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About the experience in operation of reciprocating compressors under control of the vibration monitoring system

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Abstract

The article presents the results of reciprocating compressors operation under the control of Vibration-Based Diagnostics monitoring systems, dwells upon the issues of usage of reciprocating compressors valves by various vendors and their influence on compressors' vibroactivity. An adequate evaluation of vibroactivity of piston machines is provided by the Russian regulative database on vibration parameters.

Main differences of Russian and global methods of reciprocating compressors health evaluation, particularly, used frequency range, are presented in the article. It is shown that the approach laid in Russian standards on reciprocating compressors vibration regulations, ensures true-to-life assessment of reciprocating compressors assemblies and details condition.

The examples given in the article confirm that the criteria of reciprocating compressors repair correctness assessment should be the machinery health, including its vibroactivity, not just mindless usage of new components purchased from the global brands.

Practical examples of operation and monitoring of reciprocating compressors show that Russian developments and products, particularly, scientific-methodological and standards base of Vibration-Based Diagnostics monitoring, reciprocating compressors monitoring systems, reciprocating compressors valves are highly competitive with foreign ones, and sometimes even superior to them in parameters and characteristics, which is a positive factor under the conditions of current economic situation and import substitution policy.

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Keywords: reciprocating compressors, valve, vibration, monitoring, diagnostics, condition

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1. Introduction

Safe resource-saving operation of hazardous production machinery, particularly reciprocating compressors, is impossible without their health monitoring in real time. The main parameter that helps to adequately and accurately evaluate the state of machinery structural parameters is vibration [1, 2, 3]. Until recently, the procedure of reciprocating compressors health evaluation according to vibration parameters was a challenge, since neither Russia nor other countries had necessary regulatory and procedural base. ISO 10816-5:1995, the recently enacted ISO 10816-8:2014 and API 618 did not and still has not ensured true-to-life evaluation of piston machines health [4]. And only when GOST R 56233-2014 [5] was adopted there appeared vibration standards in Russia allowing not only to conduct a reliable and adequate control of reciprocating compressors vibration, but to monitor piston machines health. Since 2011 the industry standard [6] was being used in Russia. This standard is a prototype of the national standard [5]. The standards contain the values of the specified vibration parameters and methods of reciprocating compressors health evaluation according to vibration parameters. All these data are the result of more than 20-years' experience in Vibration-Based Diagnostics monitoring of dozens of reciprocating machines [1, 7].

The object of this article is to present statistics for faults of assemblies and details of reciprocating compressors, and analyze vibroactivity of reciprocating compressor valves, as one of the most often failed components.

2. Estimation of statistics for faults of reciprocating compressors assemblies and details

The implementation of reciprocating compressor monitoring systems and the selection of assemblies for health monitoring are based on the statistics of assemblies and details faults. The survey of consumers and manufacturers of reciprocating compressors from the USA, Canada, UK, France, Belgium, Norway, Kuwait, Singapore, China and UAE revealed the components that most frequently cause reciprocating compressor shutdowns [8].

The results of the survey [8] showed that five systems and components of compressors cause about 76.5% of all unplanned compressors shutdowns. Faults of valves make up 36%, and the cost of their repair is 50% of the total repair costs.

Analysis of distribution of reciprocating compressors failure causes [8, 9, 10] shows that one of the main reasons for compressors failures, and in the first place valves, is overload that occurs due to changes of physicochemical state of gas during compression. This fact is easy to exemplify by the compressors squeezing hydrogenous gas.

According to sources [9, 10, 11] failures of valves (mainly plates) cause up to 70-90% of shutdowns of mine and factory compressors. Valve faults in compressors of 5G-100/8, 4M10-100/8 types can make up to 50% of the total repaired assemblies [11].

The data regarding reciprocating compressors repair and data of compressors monitoring systems were analyzed by statistical mathematics. The data were provided by one of the Russian oil refineries. The analysis results are presented in Table 1 [9, 10].

The results here show that the statistics of valves and seals failures obtained at one of the Russian oil refineries [9, 10] agree with research data of [8]. However, piston-cylinder units cause a significant percentage (over 30%) of all faults, where the ring failures are more than 25% (according to [8] they are 14%). Failures in the slide-crank mechanism (SCM) and cranking mechanism (CM) are very significant as well.

Table 1. Reciprocating compressors shutdowns caused by different components.

Assemblies and repair causes	Percent, %	
	Russian oil refinery [9, 10]	Source [8]
Repair and replacement of valves	36.4	36
Repair and replacement of piston-cylinder units, including:	17.5.	
packing	25.8	17.8
rings	5.0	13.9
others		…