METHODS OF DIAGNOSTICS OF METAL-CUTTING MACHINES

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Abstract:
This article discusses the methods of control and diagnostics of metal-cutting machines. Intelligent measuring transducer, sensors and executive components in the form of microchips. The article presents the theory of vibroacoustic diagnostics of metal-cutting machines.

Keywords: Technical diagnostics, vibroacoustic diagnostics, diagnostics, quality, metal-cutting machines, equipment, cutter, tool, control, sensor, cutting tool.

Introduction

According to the scope of application, the methods of technical diagnostics are classified as used during the periods of commissioning, operation, preparation and scheduled repairs and maintenance of equipment.

According to the degree of application of technical means (instrumentation and instruments), diagnostic methods are classified as performed without technical means or using the simplest means to amplify the signal (subjective) and using technical means (objective). Technical means can be connected specifically for diagnostics, automatically operating, built into the equipment or connected to it via communication channels.

According to the depth of diagnostics of the technical system (machine, automatic line), the methods of technical diagnostics are divided into general and piecemeal (in-depth).

According to the volume of information, there are methods of technical diagnostics that provide information about the moment, place and cause of failure when using automatic technical diagnostic tools, and in other cases, information about the place and cause of failure.

According to the types of diagnostic information, there are methods that reveal information about the process itself, violations of which need to be determined, or about indirect indicators associated with the passage of the process.

To obtain diagnostic information, measurements are made of the values of vibrations, acoustic vibrations, constant and variable deformations and forces, processing parameters (productivity, cutting modes, duration of processing cycles, tool heating temperature, etc.), the state of the contacting media, flaw detection, etc.

According to the construction of the process of diagnosing metal-cutting machines and automatic lines, there are piecemeal, group checks, logical analysis of failure symptoms.

According to the principle of diagnostics, all means are divided into:

1. To check the functioning of the equipment. The performance of the machine cycle is evaluated, which is typical for automatic equipment.
2. To assess the accuracy of the parameters of the processed products or the accuracy standards of the equipment.

According to the degree of automation of technical diagnostic tools, they are divided into manual, semi-automatic and automatic.

According to the nature of the tasks to be solved , the means of technical diagnostics of equipment are divided into:

1. To check the serviceability. The full compliance of the equipment with the technical conditions is checked. This check is carried out, for example, during the acceptance of new equipment into commercial operation.
2. To check the operability. The ability of the equipment to perform a working algorithm of functioning is checked. During this check, undetected malfunctions may remain that do not interfere with the operation of the machine under normal conditions. For example, on grinding machines, this is the control of the minimum allowable value of the diameter of the grinding wheel.
3. To check the correct functioning in the working cycle. For example, on an automatic machine, before starting a shift, the working cycle and the operability of the most frequently operating locks are checked.

Thus, if the machine is serviceable, it is always operable and functions correctly. If the machine is in a faulty condition, then a failure has occurred — an event consisting in a violation of its operability.

In relation to the tasks of technical diagnostics , failures are classified:

1. By external manifestation (hidden and explicit). Hidden is a failure, the external manifestations of which may depend on several reasons. The obvious ones include failures of elements that can be detected visually.
2. By function and parameter. In case of malfunctions, the operation of the machine or automatic line becomes impossible. If the parameter fails, the dimensions of the processed part go beyond the tolerances or the cycle time exceeds the permissible, but the operation of the equipment can continue.
3. By relationship (independent and dependent). Independent refusals occur for any reason other than the action of another refusal. Dependent (secondary) failures are caused by the action of the primary failure.

Thermometry method .Thermometry can be used as a diagnostic method — measuring the temperature of machine parts and assembly units. With the help of thermometry, it is possible to determine: the deformation of machine assembly units caused by uneven heating of its individual parts; the condition of bearing assembly units, lubrication systems, brakes and clutch couplings.

In the course of technical diagnostics, the following are carried out:

- control of the technical condition;
- finding a place and determining the causes of failure (malfunction);
- forecasting the technical condition.

In this regard, the use of technical diagnostic methods is aimed at timely detection of malfunctions and defects.

The structure of technical diagnostics is given below (Fig. 1).

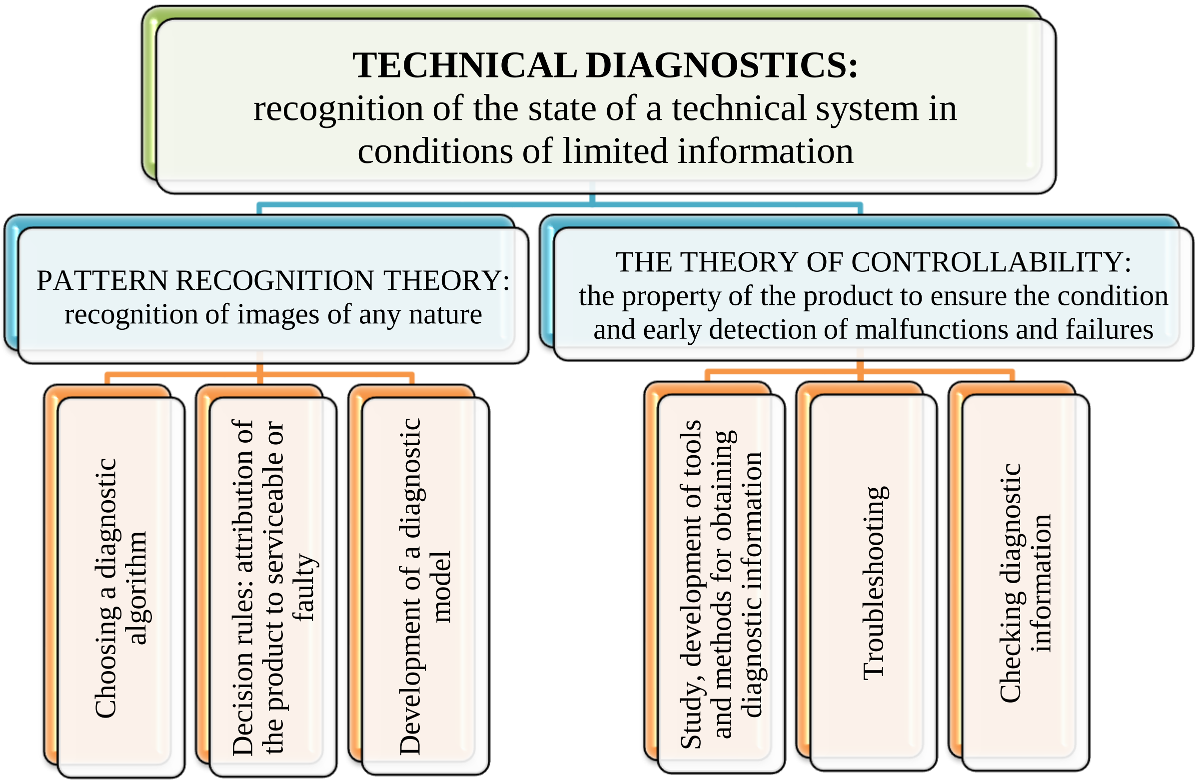

Fig. 1. Structure of technical diagnostics

The colorimetric method is based on determining the concentration of the element of interest in oil by comparing the color of the test solution with the color of the standard one, in which the concentration of this element is known.

The polarographic method is based on measuring the relationship between current and voltage by means of a drop mercury electrode immersed in the test solution. The name of the method is associated with the polarization processes that occur when an electric current is passed through electrolyte solutions. For this purpose, devices called polarographs are used.

The polarographic method allows to determine the concentration of iron up to 10-5 g in 1 g of oil.

The magnetic inductive method takes into account the dependence of magnetic induction on the content of wear products in the oil sample injected into the inductor and causing a change in the magnitude of the current flowing through the coil. This method is suitable for determining the iron content in oil. It is used at very high concentrations of iron in oil. The readings of the device are indicative.

The radioactivation method is based on the fact that the oil sample is irradiated with a neutron flux, as a result of which the wear products become radioactive.

A common disadvantage of these methods for determining the content of wear products in oils is the difficulty of identifying the intensity of wear of individual interfaces, since the results of the analysis in most cases are integral.

The spectrographic method is based on determining the content of wear products in an oil sample by decomposing their radiation, occurring under the action of a voltaic arc, into separate spectra. The results of the analysis are obtained by photographing spectra with subsequent decoding of spectrograms or using calculating devices.

The spectrographic method lacks the disadvantages inherent in the methods listed above for determining the content of wear products in working oils. It allows you to determine the content of any elements used in mechanical engineering in oils.

Method of vibroacoustic diagnostics. Vibroacoustic diagnostics refers to promising methods for assessing the technical condition of technological equipment. The vibration processes occurring in the operating equipment are highly informative and sufficiently fully reflect its technical condition. Vibroacoustic diagnostics uses various characteristics of oscillatory processes as diagnostic signals: mechanical vibrations, acoustic vibrations in elastic media, dynamic deformations, etc.

Vibration signals have a wide frequency range and react quickly, almost instantly, to changes in the technical condition of individual assembly units or the entire machine as a whole. They are relatively easy to convert into electrical signals, which makes it possible to automate the diagnostic process.

When the machine is running, each kinematic pair generates only its inherent pulse signal, which appears in a certain sequence, depending on the order of operation of the mechanism. The strength of the excited pulse signals depends on the size of the gaps in the colliding parts of the mechanism.

To diagnose a kinematic pair, it is necessary to isolate the pulse signal inherent only to it from the resulting one, evaluate the received signal in comparison with the reference one, i.e. give its quantitative assessment.

Vibration excited by gearboxes and gears is associated with kinematic, impulses, parametric excitations, as well as unbalance of rotating masses, which is due to manufacturing errors. Pulse excitation is observed when the teeth of the wheels interact at the entrance to the engagement. Parametric excitation is caused by the variable stiffness of the meshes. Pulsed and kinematic excitation causes vibration, which is determined by the frequency of engagement of the teeth.

In addition, vibrations can be excited with the frequency of natural vibrations of the wheels and due to the unbalance of the rotating parts.

The vibration excited by rolling bearings is a consequence of geometric errors, gaps and variable compliance of the elements.

In real conditions, all vibrations are realized together and form a cumulative effect, which is a disadvantage of this method.

The figure shows fragments of an oscillogram of the amplitude-frequency spectrum of vibrations of a gear pump with support bearings.

It follows from the analysis of the oscillogram that the main components of the vibration spectrum of a serviceable pump are the harmonics of the gear teeth overvoltage frequencies. The occurrence of a defect on the tracks of the support bearing leads to the appearance of reverse harmonics and an increase in their amplitudes.

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Piezoelectric vibration acceleration sensors are usually used for diagnosis. (Acoustic diagnostics is based on the fact that well-defined acoustic signals correspond to each state of the system. The choice of acoustic signals as a source of information about the condition of the equipment is due to a number of reasons: they are a reflection of the most significant physical processes taking place inside the equipment; noise as a data carrier has a large capacity; noise registration allows for quick measurements in production conditions.

Acoustic diagnostics can be used in hydraulic drives to determine the leakage of working fluid, the operability of hydraulic pumps, hydraulic amplifiers and other elements. So, according to the noise level, the flow of liquid through the gaps is determined, i.e. leaks associated with leakage. The noise level is measured using an ultrasonic leak detector consisting of an ultrasonic probe and an indicator.

The main advantages of vibroacoustic methods diagnostics:

- a wide range of vibroacoustic diagnostic tools on the market;
- easy installation of sensors on the machine;
- high sensitivity of vibroacoustic methods
- diagnostics that allows you to identify incipient defects;
- possibility of stationary installation of sensors for monitoring the condition of the most important machine components;
- the ability to solve additional tasks that arise in specific circumstances (for example, adaptation of processing modes to the variable situation in the cutting zone, control of wear and breakage of the cutting tool during cutting).

Figure 2 shows an example of installing vibration sensors, called accelerometers, on a milling machine. Figure 2 (accelerometer on the cutter) shows a lathe where a vibration sensor is mounted on the tool assembly in order to control the cutting process. Here is a three-component vibration sensor that stands on a cutting tool to remove the movement of the tip of the cutter in three-dimensional space, and an example of a signal that is removed in three directions.

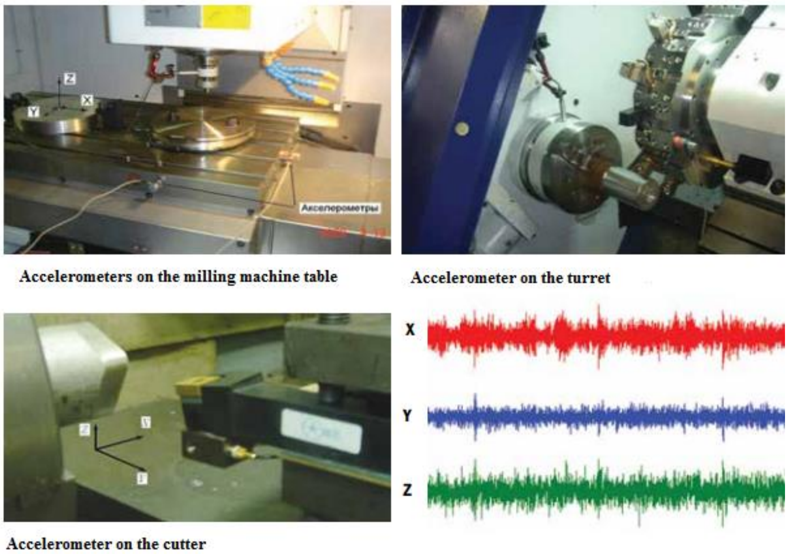

Fig. 2. Installation of sensors on diagnostic machines

A computerized system of vibroacoustic studies and monitoring of the dynamic quality of metal-cutting machines and technological equipment has been developed, which makes it possible to identify defects and assess the dynamic quality of equipment components based on data on vibrations at idle and during the technological operation.

A variant of constructing a system of vibroacoustic diagnostics and monitoring of the technical condition of metal-cutting machines is proposed, which provides obtaining a matrix of current values of diagnostic signs of the technical condition of machine components, which allows performing a regression analysis of the development of defects. For newly manufactured equipment, the initial dynamic quality is evaluated using the system.

References:

1. Diagnostics of the technological system: textbook/ comp.: A.N.Gavrilin, B.B.Moises. Tomsk Polytechnic University. - Tomsk: Tomsk Polytechnic University Publishing House, 2016 - 144 p.
2. Nomanjonov, S., Rustamov, M., Sh, R., & Akramov, M. (2019). STAMP DESIGN. *Экономика и социум*, (12 (67)), 101-104.
3. Рустамов, М. А. (2021). Методы термической обработки для повышения прочности зубчатых колес. *Scientific progress*, *2*(6), 721-728.
4. Файзиматов, Ш. Н., & Рустамов, М. А. (2018). Аэродинамический эффект для автоматизации процесса перекачки химических агрессивных реагентов. *Современные исследования*, (6), 112-115.
5. Akbaraliyevich, R. M. (2022). Improving the Accuracy and Efficiency of the Production of Gears using Gas Vacuum Cementation with Gas Quenching under Pressure. *Central Asian Journal of Theoretical and Applied Science*, *3*(5), 85-99.
6. Файзимтов, Ш. Н., & Рустамов, М. А. (2017). ПРИМЕНЕНИЕ ПРОГРЕССИВНЫХ МЕТОДОВ ДЛЯ ОРИЕНТАЦИИ И УСТАНОВКИ ЗАКЛЕПОК В ОТВЕРСТИЕ С ГОРИЗОНТАЛЬНОЙ ОСЬЮ. In *НАУЧНЫЙ ПОИСК В СОВРЕМЕННОМ МИРЕ* (pp. 44-45).
7. Рубидинов, Ш. Ғ. Ў. (2021). Бикрлиги паст валларга совуқ ишлов бериш усули. *Scientific progress*, *1*(6), 413-417.
8. Тешабоев, А. Э., Рубидинов, Ш. Ғ. Ў., Назаров, А. Ғ. Ў., & Ғайратов, Ж. Ғ. Ў. (2021). Машинасозликда юза тозалигини назоратини автоматлаш. *Scientific progress*, *1*(5), 328-335.
9. Рубидинов, Ш. Ғ. Ў., & Ғайратов, Ж. Ғ. Ў. (2021). Штампларни таъмирлашда замонавий технология хромлаш усулидан фойдаланиш. *Scientific progress*, *2*(5), 469-473.
10. Qosimova, Z. M., & RubidinovSh, G. (2021). Influence of The Design of The Rolling Roller on The Quality of The Surface Layer During Plastic Deformation on the Workpiece. *International Journal of Human Computing Studies*, *3*(2), 257-263.
11. Тожибоев, Ф. О. (2023). ИЗУЧЕНИЕ ПРОЦЕССА ПОЛИМЕРИЗАЦИИ ПОЛИМЕРОВ И ЗАЩИТНЫХ МЕТАЛЛИЧЕСКИХ ПОКРЫТИЙ ОТ ЭЛЕМЕНТОВ. *Gospodarka i Innowacje.*, *35*, 41-50.

12. O‘G, R. S. G. A., Obidjonovich, T. F., Oybek O'g'li, O. A., & Bahodirjon O'g'li, L. A. (2023). ANALYSIS OF THE MILLING PROCESSING PROCESS ON THE SHAPED SURFACES OF STAMP MOLDS. *European International Journal of Multidisciplinary Research and Management Studies*, *3*(04), 124-131.

13. Shoxrux G'ayratjon o'g, R., Oybek o'g'li, O., & Bahodirjon o'g'li, L. A. (2022). Effect of Using Rolling Material in the Manufacture of Machine Parts. *Central Asian Journal of Theoretical and Applied Science*, *3*(12), 137-145.

14. Рубидинов, Ш. Ғ. У., Қосимова, З. М., Ғайратов, Ж. Ғ. У., & Акрамов, М. М. Ў. (2022). МАТЕРИАЛЫ ТРИБОТЕХНИЧЕСКОГО НАЗНАЧЕНИЯ ЭРОЗИОННЫЙ ИЗНОС. *Scientific progress*, *3*(1), 480-486.

15. Akramov, M., Rubidinov, S., & Dumanov, R. (2021). METALL YUZASINI KOROZIYABARDOSH QOPLAMALAR BILAN QOPLASHDA KIMYOVIY-TERMIK ISHLOV BERISH AHAMIYATI. *Oriental renaissance: Innovative, educational, natural and social sciences*, *1*(10), 494-501.

16. Косимова, З. М., & Акрамов, М. М. Ў. (2021). Технологические особенности изготовления поршней. *Scientific progress*, *2*(6), 1233-1240.

17. Rayimjonovich, M. A. (2023). Improvement of Operational Characteristics Crankshafts Made of High-Strength Cast Iron. *Central Asian Journal of Theoretical and Applied Science*, *4*(5), 56-63.

18. Rayimjonovich, M. A., & Ogli, A. M. M. (2023). FEATURES OF PRODUCTION PROCESSES BODY CASTINGS MADE OF HIGH-STRENGTH CAST IRON. *European International Journal of Multidisciplinary Research and Management Studies*, *3*(05), 4-12.

19. Рубидинов, Ш. Г. У., & Ғайратов, Ж. Г. У. (2021). Кўп операцияли фрезалаб ишлов бериш марказининг тана деталларига ишлов беришдаги унумдорлигини тахлили. *Oriental renaissance: Innovative, educational, natural and social sciences*, *1*(9), 759-765.

20. Рубидинов, Ш. Г. У., & Ғайратов, Ж. Г. У. (2021). Кўп операцияли фрезалаб ишлов бериш марказининг тана деталларига ишлов беришдаги унумдорлигини тахлили. *Oriental renaissance: Innovative, educational, natural and social sciences*, *1*(9), 759-765.

21. Шохрух, Г. У. Р., & Гайратов, Ж. Г. У. (2022). Анализ технологической системы обработки рабочих поверхностей деталей вала на токарном станках. *Science and Education*, *3*(8), 23-29.

22. O’G’Li, S. G. A., & O’G’Li, J. G. A. (2022). Ishlab chiqarish va sanoatda kompozitsion materiallarning o’rni. *Science and Education*, *3*(11), 563-570.

23. O'g, R. S. G. A. (2022). Classification of Wear of Materials Under Conditions of High Pressures and Shock Loads.

24. Ruzaliyev, X. S. (2022). Analysis of the Methods of Covering the Working Surfaces of the Parts with Vacuum Ion-Plasmas and the Change of Surface Layers. *Eurasian Scientific Herald*, *9*, 27-32.

25. Гайназаров, А. Т., & Абдурахмонов, С. М. (2021). Системы обработки результатов научных экспериментов. *Scientific progress*, *2*(6), 134-141.

26. Таджибаев, Р. К., Турсунов, Ш. Т., & Гайназаров, А. А. (2022). Повышения качества трафаретных форм применением косвенного способа изготовления. *Science and Education*, *3*(11), 532-539.

27. Akramov, M. M. (2021). Metallarni korroziyalanishi va ularni oldini olish samarodorligi. *Scientific progress*, *2*(2), 670-675.

28. Акрамов, М. М. (2021). ДЕТАЛЛАРНИНГ ЮЗАЛАРИНИ КИМЁВИЙ-ТЕРМИК ИШЛОВ БЕРИШГА ҚАРАТИЛГАН ТАКЛИФЛАР. *Scientific progress*, *2*(6), 123-128.

29. Акрамов, М. М. (2022). Краткая Характеристика Горячих Цинковых Покрытий. *Central Asian Journal of Theoretical and Applied Science*, *3*(5), 232-237.

30. Акрамов, М. М. (2021). Повышение физико-механических свойств стальных деталей при пластической деформационной обработке. *Scientific progress*, *2*(6), 129-133.

31. Tursunovich, M. E. (2022). ROBOTLARNING TURLARI VA ISHLATILISH SOXALARI. *Educational Research in Universal Sciences*, *1*(7), 61-64.

32. Mamurov, E. T. (2022). Diagnostics Of The Metal Cutting Process Based On Electrical Signals. *Central Asian Journal of Theoretical and Applied Science*, *3*(6), 239-243.

33. Mamurov, E. T. (2022). Control of the Process of Cutting Metals by the Power Consumption of the Electric Motor of the Metal-Cutting Machine. *Eurasian Scientific Herald*, *8*, 176-180.

34. Mamurov, E. T. (2022). Metal Cutting Process Control Based on Effective Power. *Central Asian Journal of Theoretical and Applied Science*, *3*(5), 238-244.

35. Eldor, M. (2022). CONTROL OF METAL CUTTING PROCESS BASED ON VIBROACOUSTIC SIGNAL. *Universum: технические науки*, (6-6 (99)), 63-67.

36. Medatovna, Q. Z., & Ogli, U. M. B. (2023). ROUGHNESS PARAMETERS DURING MECHANICAL PROCESSING ACCORDING TO INTERNATIONAL STANDARDS. *European International Journal of Multidisciplinary Research and Management Studies*, *3*(04), 148-157.

37. Косимова, З. М. (2022). Анализ Измерительной Системы Через Количественное Выражение Ее Характеристик. *Central Asian Journal of Theoretical and Applied Science*, *3*(5), 76-84.

38. Tadjibayev, R., & Homidjonov, M. (2023). PROCESSING OF LARGE LENGTH SHAFTS. *International Bulletin of Applied Science and Technology*, *3*(4), 813-818.

39. Karimovich, T. R., & O'gli, R. Z. O. (2023). MODERNIZATION OF CNC MACHINES. *European International Journal of Multidisciplinary Research and Management Studies*, *3*(04), 107-113.

40. Tadjibaev, R. K., & Tursunov, S. T. (2022). Scientific Research and Study Behavior of Curved Pipes Under Loads. *Central Asian Journal of Theoretical and Applied Science*, *3*(3), 81-86.

41. Шохрух, Г. У. Р., & Гайратов, Ж. Г. У. (2022). Анализ теории разъемов, используемых в процессе подключения радиаторов автомобиля. *Science and Education*, *3*(9), 162-167.

42. Mamirov, A. R., Rubidinov, S. G., & Gayratov, J. G. (2022). Influence and Effectiveness of Lubricants on Friction on the Surface of Materials. *Central Asian Journal of Theoretical and Applied Science*, *3*(4), 83-89.
43. Шохрух, Г. У. Р., Гайратов, Ж. Г. У., & Усмонов, А. И. У. (2022). Анализ применения износостойких покрытий и модифицированных покрытий на рабочих поверхностях деталей. *Science and Education*, *3*(6), 403-408.
44. Makhamasadikovich, S. S. (2022). Control of Design Documentation. *Eurasian Scientific Herald*, *9*, 109-114.
45. Makhamasadikovich, S. S. (2022). Classification of Design Errors in Mechanical Engineering. *Eurasian Scientific Herald*, *9*, 103-108.