

## **Experimental Research of Screw Compressors Vibration**

Vasilyev Andrey V.<sup>1</sup>

Samara State Technical University

Molodogvardeyskaya str., 244, Samara, Russia, 443100

### **ABSTRACT**

Negative results of industrial vibration impact are well known: industrial breakdown, staff vibration illness, decreasing of industrial equipment operating characteristics etc. One of the main sources of industrial vibration are compressor mounts. There are different kinds of compressors, and every compressor type has some peculiarities of vibration generation and diagnostics. Screw compressors are variety of rotor compressors type. The main diagnostics parameters of screw compressors are discussed. Experimental results of vibration characteristics research on the example of "AVTOVAZ" Public Joint Stock Company screw compressors are discussed. Vibration velocity levels were measured in the different points of bearing seats in three directions. The results of experimental measurements of vibration levels are discussed. Experimental data are submitted, including 1/12 vibration velocity spectra diagrams, table data for every measuring points etc. According to experimental results analysis the vibration state of compressors was estimated. The ways of vibration reduction including compressor mount and the elements are suggested.

**Keywords:** Vibration, Compressors, Research

**I-INCE Classification of Subject Number:** 46

### **1. INTRODUCTION**

Negative results of industrial vibration impact are well known: industrial breakdown, staff vibration illness, decreasing of industrial equipment operating characteristics etc. [3, 4]. One of the main sources of industrial vibration are compressor mounts. Vibration of compressors plants and of joining pipeline systems may cause significant damage both to the compressor mounts and the health of workers.

There are different kinds of compressors, and every compressor type has some peculiarities of vibration generation and diagnostics. Screw compressors are variety of rotor compressors type.

In order to investigate compressors vibration levels and to develop the technical solutions for reduction of screw compressors vibration it is necessary to determine the main diagnostics parameters of screw compressors and to carry out experimental characteristics compressors vibration.

This paper is devoted to experimental research and reduction of screw compressors vibration.

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<sup>1</sup>avassi62@mail.ru; vasilyev.av@samgtu.ru

## 2. DIAGNOSTICS AND EXPERIMENTAL RESEARCH OF SCREW COMPRESSORS VIBRATION

### 2.1 Approaches to Diagnostics of Vibration of Screw Compressors

Screw compressors are the variety of rotor compressors types in which volume variation is caused by rotor rotary movement. Comparing with compressors of other types (e.g. piston or centrifugal compressors), diagnostics of vibration of screw compressors is having some specifics. Typically screw compressor is having two rotors: main and female rotating with high velocity. Support and thrust bearings are typically using.

Results of screw compressor vibration diagnostic parameters are showing that the most important parameters are vibration levels on bearings seats, on electrical engine and on low and high pressure mounts. It is important to measure vibration in three axial directions. It is important also to measure vibration of pipelines abutting to compressor.

The number of points of measuring of vibration is selected in dependence from the kind of screw compressor, productivity of it operation, intensity of compressors exploitation etc.

### 2.2 Experimental Research of Screw Compressors Vibration

Experimental research of vibration characteristics was carried out in energetic production of "AVTOVAZ" Public Joint Stock Company.

Vibration velocity levels were measured in the different points of bearing seats in three directions: V – vertical, H – horizontal and A – axial direction.

The results of experimental measurements of vibration levels are discussed. Experimental data are submitted, including 1/12 vibration velocity spectra diagrams, table data for every measuring points etc. According to experimental results analysis the vibration state of compressors was estimated.

Measurements of vibration velocity root mean square values were done by using of integrating vibration meter 2513 of "Bruel & Kjaer" company (operational frequency range 10 – 10000 Hz). Scheme of points of measurements is shown in figure 1.

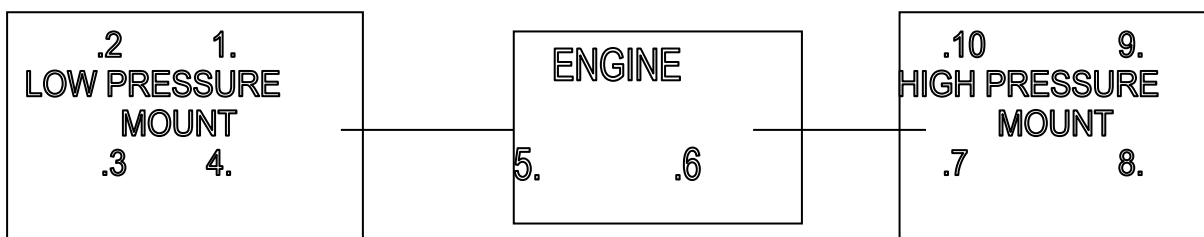


Figure 1 - Scheme of points of measurements of vibration levels of screw compressor N43 of energetic production of "AVTOVAZ" Public Joint Stock Company

Results of measurements of vibration levels (vibration velocity, mm/s) are shown in table 1.

Table 1. Results of measurements of vibration levels of screw compressor N43 of energetic production of "AVTOVAZ" Public Joint Stock Company (measuring parameter - vibration velocity, mm/s).

Axis/ Number of point	1	2	3	4	5	6	7	8	9	10
V	6,7	7,5	6,0	7,5	1,2	0,9	5,0	2,8	4,2	4,0
H	6,0	4,5	4,2	7,5	5,2	4,7	6,5	3,5	3,5	5,5
A	9,5	8,5	10,0	10,0	3,5	3,5	9,0	6,7	4,7	6,7

In figures 2-4 spectral levels of vibration velocity for different points of measurements are shown.

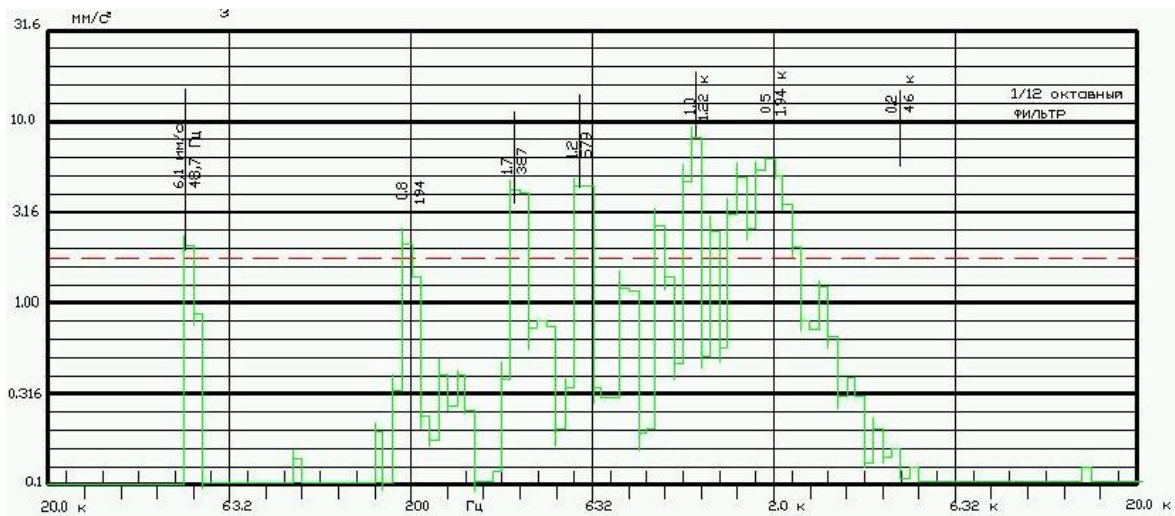


Figure 2. 1/12 octave spectrum of vibration velocity of screw compressor in point 1 (axial direction)

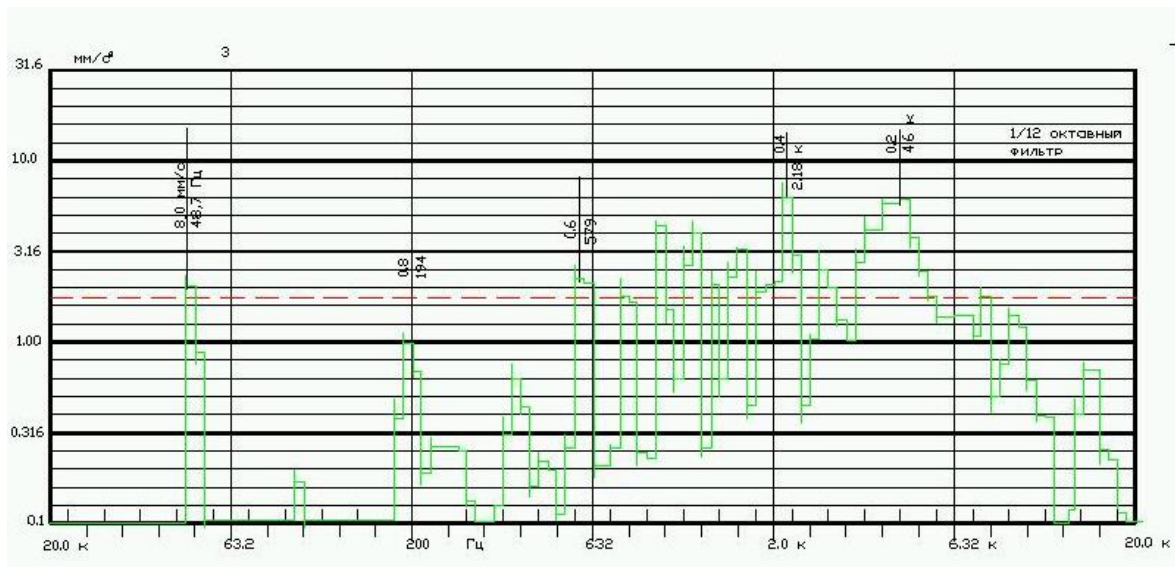


Figure 3. 1/12 octave spectrum of vibration velocity of screw compressor in point 3 (axial direction)

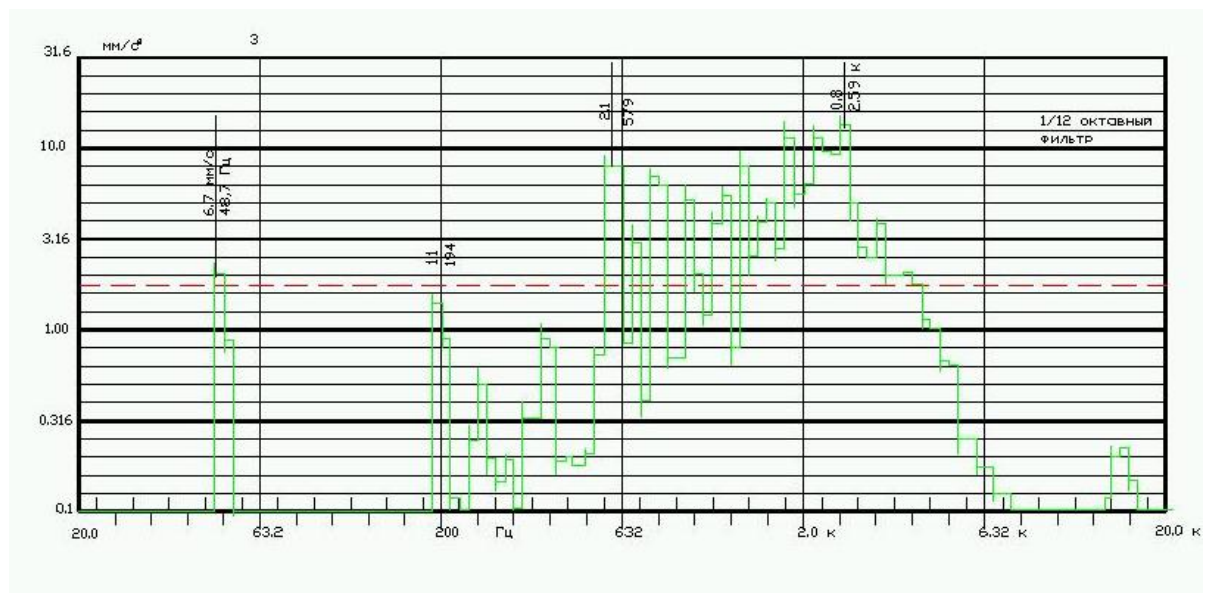


Figure 4. 1/12 octave spectrum of vibration velocity of screw compressor in point 7 (axial direction)

Analysis of measurements results is allowing to make the following conclusions:

1. Vibrational state of screw compressor according to ISO – 2372 standard for machines of G group is corresponding to the quality estimation:

- a) Low pressure mount – Admissible level (from 4,5 up to 11,2 mm/s);
- b) High pressure mount – Admissible level;
- c) Electrical engine - Admissible level.

2. In all points of measurements in vibration spectra maximal values are having components with frequency of driver rotation  $f = 48,7 \text{ Hz}$  and  $f = 49,6 \text{ Hz}$ . This confirms that there is misalignment of junction “low pressure mount – electrical engine” and insignificant misalignment of junction “high pressure mount – electrical engine”.

3. Significant level are having the vibration components with frequency 194 Hz and 198,2 Hz. Vibration on these frequencies is caused by air pulsation in проточной части компрессора:

$$fp = Ns * fr , \quad (1)$$

where  $fp$  – frequency of pulsations;  
 $Ns$  - number of rotor screws;  
 $fr$  – frequency of rotation.

4. Vibration levels according to pp. 2 and 3 may be simplified due insignificant rigidity of foundation (cracks are occurring) and attenuation of connection mount – foundation.

5. Components with frequencies of gearing (wear of gear pare), electrical engine rod defect, shaft imbalance, roller bearings defets are having insignificant levels.

### 3. THE WAYS OF SCREW COMPRESSORS VIBRATION REDUCTION

Vibration of screw compressors may be reduced by complex of measures. The most often used are vibration isolation (including vibration isolating mounts) and vibration damping.

Number of technical solutions for vibration reduction of compressor plants and of joining mechanical systems was developed by author [1, 2, 4-7 etc.]. Let us consider some of them. Constructions of vibration dampers have been developed using hydraulic resistance occurring e.g. during punching of working fluid through the small calibrated holes. Such constructions allow change the coefficients of resistance in wide range. Using of silicon oil as working fluid provides stability of the coefficients in wide temperature diapason of exploitation. Vibration damper may be performed as hermetically closed cylinder filled in by working fluid, in which may occurs vibration displacement of inertial mass made in form of piston and connected with cylinder by system of springs. In order to exclude influence of temperature deformations working fluid should have some excess pressure which is occurring during assembly and supporting by the elastic deformation of the cylinder.

For screw compressors during repairing it is necessary to make more thoroughly centering the unit, tightness of fastening bolts of compressor housing, to select a number and dimensions of alignment pads, to carry out a setting of axial run of rotors of compressor.

#### **4. CONCLUSIONS**

The main diagnostics parameters of screw compressors were discussed. Results of screw compressor vibration diagnostic parameters are showing that the most important parameters are vibration levels on bearings seats, on electrical engine and on low and high pressure mounts.

Experimental results of vibration characteristics research on the example of "AVTOVAZ" Public Joint Stock Company screw compressors are discussed. Vibration velocity levels were measured in the different points of bearing seats in three directions. The results of experimental measurements of vibration levels are discussed. Experimental data are submitted, including 1/12 vibration velocity spectra diagrams, table data for every measuring points etc. According to experimental results analysis the vibration state of compressors was estimated.

The ways of vibration reduction including compressor mount and the elements are suggested. For screw compressors during repairing it is necessary to make more thoroughly centering the unit, tightness of fastening bolts of compressor housing, to select a number and dimensions of alignment pads, to carry out a setting of axial run of rotors of compressor.

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#### **6. REFERENCES**

1. Abram I. Gleyzer, Andrey V. Vasilyev, Andrey I. Bahtemirov. *Vibration Mount*. Patent of Russian Federation for Invention No 2466313, publ. in Bull. No 31, 2012.

2. Abram I. Gleyzer, Andrey V. Vasilyev, Andrey I. Bahtemirov. *Dynamic Vibration Damper*. Patent of Russian Federation for Invention No 2468238, publ. in Bull. No 33, 2012.
3. Nicolay I. Ivanov and Aleksey S. Nikiforov, "*Foundations of Vibration and Acoustics*", book, Polytechnika, St.-Petersburg, (2000)
4. Andrey V. Vasilyev, "*Reduction of Low Frequency Noise and Vibration in Gas Guides of Power Plants*", book, Edition of Samara Scientific Center of Russian Academy of Science, Samara (2004)
5. Andrey V. Vasilyev, "*Modeling and Reduction of Low Frequency Noise and Vibration of Power Plants and Joining Mechanical Systems*", book, Edition of Samara Scientific Center of Russian Academy of Science, Samara (2011)
6. Andrey V. Vasilyev, "*Development and approbation of methods and technical solutions of reduction of vibration of power plants and joining mechanical systems*", Procedia Engineering. Vol. 106. pp. 354-362 (2015)
7. Andrey V. Vasilyev, "*Reduction of Low-Frequency Noise and Vibration of Power and Energetic Plants*", Scientific Edition "The Bulletin of Samara Scientific Center of Russian Academy of Sciences", volume 5, No 2, July – December 2003, pp. 419-430 (2003).