microstructure of rotors material consist of ferrite and eutectic grains. It mutual correlation is depends from maintenance of carbon in steel (figure 4).

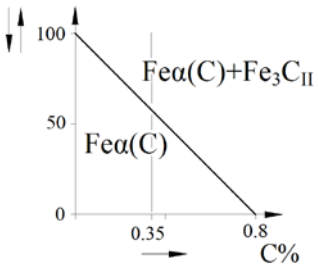
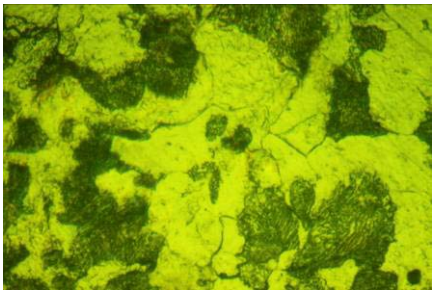
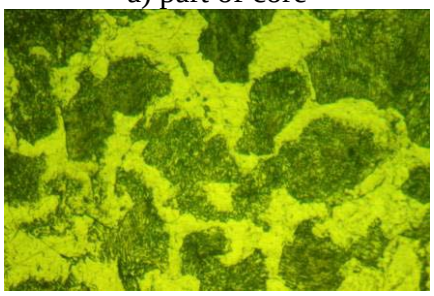


Fig.4. Correlation of ferrite and eutectic

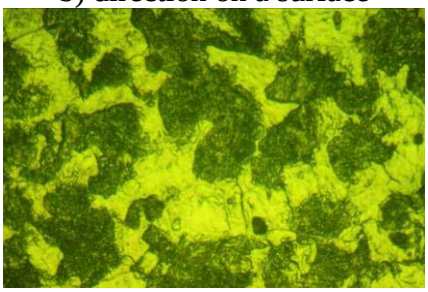
The analysis of microstructure shows, that structure in middle part of rotors consist from large grains of ferrite (figure 5 a), and some small grains of eutectic.
Such correlations of phase conform to chemical composition of steel of rotors. Coarse-grained ferrite structure does part of core more plastic and softer. More closely to overhead layer microstructure of steel stands fine-grained structure (figure 5 b,c), so as increase amount of fine-grained structure of eutectic. It together indicates on increasing of carbon substance, or chemical composition liquacion of moulding [3]. For material with more refined structure mechanical properties are higher than for a coarse-grained structure.



a) part of core



b) direction on a surface



c) to the surface

Fig.5. Microstructure of rotors 100x/0.9

However, the changes of microstructure are not so considerable from part of core on an overhead layer, what provide high resistance to wear of rotors.

2.4. Analyze of mechanical properties

Hardness measuring in various cross-section points was used for determination of mechanical properties of screw rotor. Hardness was measured by dynamic measuring device Equotip Piccolo.
Figure 6 shown results of measuring.

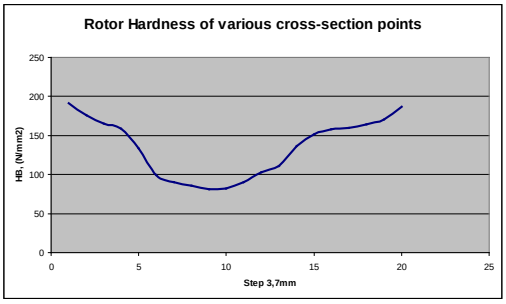


Fig.6. Change of rotor hardness

As we see, hardness of rotor increases in direction from part of core on an overhead layer. It corresponds to change of rotor microstructure in various cross-section points.
Hardness of overhead layer does not provide resistance to wear of rotor surface; therefore, it is necessary to multiply it. Part of core should stay viscous with less hardness, what provides actions of rotors during dynamic loads [3]. The analysis of mechanical properties in various cross-section points of rotors compels to search the new receptions of strengthening of overhead layer - new technologies.

3. CONCLUSION

By executing of all these verifications, we obtain information on semi-finished rotors production, on features

of structure and their changes, and changes of mechanical properties. Such mechanical properties do not provide necessary resistance to wear for these screw rotors. In the result of overhead layer analysis (figure 2) we see influencing of abrasives matters on the contact surface of rotors. Lifetime diminishes together with it. Foreign bodies, which reaches surface of rotors create most characteristic damages of contact surface. For increasing of rotors lifetime, it is necessary to increase resistance to wear of rotor surface. The resistance to wear could be increased by using of various modern technologies, for example, strengthening of rotors overhead layer with plastic deformation and hardening of overhead layer. It is not impossible to realize it even starting from complicated type of rotor and low carbon substance in steel. The contact surface of rotors could be subordinated by chemical heat treatment, what satiating it with a carbon and tempering it or satiating with nitrogen. Such technology considerably promotes resistance to wear, without changes of rotor form and size. Hardness change for steels of this group could not be changeable by using of heat treatment of overhead layer. By coating of various coatings arise abilities to multiply resistance to wear of rotors surface. Coating of rotor contact surface by various coatings increase resistance to wear and multiplies lifetime approximately up to 10%. We can use coatings as part of rotors repair technology also.

4. REFERENCES

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