ISSN 2518-170X (Online)
ISSN 2224-5278 (Print)

ҚАЗАҚСТАН РЕСПУБЛИКАСЫ
ҰЛТТЫҚ ҒЫЛЫМ АКАДЕМИЯСЫ
Satbayev University

Х А Б А Р Л А Р Ы

ИЗВЕСТИЯ

НАЦИОНАЛЬНОЙ АКАДЕМИИ
НАУК РЕСПУБЛИКИ
КАЗАХСТАН
Satbayev University

N E W S

OF THE ACADEMY OF SCIENCES
OF THE REPUBLIC OF
KAZAKHSTAN
Satbayev University

SERIES

OF GEOLOGY AND TECHNICAL SCIENCES

2 (458)

MARCH – APRIL 2023

THE JOURNAL WAS FOUNDED IN 1940

PUBLISHED 6 TIMES A YEAR

ALMATY, NAS RK

NAS RK is pleased to announce that News of NAS RK. Series of geology and technical sciences scientific journal has been accepted for indexing in the Emerging Sources Citation Index, a new edition of Web of Science. Content in this index is under consideration by Clarivate Analytics to be accepted in the Science Citation Index Expanded, the Social Sciences Citation Index, and the Arts & Humanities Citation Index. The quality and depth of content Web of Science offers to researchers, authors, publishers, and institutions sets it apart from other research databases. The inclusion of News of NAS RK. Series of geology and technical sciences in the Emerging Sources Citation Index demonstrates our dedication to providing the most relevant and influential content of geology and engineering sciences to our community.

Қазақстан Республикасы Ұлттық ғылым академиясы «ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы» ғылыми журналының Web of Science-тің жаңаланған нұсқасы Emerging Sources Citation Index-те индекстелуге қабылданғанын хабарлайды. Бұл индекстелу барысында Clarivate Analytics компаниясы журналды одан әрі the Science Citation Index Expanded, the Social Sciences Citation Index және the Arts & Humanities Citation Index-ке қабылдау мәселесін қарастыруда. Webof Science зерттеушілер, авторлар, баспашылар мен мекемелерге контент тереңдігі мен сапасын ұсынады. ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы Emerging Sources Citation Index-ке енуі біздің қоғамдастық үшін ең өзекті және беделді геология және техникалық ғылымдар бойынша контентке адалдығымызды білдіреді.

НАН РК сообщает, что научный журнал «Известия НАН РК. Серия геологии и технических наук» был принят для индексирования в Emerging Sources Citation Index, обновленной версии Web of Science. Содержание в этом индексировании находится в стадии рассмотрения компанией Clarivate Analytics для дальнейшего принятия журнала в the Science Citation Index Expanded, the Social Sciences Citation Index и the Arts & Humanities Citation Index. Web of Science предлагает качество и глубину контента для исследователей, авторов, издателей и учреждений. Включение Известия НАН РК. Серия геологии и технических наук в Emerging Sources Citation Index демонстрирует нашу приверженность к наиболее актуальному и влиятельному контенту по геологии и техническим наукам для нашего сообщества.

«ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы».
ISSN 2518-170X (Online),
ISSN 2224-5278 (Print)

Меншіктеуші: «Қазақстан Республикасының Ұлттық ғылым академиясы» РҚБ (Алматы қ.).
Қазақстан Республикасының Ақпарат және қоғамдық даму министрлігінің Ақпарат комитетінде 29.07.2020 ж. берілген **№ KZ39VPY00025420** мерзімдік басылым тіркеуіне қойылу туралы куәлік. Тақырыптық бағыты: *геология, мұнай және газды өңдеудің химиялық технологиялары, мұнай химиясы, металдарды алу және олардың қосындыларының технологиясы.*
Мерзімділігі: жылына 6 рет.
Тиражы: 300 дана.
Редакцияның мекен-жайы: 050010, Алматы қ., Шевченко көш., 28, 219 бөл., тел.: 272-13-19 http://www.geolog-technical.kz/index.php/en/

Типографияның мекен-жайы: «Аруна» ЖК, Алматы қ., Мұратбаев көш., 75.

«Известия НАН РК. Серия геологии и технических наук».
ISSN 2518-170X (Online),
ISSN 2224-5278 (Print)

Собственник: Республиканское общественное объединение «Национальная академия наук Республики Казахстан» (г. Алматы).

Свидетельство о постановке на учет периодического печатного издания в Комитете информации Министерства информации и общественного развития Республики Казахстан **№ KZ39VPY00025420,** выданное 29.07.2020 г.

Тематическая направленность: *геология, химические технологии переработки нефти и газа, нефтехимия, технологии извлечения металлов и их соеденений.*

Периодичность: 6 раз в год.

Тираж: 300 экземпляров.

Адрес редакции: 050010, г. Алматы, ул. Шевченко, 28, оф. 219, тел.: 272-13-19
http://www.geolog-technical.kz/index.php/en/

Адрес типографии: ИП «Аруна», г. Алматы, ул. Муратбаева, 75.

News of the National Academy of Sciences of the Republic of Kazakhstan. Series of geology and technology sciences.
ISSN 2518-170X (Online),
ISSN 2224-5278 (Print)
Owner: RPA «National Academy of Sciences of the Republic of Kazakhstan» (Almaty).
The certificate of registration of a periodical printed publication in the Committee of information of the Ministry of Information and Social Development of the Republic of Kazakhstan **No. KZ39VPY00025420,** issued 29.07.2020.
Thematic scope: *geology, chemical technologies for oil and gas processing, petrochemistry, technologies for extracting metals and their connections.*
Periodicity: 6 times a year.
Circulation: 300 copies.
Editorial address: 28, Shevchenko str., of. 219, Almaty, 050010, tel. 272-13-19
http://www.geolog-technical.kz/index.php/en/

Address of printing house: ST «Aruna», 75, Muratbayev str, Almaty.

NEWS of the National Academy of Sciences of the Republic of Kazakhstan
SERIES OF GEOLOGY AND TECHNICAL SCIENCES
ISSN 2224-5278
Volume 2, Number 458 (2023), 126–133
https://doi.org/10.32014/2023.2518-170X.287
UDC 621. 1

© N.Zh. Karsakova[1], K.T. Sherov[2*], B.N. Absadykov[3], M.R. Sikhimbayev[4], G.M. Tussupbekova[1], 2023
[1]A. Saginov Karaganda Technical University, Karaganda, Kazakhstan;
[2]S. Seifullin Kazakh Agro Technical University, Astana, Kazakhstan;
[3]A.B. Bekturov Institute of Chemical Sciences, Almaty, Kazakhstan;
[4]Karaganda Economic University of Kazpotrebsoyuz, Karaganda, Kazakhstan.
E-mail: shkt1965@mail.ru

THE ISSUES OF IMPROVING THE TECHNOLOGY FOR MACHINING THE LARGE DIAMETER HOLES OF THE LARGE–SCALE PARTS OF THE TECHNOLOGICAL EQUIPMENT

Karsakova Nurgul Zholaevna — doctoral student. Karaganda State Technical University, Karaganda, Kazakhstan
E-mail: karsakova-87@mail.ru. ORCID: https://orcid.org/0000-0003-2002-1557;
Sherov Karibek Tagayevich — Doctor of Engineering Sciences. Professor. S. Seifullin Kazakh Agro Technical University, Astana, Kazakhstan
E-mail: shkt1965@mail.ru. ORCID: https://orcid.org/0000-0003-0209-180X;
Absadykov Bakhyt Narikbayevich — Doctor of Technical Sciences. Professor, the Corresponding member of National Academy of Sciences of the Republic of Kazakhstan. A.B. Bekturov Institute of Chemical Sciences, Almaty, Kazakhstan
E-mail: b_absadykov@mail.ru. ORCID: https://orcid.org/0000-0001-7829-0958;
Sikhimbayev Muratbay Ryzdikbayevich — Doctor of Economic Sciences. Professor. Karaganda economic university of Kazpotrebsoyuz, Karaganda, Kazakhstan
E-mail: smurat@yandex.ru. ORCID: https://orcid.org/0000-0002-8763-6145;
Tussupbekova Gulim Magauiyanovna — doctoral student. S. Seifullin Kazakh Agro Technical University. Technical faculty, Astana, Kazakhstan
E-mail: gulim_tus@mail.ru. ORCID: https://orcid.org/0000-0003-3373-9541.

Abstract. The leading industries such as mining, oil and gas, exploration, etc. play a special role in the development of the economy of the Republic of Kazakhstan (RK). Ensuring the smooth operation of these industries primarily depends on the quality of the parts manufacturing and the components of the process equipment. Machines and technological equipment produced for these industries are characterized by high metal consumption and high labor intensity of their manufacture. Such details include the frame of the submersible pumps. The base of the NP8 submersible pump is its supporting part, on which the components and parts of the pump are mounted and to which particularly high requirements are imposed in terms of its strength, rigidity and manufacturability. The conducted studies have shown that one of the main problems arising in the manufacture of large-sized parts is the processing of the large diameter holes. The frame part has stepped holes of the large diameters, and when processing them, it is necessary to ensure the alignment of the holes. The study in this article aims to solve this problem. The authors suggest the design of a special boring bar, which provides simultaneous processing of the stepped holes. However, there is the issue of vibration when boring holes of large diameters, which negatively affects the machining accuracy. To dampen vibration during processing, it is offered to use special controlled technological equipment. The design of a special controlled technological tooling can compensate for elastic squeezing during processing. The results of experimental studies are also presented to determine the response of the system to a power surge and to a mechanical shock disturbance with and without correction of the elastic pressures.
Keywords. Large parts, large diameter holes, bed, boring bar, vibration

© Н.Ж. Карасакова[1], К.Т. Шеров[2*], Б.Н. Абсадыков[3], М.Р. Сихимбаев[4], Г.М. Тусупбекова[2], 2023
[1]А. Сағынов атындағы Қарағанды техникалық университеті, Қарағанды, Қазақстан;
[2]С. Сейфуллин атындағы Қазақ агротехникалық университеті, Астана, Қазақстан;
[3]Ә.Б. Бектұров атындағы химия ғылымдары институты, Алматы, Қазақстан;
[4]Қазтұтынуодағы Қарағанды экономикалық университеті, Қарағанды, Қазақстан.
E-mail: shkt1965@mail.ru

ТЕХНОЛОГИЯЛЫҚ ЖАБДЫҚТЫҢ ҮЛКЕН ДИАМЕТРЛІ ІРІ БӨЛШЕКТЕРІНІҢ ТЕСІКТЕРІН ӨҢДЕУ ТЕХНОЛОГИЯСЫН ЖЕТІЛДІРУ МӘСЕЛЕЛЕРІ

Аннотация. Қазақстан Республикасы экономикасының дамуында тау-кен, мұнай-газ, геологиялық барлау және т.б. сияқты өнеркәсіптің жетекші салалары ерекше рөл атқарады. Бұл салалардың үздіксіз жұмыс істеуін қамтамасыз ету ең алдымен технологиялық жабдықтың бөлшектері мен тораптарын дайындау сапасына байланысты болады. Жоғарыда аталған салалар үшін өндірілген машиналар мен технологиялық жабдықтар үлкен металл сыйымдылығымен және оларды өндірудің жоғары еңбек сыйымдылығымен сипатталады. Мұндай бөлшектерге суасты сорғыларының тұғырын да жатқызуға болады. Суасты сорғының НП8 тұғыры оның тірек бөлігі болып табылады, онда сорғының тораптары мен бөлшектері орнатылады және оның беріктігі, қаттылығы және өнімділігі тұрғысынан ерекше жоғары талаптар қойылады. Жүргізілген зерттеулер көрсеткендей, үлкен өлшемді бөлшектерді өндіруде туындайтын негізгі мәселелердің бірі-үлкен диаметрлі тесіктерді өңдеу. Тұғыр тетігі үлкен диаметрлі сатылы тесіктерге ие және оларды өңдеу кезінде тесіктердің үйлесімділігін қамтамасыз ету қажет. Осы мақаладағы зерттеу осы мәселені шешуге бағытталған. Авторлар сатылы тесіктерді бір уақытта өңдеуді қамтамасыз ететін арнайы борштанга құрылымын ұсынады. Дегенмен, өңдеу дәлдігіне теріс әсер ететін үлкен диаметрлі тесіктерді кеңейтежону кезінде діріл мәселесі бар. Өңдеу үрдісінде дірілді жоғалту үшін арнайы басқарылатын технологиялық жабдықты қолдану ұсынылады. Арнайы басқарылатын технологиялық жабдықтың құрылымы өңдеу үрдісінде серпімді қысуды өтей алады. Сондай-ақ, жүйенің серпімді қысуды түзетумен және онсыз кернеудің жоғарылауына және механикалық соққының бұзылуына реакциясын анықтау бойынша эксперименттік зерттеулердің нәтижелері келтірілген.

Түйін сөздер. Үлкен өлшемді бөлшектер, үлкен диаметрлі тесіктер, тұғыр, борштанга, діріл

© Н.Ж. Карсакова[1], К.Т. Шеров[2*], Б.Н. Абсадыков[3], М.Р. Сихимбаев[4], Г.М. Тусупбекова[2], 2023
[1]Карагандинский технический университет им. А. Сагинова, Караганда, Казахстан;
[2]Казахский агротехнический университет им. С. Сейфуллина, Астана, Казахстан;
[3]Институт химических наук имени А.Б. Бектурова, Алматы, Казахстан;
[4]Карагандинский экономический университет Казпотребсоюза, Караганда, Казахстан.
E-mail: shkt1965@mail.ru

ВОПРОСЫ СОВЕРШЕНСТВОВАНИЯ ТЕХНОЛОГИИ ОБРАБОТКИ ОТВЕРСТИЙ БОЛЬШИХ ДИАМЕТРОВ КРУПНОГАБАРИТНЫХ ДЕТАЛЕЙ ТЕХНОЛОГИЧЕСКОГО ОБОРУДОВАНИЯ

Аннотация. В развитии экономики Республики Казахстан особую роль играет ведущие отрасли промышленности, такие как горная, нефтегазовая, геологоразведочная и др. Обеспечение бесперебойной работы этих отраслей, в первую очередь, зависит от качества изготовления деталей и узлов технологического оборудования. Машины и технологическое оборудование, производимые для вышеуказанных отраслей промышленности, характеризуются большой металлоемкостью и высокой трудоемкостью их изготовления. К таким деталям можно отнести станину погружных насосов. Станина НП8 насоса погружного является его опорной частью, на которой монтируются узлы и детали насоса и к которой предъявляются особенно высокие требования с точки зрения ее прочности, жесткости и технологичности. Проведенные исследования показали, что одной из основных проблем, возникающих при изготовлении крупногабаритных деталей, является обработка отверстий больших диаметров. Деталь станина имеет ступенчатые отверстия больших диаметров и при их обработке необходимо обеспечение соосности отверстий. Исследование в данной статье направлено на решение этой проблемы. Авторами предлагается конструкция специальной борштанги, которая обеспечивает одновременную обработку ступенчатых отверстий. Однако существует вопрос вибрации при растачивании отверстий больших диаметров, которая отрицательно влияет на точность обработки. Для гашения вибрации в процессе обработки, предлагается применение специальной управляемой технологической оснастки. Конструкция специальной управляемой технологической оснастки может компенсировать упругие отжатия в процессе обработки. Также приводятся результаты экспериментальных исследований по определению реакции системы на скачок напряжения и на механическое ударное возмущение с коррекцией упругих отжатий и без нее.

Ключевые слова: крупногабаритные детали, отверстия больших диаметров, станина, борштанга, вибрация

Introduction

In the manufacture of the large-sized body parts of the heavy machines, the largest share in the total labor intensity is accounted for by operations associated with the processing of the main holes, i.e. holes of a very large diameter. As blanks for large-sized body parts, steel or cast-iron castings are usually used. In some cases, welded steel blanks are used, which, other things being equal, are significantly lighter than cast blanks. For welded blanks, rolled products are used, or they are made as welded-cast or welded-forged structures. High requirements are placed on the large-diameter holes in large-sized body parts in terms of accuracy in a size, shape and location. The most common diameters of such holes are in the range of 280–550 mm. The accuracy of these diameters is within 6–8 quality, ovality and taper are from half to the whole tolerance field, depending on the type of bearing, the tolerances for the location of surfaces are 6–8 degrees of accuracy, the surface roughness of holes in body parts is Rz = 10÷20 μm (Ivanov et al., 2014: 5). In the conditions of the repair and machining industries in the mining, geological exploration, oil and gas, chemical and other industries, measuring tools are the most often used to process holes in large-sized body parts, this is due to their following advantages: relatively high productivity, low costs for production preparation and low requirements for accuracy of machine tools, since the accuracy of the machined holes is determined mainly by the accuracy of the equipment used. In addition, unlike tools of other designs, in the process of machining, measuring tools are based coaxially relative to the machined or machined hole, or the axis of rotation. Therefore, the smaller the error in basing measuring tools, the higher the accuracy of the machined holes should be. Studies show that the error of basing depends on a number of factors and, in particular, on the method of locating the tool and the equipment used. The processing of holes, which are subject to high requirements for the accuracy of a size, shape and location, still remains one of the urgent problems of modern mechanical engineering. Figure 1 shows the classification of measuring instruments:

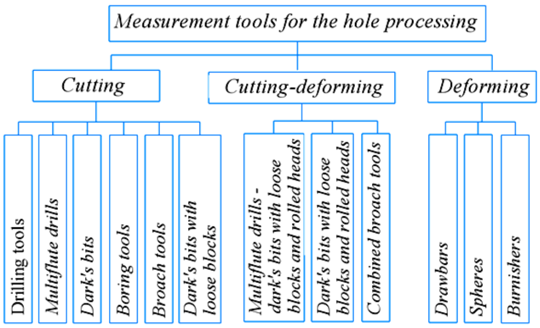


Figure 1 - Classification of measuring tools for the hole processing

At the same time, the processing of the precise holes with measuring tools is associated with a number of difficulties, primarily due to the limited rigidity of the tool due to its design characteristics, the difficulty of supplying coolant to the cutting zone and removal, and chip removal. These problems lead to the need to reduce the parameters of cutting modes, as well as the introduction of the additional operations into the technological process.

Research materials and methods

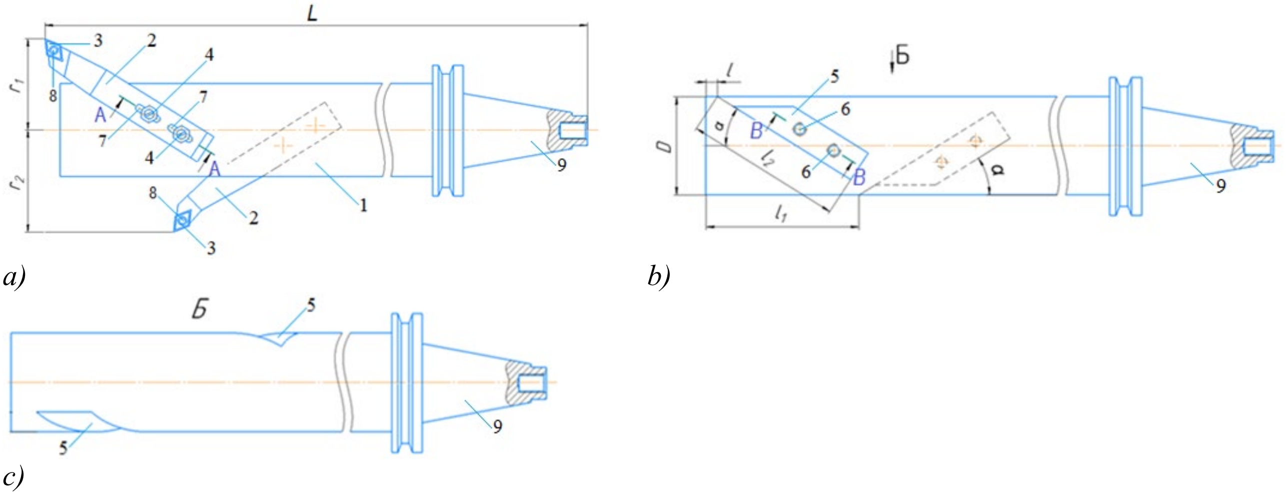
The machines and the technological equipment produced for the exploration, oil and gas, chemical and other industries are characterized by high metal consumption and high labor intensity of their manufacture. Such details include the frame of the submersible pumps. The frame of the NP8 submersible pump is its supporting part, on which the components and parts of the pump are mounted and to which especially high requirements are imposed in terms of its strength, rigidity and manufacturability (Anikin et al., 2018: 138; Karsakova et al., 2022a: 10). The bed in most cases is made of gray cast iron GCI15, GCI 18, GCI 21, GCI 32, and sometimes the beds are made welded from sheet steel (Morgunov, 2021: 308; Korzh, 2010: 184, Rakhimov et al., 2021: 9; Baydjanov et al., 2019: 8; Ganyukov et al., 2018: 12). Figure 2 shows the frame of the submersible pump.

a) *b)* *c)*

a - front view; b, c – side view

Figure 2 - Submersible pump frame

For boring of the stepped holes in the frame, a design of the special boring bar for the boring stepped holes has been developed (Sherov et al., 2021a: 6). Figure 3 shows a boring bar for boring stepped holes.

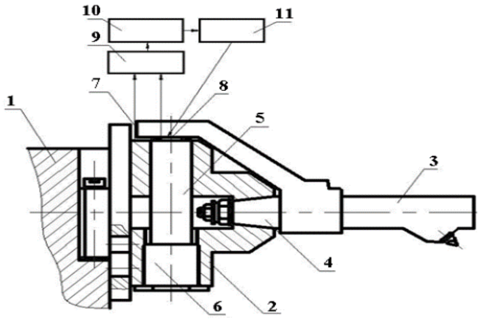


a – is boring bar for boring stepped holes, complete; b – is body of the boring bar for boring stepped holes, side view; c – is view B; 1 – is a body of the boring bar; 2 – is a tool holder; 3 – is a hard alloy plate; 4 – is a screw for fixing the tool holder; 5 – is a mounting groove; 6 – is threaded holes; 7 – is adjusting through groove; 8 – is a screw for fixing the plate; L – is the length of the boring bar; l, l_1 – are distances from the end face of the boring bar body to the mounting groove; l_2 – is the length of the installation groove; D – is the diameter of the boring bar body; r_1 – is the radius of the hole with a smaller diameter; r_2 – is the radius of the hole with a large diameter; α – is the angle of the mounting groove inclination

Figure 3 – Boring bar for boring stepped holes

Simultaneous boring of the stepped holes from the same setup improves machining accuracy while maintaining a hole alignment. The adjustment through grooves made on the tool holders allow the adjustment of the boring bar for boring stepped holes of the various diameters (Karsakova et al., 2023b: 13, Kadyrov 2021: 9, Mukanov, 2019: 4). It is known that there is an issue of vibration when boring holes of the large diameters, which adversely affects the machining accuracy (Dudak et al., 2019: 12, Zhetessova, 2022:8). In this regard, in the future, it is important to improve the accuracy of machining holes in large-sized body parts by stabilizing the position of the cutting tool. Stabilization of the position of the cutting tool can be effectively solved by controlling the dynamic characteristics of the system, for example, by using additional supports to support the boring bar and to stabilize the position of the workpiece during processing (Kirsanov et al., 2003: 330).

The authors have developed controlled technological equipment (CTE) for boring holes on metalworking machines of the various groups (Sherov et al., 2014b: 12). The purpose of the CTE is to increase the technological capabilities of the equipment to ensure the accuracy of processing in a comparison with the accuracy regulated by the standards for this type of equipment. A functional diagram of a controlled tooling (CTE) for compensating elastic pressures during the processing of parts is shown in Figure 4. The developed CTE (Sherov et al., 2014b: 12, Meshcheryakov et al., 1987: 6) is designed to work on the principle of stabilizing the position of the shaping tip of the cutter in the process of the boring holes. The body of the device is mounted in the turret head 1 of the metal-cutting machine and consists of: a fixed part of the controlled equipment 2 and a movable part of the controlled equipment 3, connected to each other through a conical surface by a threaded connection 4. A cutting insert is fixed in the movable part of the controlled equipment. In the fixed part 2, a cup made of a dielectric material 6 is installed, in which a piezoelectric transducer 5 (piezo motor) is located, made of piezoceramic elements sintered together, made of ceramics zirconate-titanate lead-19. The piezo motor has the following characteristics: L is length 230 mm; D is diameter 20 mm; ΔL is elongation of the transducer ± 45 µm with a change in the control voltage ± 400 V; f is natural frequency of the first mechanical resonance of the piezoelectric transducer equal 10 kHz



1 is a turret head of the machine; 2 is a fixed part of the controlled equipment; 3 is a movable part of the controlled equipment; 4 is a threaded conical fastening of the mandrel; 5 is a piezoelectric motion transducer (piezo motor); 6 is fastening of the piezoelectric motor; 7 is a sensor for measuring deviations of elastic pressings of the shaping vertex of the boring cutter; 8 is a sensor that registers the development of the control action; 9 is a preliminary amplifier; 10 is a comparison block; 11 is a power amplifier

Figure 4 - Controlled technological equipment (CTE) for compensation of the elastic pressing of the tool when boring holes.

The fixed body of the device has a perpendicular protrusion with a threaded hole into which a glass is screwed, the bottom of which is a fixed support for the piezoelectric displacement transducer 5 (piezoelectric motor). When installing a piezoelectric motor in the body of the device, to eliminate gaps in mating with the supporting surfaces, it is necessary to carry out a preload.

Displacement sensors 7 and 8 are located on the fixed part of the device 2 and in the piezo motor 5. Capacitive displacement sensors are used to measure the deviations of the elastic pressures of the forming tip of the boring cutter (sensor 7) and to record the processing of the control action (sensor 8) by the piezo motor. The sensor is a capacitor consisting of two plates, one of which is fixed and the other moves. The use of tooling allows you to control the accuracy of the form and the location of the surfaces of parts. It should be noted that even with very high geometric accuracy of modern equipment, high accuracy of pre-machined holes is required to achieve high shape accuracy of the bored holes. This condition is a consequence of the presence in the technological system of a link with low rigidity of a cutter. An increase in the rigidity of this link is prevented by objective reasons from the dimensions of the holes being machined (the diameter and the length of the hole).

Results

To evaluate the operation of the proposed device, a series of experiments was carried out to determine the response of the system to a power surge and to a mechanical shock disturbance with and without correction of the elastic compressions (Sherov et al., 2014b: 12; Sherov et al., 2021c: 9, Goltsev et al., 2021: 7). This will give us data on the regulation time (speed) and stability of the control action processing by the device for automatic control of the tool's elastic depressions when boring holes. First of all, let's check the reaction of the device without correcting its dynamic properties (sensors 7,8 and the piezo motor in the off state). When a signal is applied to the system in the form of a voltage jump, the transient process (Figure 5) is oscillatory and weakly damped. The price of one division of the oscilloscope grid is 0.002s along the abscissa and 1B along the ordinate. The overshoot is about 30 % and the regulation time is 18ms. With such characteristics of the transient process, the control system is unsuitable for controlling the accuracy of the shape and location of holes in the cross section, since at an oscillation frequency of 200 Hz to 600 Hz (basic harmonic oscillations of the shape and location errors), the time of one oscillation of the forming tip of the cutter is from 5 to 1,6 ms, and the device without correction of its dynamic properties (in the off state) has a regulation time of 18 ms, i.e. the system will not have time to respond to the rate of change in the elastic pressures of the tool during processing.

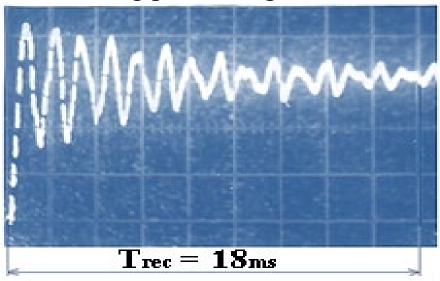


Figure 5 – The system response to a power surge without correction of its dynamic properties

The response of the system to a signal coming from the tool position sensor to a mechanical impact disturbance is shown in Figure 6. Control time, more than 20 ms.

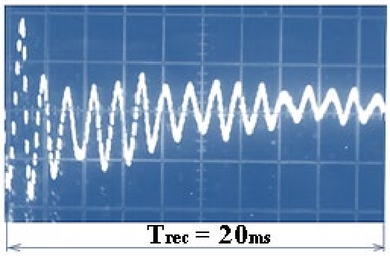


Figure 6 - The response of the system without correction for mechanical impact disturbance

Let us now consider the reaction of the device with the correction of its dynamic properties by introducing a feedback circuit, which will significantly improve its characteristics.

Since the developed device is a sixth-order system and the calculation of the tuning coefficients for its optimal parameters is somewhat difficult, the system was tuned according to the type of transient process by selecting the integration coefficient KU and the values of the coefficients included in the corrective elements WK1 and WK2. The criterion for a satisfactory adjustment of the automatic control system was taken to be the minimum control time, while ensuring the stability of the system and the overshoot value of no more than 5 % (Korol'kov, 1984: 250). As a result of the introduction of corrective actions and the selection of their parameters, the system regulation time under a disturbing action in the form of a voltage jump has decreased, the overshoot value does not exceed 5 %. The transient process of the corrected automatic control system is shown in Figure 7.

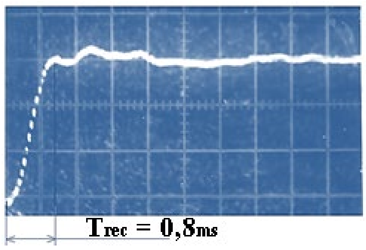


Figure 7 – The system response with the correction of its dynamic properties for a power surge

The price of division of the oscilloscope coordinate grid along the abscissa axis is 1 ms, along the ordinate axis 1 B. The control time is 0.8 ms when working out the control action, which is 22 times less than in the system without correction. The response of the automatic control system to a mechanical shock disturbance is shown in Figure 8.

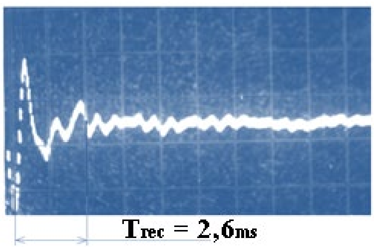


Figure 8 – The system response with the correction of its dynamic properties to mechanical shock disturbance

The price of division of the coordinate grid of the oscilloscope along the abscissa axis is 2 ms, along the ordinate axis 1 B. The regulation time is 2.6 ms, which is 8 times less than in a system without correction.

Discussion

Bench tests have shown that the natural frequency of the elastic vibrations of the assembled device is 1200 Hz, the mechanical quality factor is about 40. The adjusted CTE parameters did not change during the experimental studies.

The proposed CTE, operating on the principle of the vibration damping, is designed to compensate for elastic displacements of the controlled element of the technological system (in this case, a mandrel with a disk) due to fluctuations in cutting forces and uneven rigidity of the technological system in various directions. The design of the device must prevent the ingress of lubricating-cooling liquid and chips on the internal structural elements.

Conclusions

In the process of boring when using CTE, it is advisable to obtain information about the magnitude of the disturbing influences by measuring the values of the elastic pressures of the cutter with sensor 7.

The speed required to ensure the required accuracy of the location and shape of the cross-section of the holes in the developed CTE is provided by the use of piezoelectric electromechanical displacement transducers with corrected dynamic properties. The developed system has a control time Trec = 0.8 ms and a bandwidth f = 0 – 1200 Hz.

The effective stabilization of the position of the shaping tip of the cutter, necessary for the implementation of the control action with elastic pressures from 0 to 0.035 mm, was obtained through the use of the developed design of controlled technological equipment at fine boring transitions.

REFERENCES

Anikin YU.V., 2018. Nasosy i nasosnye stancii: ucheb. posobie / YU.V. Anikin, N.S. Carev, L.I. Ushakova; Ural. feder. un-t. - Ekaterinburg: Izd-vo Ural. un-ta, 2018. - 138 p. (in Russ.).

Baydjanov D.O., Abdrakhmanova K.A., Kropachev P.A., Rakhimova G.M., 2019. Modified concrete for producing pile foundations. Magazine of Civil Engineering, 86 (2). Pp. 3–10. DOI: https://doi.org/10.18720/MCE.86.1 (in Eng).

Dudak N., Itybayeva G., Kasenov A., Mussina Zh., Taskarina A., Abishev K., 2019. Multi-flute drill-broach for precision machining of holes / Scientia Iranica, Transactions B: Mechanical Engineering 26. Pp. 1415–1426. DOI: https://doi.org/10.24200/sci.2018.5623.1379 (in Eng.).

Ganyukov A.A., Kadyrov A.S., Balabekova K.G., Kurmasheva B.K., 2018. Tests and calculations of structural elements of temporary bridges / Roads and Bridges - Drogi i Mosty. 17. 215–226. DOI: 10.7409/rabdim.018.014 (in Eng.).

Goltsev A.G., Kurmangaliev T.D., Sherov K.T., Sikhimbayev M.R., Absadykov B.N., Mardonov B.T., Sikhimbayeva D.R., 2021. Determining limit displacements in spacer propping single bolting. News of the National Academy of Sciences of the Republic of Kazakhstan. Series of geology and technical sciences. 2021. Volume 2. Number 446. (2021). Pp. 55–61.

DOI: https://doi.org/10.32014/2021.2518-170X.34 (in Eng).

Ivanov E.I., Ivanov I.E., 2014. Tekhnologicheskoe obespechenie tochnosti obrabotki otverstij bol'shogo diametra // Sbornik nauchnyh trudov XI Mezhdunarodnoj nauchno-prakticheskoj konferencii: Tom. 2. – Mariupol': Izd-vo PGTU- 2014. - Pp.113–117. (in Russ.).

Karsakova N.Zh., Sherov K.T, Absadykov B.N., Sikhimbayev M.R., Balgabekov T.K., 2022. The control problems of the large diameter holes in processing of the large parts. News of the National Academy of Sciences of the Republic of Kazakhstan. Series of geology and technical sciences. 2022. Volume 6. Number 456 (2022). 70–79. DOI:https://doi.org/10.32014/2022.2518-170X.239 (in Eng.).

Korzh V.V., 2010. Ekspluataciya i remont oborudovaniya nasosnyh i kompressornyh stancij: Uchebnoe posobie. – Uhta: UGTU, 2010. – 184s. (in Russ.)

Karsakova N., Sherov K., Donenbayev B., Abulkhairov D., Sagynganova I., Usserbayev M., Teliman I., Sherov A., Tussupbekova G., 2023. Calculation of the boring bar design for static rigidity and strength with simultaneous boring of a stepped hole with further optimization. Journal of Applied Engineering Science. Vol. 21. № 1, 2023. Pp. 300–312. DOI: https://doi.org/10.5937/jaes0-40340 (in Eng).

Kadyrov A., Zhunusbekova Zh., Ganyukov A., Kadyrova I., Kukesheva A., 2021. General Characteristics for Loading the Working Elements of Drilling and Milling Machines when Moving in the Clay Solution // Communications - Scientific Letters of the University of Zilina. - Vol. 23. № 2.- Pp. B97–B105. DOI: https://doi.org/10.26552/com. (in Eng.).

Kirsanov S.V., Grechishnikov V.A., Skhirtladze A.G., Kokarev V.I., 2003. Instrumenty dlya obrabotki tochnyh otverstij: nauchnoe izdanie - M.: Mashinostroenie, 2003. - 330 p. (in Russ.)

Korol'kov B.A., 1984. Issledovanie i razrabotka sposobov povysheniya tochnosti obrabotki otverstij na tokarnyh stankah s CHPU: Dis. ... kand. tekhn. nauk. - M.: MVTU im. N.E. Baumana, 1984. – 250 p. (in Russ.)

Morgunov K.P., 2021. Nasosy i nasosnye stancii: Uchebnoe posobie dlya SPO. – Moskva: OOO "Izdatel'stvo "Lan"", 2021. - 308 p. (in Russ.)

Mukanov R.B., Kasenov A.Z., Itybaeva G.T., Musina Zh.K., Abishev K., Bykov P.O., 2019. Face Turning of Holes // Russian Engineering Research, Volume 39. Issue 1. Pp. 75–78. DOI: 10.3103/S1068798X19010064 (in Eng.).

Meshcheryakov R.K., Sihimbaev M.R. Sposob upravleniya polozheniem formoobrazuyushchej vershinoj rezca pri tochenii (rastachivanii) vysokotochnyh otverstij / Avtorskoe svidetel'stvo. A1/V23V25/06. BI № 38 ot 15.10.87. (in Russ.).

Rakhimov, M.A., Rakhimova, G.M., Suleimbekova, Z.A. (2021) Modification of Concrete Railway Sleepers and Assessment of Its Bearing Capacity International Journal of GEOMATE. 20(77). Pp. 40–48. DOI: https://doi.org/10.21660/2020.77.01916 (in Eng).

Sherov K.T., Karsakova N.ZH., Musaev M.M., Ķuanov I.S., Myrzahmet B., Bekzhanov E.S., Gabdysalyk R., Okimbaeva A.E., Imasheva K.I., 2021. Borshtanga dlya rastachivaniya stupenchatyh otverstij / Patent № 6486 RK na poleznuyu model'. Opublikovano 08.10.2021. Byul. № 40. (in Russ.).

Sherov K.T, Sikhimbayev M.R. The development and analysis of the machining attachments for the decrement of oscillations of a boring bar in the process of the refinement of high-accuracy apertures / JVE journal of Vibroengineering – Kaunas, Lithuania. Volume 16. Issue 2. March 2014. Pp. 1022–1032. (in Eng).

Sherov A.K., Sherov K.T., Sikhimbayev M.R., Absadykov B.N., Kuanov I.S. Research of qualitative indicators of a gear pump with two-shaft connection for pumping petroleum products. News of the National Academy of Sciences of the Republic of Kazakhstan. Series of geology and technical sciences. 2021. Volume 4. Number 448. (2021). 108–116.

https://doi.org/10.32014/2021.2518-170X.88 (in Eng).

Zhetessova G., Nikonova T., Gierz Ł., Zhunuspekov D., Yurchenko V., Zharkevich O. Preparation of the Surface of Long-Dimensional Rods of Hydro-Cylinders for Thermal Spraying Using an Abrasive Jet // Coatings, 2022, 12(10), 1514. https://doi.org/10.3390/coatings12101514 (in Eng.).

CONTENTS

Publication Ethics and Publication Malpractice in the journals of the National Academy of Sciences of the Republic of Kazakhstan

For information on Ethics in publishing and Ethical guidelines for journal publication see http://www.elsevier.com/publishingethics and http://www.elsevier.com/journal-authors/ethics.

Submission of an article to the National Academy of Sciences of the Republic of Kazakhstan implies that the described work has not been published previously (except in the form of an abstract or as part of a published lecture or academic thesis or as an electronic preprint, see http://www.elsevier.com/postingpolicy, that it is not under consideration for publication elsewhere, that its publication is approved by all authors and tacitly or explicitly by the responsible authorities where the work was carried out, and that, if accepted, it will not be published elsewhere in the same form, in English or in any other language, including electronically without the written consent of the copyright-holder. In particular, translations into English of papers already published in another language are not accepted.

No other forms of scientific misconduct are allowed, such as plagiarism, falsification, fraudulent data, incorrect interpretation of other works, incorrect citations, etc. The National Academy of Sciences of the Republic of Kazakhstan follows the Code of Conduct of the Committee on Publication Ethics (COPE, and follows the COPE Flowcharts for Resolving Cases of Suspected Misconduct (http://publicationethics.org/files/u2/New_Code.pdf). To verify originality, your article may be checked by the Cross Check originality detection service http://www.elsevier.com/editors/plagdetect.

The authors are obliged to participate in peer review process and be ready to provide corrections, clarifications, retractions and apologies when needed. All authors of a paper should have significantly contributed to the research.

The reviewers should provide objective judgments and should point out relevant published works which are not yet cited. Reviewed articles should be treated confidentially. The reviewers will be chosen in such a way that there is no conflict of interests with respect to the research, the authors and/or the research funders.

The editors have complete responsibility and authority to reject or accept a paper, and they will only accept a paper when reasonably certain. They will preserve anonymity of reviewers and promote publication of corrections, clarifications, retractions and apologies when needed. The acceptance of a paper automatically implies the copyright transfer to the National Academy of Sciences of the Republic of Kazakhstan.

The Editorial Board of the National Academy of Sciences of the Republic of Kazakhstan will monitor and safeguard publishing ethics.

Правила оформления статьи для публикации в журнале смотреть на сайтах:
www:nauka-nanrk.kz
http://www.geolog-technical.kz/index.php/en/
ISSN 2518-170X (Online),
ISSN 2224-5278 (Print)

Заместитель директор отдела издания научных журналов НАН РК *Р. Жәлиқызы*
Редакторы: *М.С. Ахметова, Д.С. Аленов*
Верстка на компьютере *Г.Д.Жадыранова*

Подписано в печать 14.04.2023.
Формат 70x90 $^{1}/_{16}$. Бумага офсетная. Печать – ризограф.
20,0 п.л. Тираж 300. Заказ 1.

Национальная академия наук РК
050010, Алматы, ул. Шевченко, 28, т. 272-13-19