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Quality Management in Bearing Manufacturing

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***Abstract* — The issue of quality, reliability and safety of finished bearings is considered. The basis of the quality management system is the process approach; the monitoring program is considered as an example.**

Keywords — quality, process approach, reliability, technological procedure monitoring and bearing components' manufacturing.

I. INTRODUCTION

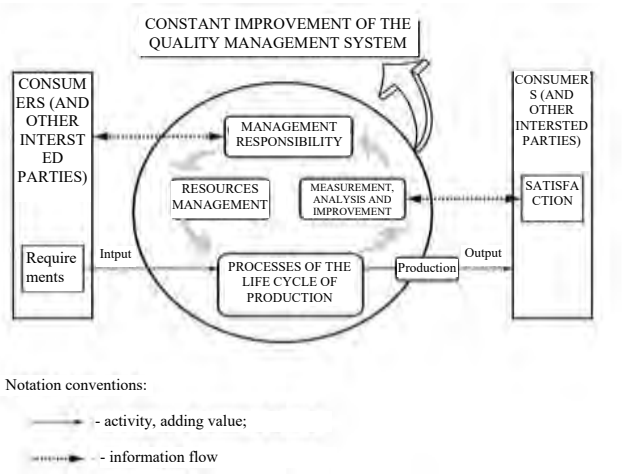
For more than 15 years, national Russian standards have been equivalent to international standards, the industry has tried to adapt to a new management philosophy, but has not received the expected results. Scientists and production workers have risen fundamental questions: do we understand how to manage quality, who should do it, at what stages and by what parameters to control the processes? We came to the "paper" quality of products through high costs and red tape on the construction and documentation of the quality management system (QMS), but in fact we still control only certain ongoing processes of finished products.

"The quality of an organization's products and services is determined by its ability to satisfy consumers and to intentionally or unintentionally influence relevant stakeholders.

The quality of products and services includes not only the performance of functions in accordance with the purpose and their characteristics, but also perceived value and benefits to the consumer. "

Indeed, the above term does not contain any precise controlled parameters. However, GOST R ISO 9001-2015 "Quality Management Systems. Requirements" describes in detail the system of management building of this generalized category.

According to the GOST mentioned above, the basis of the system is the process approach shown in the figure (Fig. 1). It is assumed that results are achieved more quickly, efficiently, when all activities occur as a coordinated process, which operates the system, provides the definition of system tasks; establishes authority, responsibility and accountability; risk management; performance auditing of the QMS.



The term "quality management" should include:

1. policy development;

2. purpose;

3. process management:

- planning;

- management;

- quality assurance;

- improvements.

Modern enterprises very often focus their attention on only one component of quality management - quality assurance. At this stage, it is advisable to refer to the program of monitoring the bearing production process.

Technological process is a part of the process, which includes actions to change and define indicators, parameters of the subject. Let us consider a model of a process monitoring system in an enterprise of the bearing industry (Fig.2).

To ensure high quality products in modern enterprises, a quality management system (QMS) is being widely implemented, which contributes to the competitiveness of products in market conditions. An important element of the QMS is the system of technological process monitoring (STPM), which monitors manufacturing equipment and parts, processes data on the parameters of monitored objects and makes decisions on adjusting the process or maintaining machines while reducing the quality of parts [1, 2]. The above fully applies to enterprises manufacturing bearings for aviation, railway and automobile transport, etc.

In the manufacture of bearing components, the most important operation is grinding, which fully determines the quality of the rings raceways' surface layer. As a result of temperature and vibration effects during grinding, a number of defects arise in the surface layer due to structural and physico-mechanical characteristics (burns, cracks, etc.), which drastically reduces the reliability of bearings in operation [3].

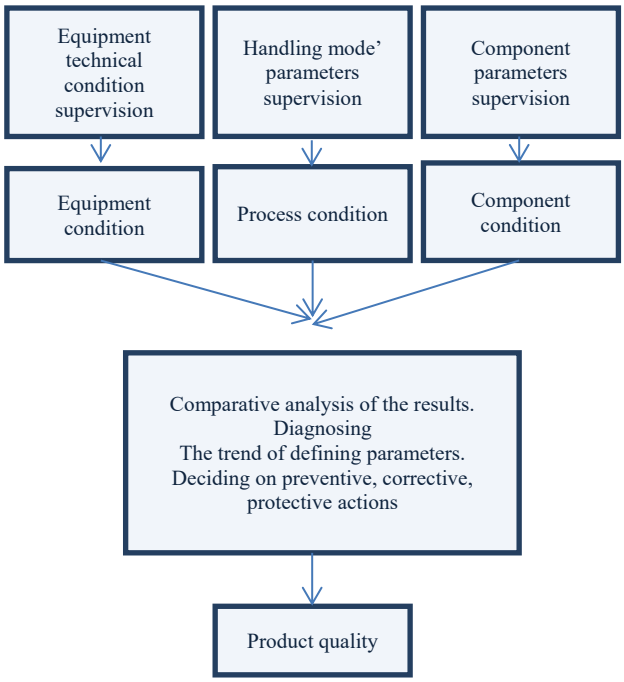


Fig. 2. Part Process Monitoring

One of the most effective methods of quality control of the surface layer of bearing rings is the eddy current method [4], widely used in EPK-Saratov JSC.

Automated devices eddy current testing PVK-K2M are included in the enterprise STPM, which allows controlling bearing's components (rings, rollers) of various types. Information about the components quality goes to the monitoring laboratory (Fig. 3), where it is processed using modern means, for example, the TRACE MODE 6 SCADA system.

Fig. 3 The monitoring laboratory

The inspection results in the STPM are used to control the technological process and equipment, especially in pre-grinding operations. An incorrectly selected grinding mode or increased vibrations in the machine due to defects in the bearing

assemblies leads to change in the structure of the surface layer to a depth that, during the final grinding, the geometrical precise characteristics of the raceway will correspond to the norm and physical and mathematical characteristics will remain the same [4].

During the operation of the diagnostic program, it is important to determine the residual heterogeneity of the surface layer, formed under the vibration in accordance with cutting conditions and other processing conditions. To determine the defects, a special software and mathematical software has been created. The coefficients serve as a quantitative estimate of the periodic heterogeneity. The definition of local defects is carried out on the basis of the defect' depiction definition by geometric characteristics, or by the coefficients of the wavelet transformation.

Initial processing of control results is performed on the computer of the monitoring laboratory. Next, the decision maker (DM), taking into account the data on the dynamic characteristics of the machine, makes a decision about the need to adjust the TP: about the sub-adjustment of the machine, about replacing the tool, about changing the technological mode, etc. The adoption of such decisions has not been formalized yet and, therefore, is not amenable to automation.

The obtained information on the quality of parts is accumulated and updated in the STPM database and is provided to users at various levels.

The use of the Trace Mode SCADA-system in the program "Monitoring of the technological process and production of bearing components" will significantly improve the quality of bearings and improve the efficiency of the entire production.

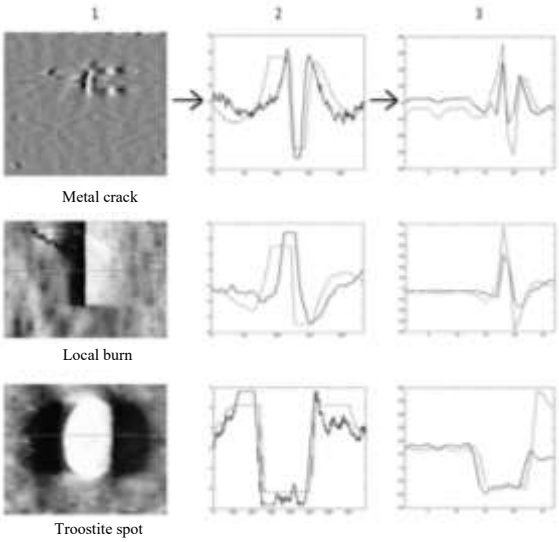


Fig. 4. Scans of defects, their localization in the signal (2) and approximation of the selected signal, from which the classification features are extracted (3), where the y-axis represents the amplitude in relative units of wavelets, and the x-axis shows the time interval in conventional units.

The algorithm of the program for diagnosing and making decisions on the quality of the bearing ring surface using Trace Mode consists in determining the amplitude and phase parameters (reading from the vortex sensor), determining the standard deviation with a running window, finding the max. and min. values of the standard deviation of the ring ((if max. / min.> = 3, then a defect exists and it is localized over the window with the max. value). Next, the standard deviation is calculated from the phase characteristic, but only the selected window with the max. amplitude counts. Then a set of wavelet coefficients is formed and compared to the coefficients of the wavelets from the reference book. Then, the defect of the ring is identified [6].

Bearing defects such as burns, cracks and a number of others are reflected in the results of scanning rolling surfaces; each type of defect gives its own unique "mark" on the image obtained using the eddy current testing device PVK-K2M image (Fig. 4).

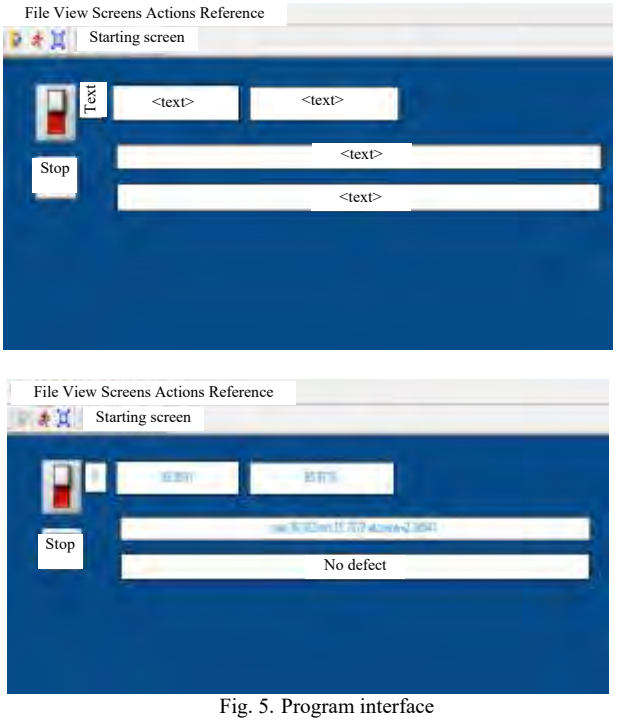


Fig. 5. Program interface

As control parameters, vibration, temperature, geometrical characteristics of the component, feed rate of the tool, condition of the cutting tool, and reliability are used. It is at the level of industry standards and enterprise standards for products and processes that specific technical parameters are formed, which ensure product quality in all technological processes of production [8].

It is important to understand that as part of the development of the QMS, the enterprise independently selects the standards of the lower levels, uses them and develops its own relevant technical documentation with specific control and regulation parameters so that the complex of these documents does not contradict the principles of GOST R ISO 9001-2015.

However, ensuring the quality of technological process control alone is not enough to form the concept of quality in general. A common situation is when fully automated and standardized production processes are hampered by the actions of the personnel servicing the equipment, ensuring the delivery

of the tool, forming the production program and working with customers.

In publications on quality management, one can find a reference to the fact that "a process can be managed only with a strictly unambiguous goal, a measure of quantitative measurement of this goal and covered by feedback in real time. Only the level of a separate technological operation can be managed like this on the production site, in which its performer is at the same time the most qualified inspector, and the executor of the controller's instructions. Strictly speaking, even the installation of a separate controller after each completed operation no longer allows managing the process, because after the end of the technological process it is no longer possible to manage it. " Such position contradicts with the essence of the process management of product quality, because one process ends, another begins. However, it may appear in actual production practice. The predecessor of a fully controlled technological operation can be a weakly controlled business process. It is common for a manufacturer to place untrained or low-skilled personnel on technically complex operations; to consciously neglect the means of automated defect control in order to speed up the execution of rush orders; to ignore the requirements of the buyer to the parameters of the product specified in the contract; to use inappropriate material technology; to eliminate the inconsistencies of components during assembly by selective methods.

II. Conclusion

Improving product quality should be coordinated. It covers all stages of the life cycle, all production processes. The problem of modern Russian enterprises is that the perception of quality begins and ends only in the process of testing the finished product. Comprehensive quality management and its confirmation is possible only through the implementation of international and Russian standards and their rigorous execution.

Ensuring the quality, reliability and safety of finished products should be an integral part of the industrial quality management policy.

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