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«ҚАЗАҚСТАН РЕСПУБЛИКАСЫ
ҰЛТТЫҚ ҒЫЛЫМ АКАДЕМИЯСЫ» РҚБ
«ХАЛЫҚ» ЖҚ

ХАБАРЛАРЫ

ИЗВЕСТИЯ

РОО «НАЦИОНАЛЬНОЙ
АКАДЕМИИ НАУК РЕСПУБЛИКИ
КАЗАХСТАН»
ЧФ «Халық»

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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.

ЧФ «ХАЛЫҚ»

В 2016 году для развития и улучшения качества жизни казахстанцев был создан частный Благотворительный фонд «Халык». За годы своей деятельности на реализацию благотворительных проектов в областях образования и науки, социальной защиты, культуры, здравоохранения и спорта, Фонд выделил более 45 миллиардов тенге.

Особое внимание Благотворительный фонд «Халык» уделяет образовательным программам, считая это направление одним из ключевых в своей деятельности. Оказывая поддержку отечественному образованию, Фонд вносит свой посильный вклад в развитие качественного образования в Казахстане. Тем самым способствуя росту числа людей, способных менять жизнь в стране к лучшему – профессионалов в различных сферах, потенциальных лидеров и «великих умов». Одной из значимых инициатив фонда «Халык» в образовательной сфере стал проект Ozgeris powered by Halyk Fund – первый в стране бизнес-инкубатор для учащихся 9-11 классов, который помогает развивать необходимые в современном мире предпринимательские навыки. Так, на содействие малому бизнесу школьников было выделено более 200 грантов. Для поддержки талантливых и мотивированных детей Фонд неоднократно выделял гранты на обучение в Международной школе «Мирас» и в Astana IT University, а также помог казахстанским школьникам принять участие в престижном конкурсе «USTEM Robotics» в США. Авторские работы в рамках проекта «Тәлімгер», которому Фонд оказал поддержку, легли в основу учебной программы, учебников и учебно-методических книг по предмету «Основы предпринимательства и бизнеса», преподаваемого в 10-11 классах казахстанских школ и колледжей.

Помимо помощи школьникам, учащимся колледжей и студентам Фонд считает важным внести свой вклад в повышение квалификации педагогов, совершенствование их знаний и навыков, поскольку именно они являются проводниками знаний будущих поколений казахстанцев. При поддержке Фонда «Халык» в южной столице был организован ежегодный городской конкурс педагогов «Almaty Digital Ustaz.

Важной инициативой стал реализуемый проект по обучению основам финансовой грамотности преподавателей из восьми областей Казахстана, что должно оказать существенное влияние на воспитание финансовой грамотности и предпринимательского мышления у нового поколения граждан страны.

Необходимую помощь Фонд «Халык» оказывает и тем, кто особенно остро в ней нуждается. В рамках социальной защиты населения активно проводится

работа по поддержке детей, оставшихся без родителей, детей и взрослых из социально уязвимых слоев населения, людей с ограниченными возможностями, а также обеспечению нуждающихся социальным жильем, строительству социально важных объектов, таких как детские сады, детские площадки и физкультурно-оздоровительные комплексы.

В копилку добрых дел Фонда «Халык» можно добавить оказание помощи детскому спорту, куда относится поддержка в развитии детского футбола и карате в нашей стране. Жизненно важную помощь Благотворительный фонд «Халык» оказал нашим соотечественникам во время недавней пандемии COVID-19. Тогда, в разгар тяжелой борьбы с коронавирусной инфекцией Фонд выделил свыше 11 миллиардов тенге на приобретение необходимого медицинского оборудования и дорогостоящих медицинских препаратов, автомобилей скорой медицинской помощи и средств защиты, адресную материальную помощь социально уязвимым слоям населения и денежные выплаты медицинским работникам.

В 2023 году наряду с другими проектами, нацеленными на повышение благосостояния казахстанских граждан Фонд решил уделить особое внимание науке, поскольку она является частью общественной культуры, а уровень ее развития определяет уровень развития государства.

Поддержка Фондом выпуска журналов Национальной Академии наук Республики Казахстан, которые входят в международные фонды Scopus и Wos и в которых публикуются статьи отечественных ученых, докторантов и магистрантов, а также научных сотрудников высших учебных заведений и научно-исследовательских институтов нашей страны является не менее значимым вкладом Фонда в развитие казахстанского общества.

С уважением,
Благотворительный Фонд «Халык»!

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ANALYSIS OF INTERACTION OF ROCK BREAKING TOOL WITH ROCK IN THE DRILLING PROCESS

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Abstract. The article deals with the issues of increasing the efficiency of drilling by developing and studying the process of interaction between the teeth of the drilling tool and the rock. A model of a tricone type drill bit has been developed. When drilling wells, 70-85% of the bits used are tricone bits. For an accurate comparative analysis, two variants of a tricone drill bit were studied, a serial one and a proposed one with a diameter of 215.9 mm. The interaction of the rock destroying tool with the rock during drilling is analyzed in a complex way using the ANSYS program, which operates on the basis of the finite element method. The change in the overall speed of an optimized tricone bit during interaction with the rock is considered. According to the results of the study, the parameters of the speed of penetration of the tooth into the rock were obtained, an analysis of the equivalent stress was carried out during the interaction of

serial and experimental tricone bits with the rock. Graphs of changes in the equivalent stress of the rock by the penetration of the cone elements into it depending on time for both drilling tools were obtained. The results obtained in the study of the interaction of a rock destroying tool with a rock during drilling make it possible to determine the optimal parameters for placing teeth on the cone body at the design stage of tricone type drilling tools in the development of energy efficient bits.

Keywords: drilling, drill bit, drilling speed, finite element method, rock, deformation, ANSYS, well

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БҰРҒЫЛАУ ПРОЦЕСІНДЕ ЖЫНЫС БҰЗАТЫН ҚҰРАЛДАРДЫҢ ТАУ ЖЫНЫСТАРЫМЕН ӨЗАРА БАЙЛАНЫСЫН ТАЛДАУ

Аннотация. Мақалада бұрғылау құралы тістерінің тау жыныстарымен өзара байланысу процесін талдау және зерттеу арқылы бұрғылау жұмысының тиімділігін арттыру мәселесі қарастырылған. Үшқажаутісті үлгідегі бұрғылау қашауының моделі әзірленген. 70-85% ұңғыманы бұрғылау кезінде қолданылатын қашаулар үшқажаутісті қашаудан тұрады. Салыстырмалы талдауды дәлме-дәл жүргізу үшін үшқажаутісті бұрғылау қашауының сериялық және ұсынылған диаметрі 215,9 мм секілді екі нұсқасы зерттелген. Жыныс бұзатын құралдың тау жыныстарымен бұрғылау процесінде сандық моделдеу әдісі негізінде жұмыс істейтін ANSYS бағдарламасы пайдаланыла отырып өзара байланысына кешенді талдау жасалған. Оңтайландырылған үшқажаутісті қашаудың кен жыныстарымен өзара байланысу кезінде жалпы жылдамдығының өзгерістері қарастырылған. Жүргізілген зерттеу нәтижелері бойынша қажау тістерінің тау жыныстарына ену жылдамдығының параметрлері алынған, сериялық және тәжірибелік үшқажаутісті қашаудың тау жыныстарымен өзара байланысуы кезінде эквивалентті кернеуіне талдау жасалған. Тау жыныстарының эквивалентті кернеуінің қажаутіс элементтерінің өзіне екі бұрғылау құралдарына арналған уақытқа қарай енуі кезінде өзгерістерге ұшырау кестелері алынған. Жыныс бұзатын құралдың тау жыныстарымен бұрғылау процесіндегі өзара байланысын зерттеу кезінде алынған нәтижелер энергиялық тұрғыда тиімді қашаулар шығару кезінде үшқажаутісті үлгідегі бұрғылау құралдарын жобалау кезеңінде қажаутістің бойында тістерді орналастырудың оңтайлы параметрлерін анықтауға мүмкіндік береді.

Түйін сөздер: бұрғылау, бұрғылау қажауы, бұрғылау жылдамдығы, түпкі элемент әдісі, кен жынысы, деформация, ANSYS, ұңғыма

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АНАЛИЗ ВЗАИМОДЕЙСТВИЯ ПОРОДОРАЗРУШАЮЩЕГО ИНСТРУМЕНТА С ГОРНОЙ ПОРОДОЙ В ПРОЦЕССЕ БУРЕНИЯ

Аннотация. В статье рассмотрены вопросы повышения эффективности бурения путем разработки и исследования процесса взаимодействии зубьев бурового инструмента с горной породой. Разработана модель бурового долота трехшарошечного типа. При бурении скважин 70-85% применяемых долот составляют трехшарошечные долота. Для точного сравнительного анализа исследованы два варианта трехшарошечного бурового долота, серийное и предлагаемое диаметром 215,9 мм. Комплексно проанализировано взаимодействие породоразрушающего инструмента с горной породой в процессе бурения с использованием программы ANSYS, функционирующая на основе метода численного моделирования. Рассмотрено изменение общей скорости оптимизированного трехшарошечного долота при взаимодействии с породой. По результатам исследовании были получены параметры скорости проникновения зуба в горную породу, проведен анализ эквивалентного напряжения при взаимодействии серийного и опытного трехшарошечных долот с горной породой. Получены графики изменения эквивалентного напряжения породы по проникновению элементов шарошки в нее в зависимости от времени для обоих буровых инструментов. Результаты, полученные при исследовании взаимодействия породоразрушающего инструмента с горной породой в процессе бурения, дают возможность определения оптимальных параметров размещения зубьев на теле шарошки на стадии проектирования буровых инструментов трехшарошечного типа при разработке энергоэффективных долот.

Ключевые слова: бурение, буровое долото, скорость бурения, метод конечных элементов, горная порода, деформация, ANSYS, скважина

Introduction

The main factors affecting the efficiency and durability of a rock destroying tool when drilling wells according to the characteristics of rocks include: dynamic (shock

and vibration) effects on the tool; insufficient sealing of the main units of drill bits from the effects of flushing water and destroyings; as well as the organization and manufacturability of preventive maintenance (Kryukov, 2006: 139; Che et al., 2012: 11). These factors have been widely studied and taken into account in the practice of designing and operating rock destroying tools. At present, everyone already understands how complex the processes of drilling and destruction of rocks at the bottom of the well are, and they realize what an important role the design model of the drilling tool plays in this (Mannanov et al., 2019: 9; Ruwan, 2016: 508; Carpinteri et al., 2005: 12).

We have studied the efficiency of the process of rock destruction while rolling the teeth of one cone of a tricone bit along the bottom hole, and two variants of tricone bits were chosen for analysis. Serial bit used in production and our proposed option of the bit with a "paired" arrangement of teeth on the cone crown (Liu, 2004: 6).

Research materials and methods

In this work, we studied a tricone drill bit with a diameter of 215.9 mm for drilling limestone with a hardness f = 8–12 on the scale of M.M. Protodyakonov and comprehensively analyzed the interaction of the rock destroying tool with the rock during drilling using the ANSYS program, which operates on the basis of finite element methods. The data for simulation are set in the program after the properties of simulation objects are entered. Certain assumptions are provided to simplify the calculation of the numerical model. For example, a bit was created in another CAD program and simplified as a solid body, which saves time for simulation and uses computer resources rationally (Kou et al., 2001: 10; Zhou, 2014: 13). In addition, the following parameters are neglected: bottom hole hydrostatic pressure, drilling fluid flow, and bit wear. The destruction of the rock is visualized by the removal of red elements upon reaching the strength threshold (Toshov et al., 2023a: 13; Kassenov et al., 2022: 6; Arystanov et al., 2022: 15; Toshov et al., 2022b: 10). The model of a tricone bit is shown in fig. 1. The properties of materials of a tricone bit, teeth, and rock, in this case often found in quarry wells — limestone, are given in Table. 1.

Table 1. Material properties of the bit, teeth and rock

Name	Bit	teeth	Breed
Material	Structural steel	Tungsten carbide	Limestone
Density	7850 kg m^{-3}	15600 kg m^{-3}	2700 kg m^{-3}
Tensile strength	4,45E+8 Pa	4.6 E+8 Pa	4.0e+6 Pa
Young's modulus	2E+11 Pa	6.34 E+11Pa	3,7845E+10 Pa
Poisson's ratio	0.3	0.21	0.3077

In addition, the table contains such parameters as compressive and tensile strength, Young's modulus and Poisson's ratio, which are necessary for analysis, are given in the ANSYS program database (Engineering data sources — Geomechanical materials — Limestone) (Gerbaud et al., 2006: 9; Kadyrov et al., 2021: 9). At the end of data entry, a simulation is launched to analyze the velocity and stress-strain state of the rock from the impact of the impact-rotational action of the bit. The time for simulation in

ANSYS explicit dynamics is set to 3 milliseconds, the value of the angular velocity is 100 rpm along the X axis and the axial load is 200 kN along the Y axis. The distance displacement of the bit towards the rock with a value of 70 mm along the Y axis and rotation of 360 degrees around its axis allows get the percussive-rotational action of the bit. The rock was laterally fixed so as not to move during contact. Given the experience with the program and the fact that the simulation process is very complex and computer resources are limited, the mesh parameters, the body of the tooth were set to default, the contact tips of the teeth were 5mm and the mesh value per rock was set to 6mm. (Figure 1.). As the grid size decreases, one can observe how the number of elements and nodes increases. It should be noted that the smaller the grid value, the more accurate the results can be obtained in the ANSYS program. The destruction of the rock at a high rate under the influence of the bit characterizes the mechanical speed of drilling, which directly determines the efficiency of the rock destroying tool in the field (Benavides-Serrano et al., 2019: 7; Anatoliy et al., 2016: 9; Dudak et al., 2019:12; Shakhmov et al., 2020: 7). The more intensively the rock is drilled with less energy for destruction, the more effective the bit used in drilling operations is.

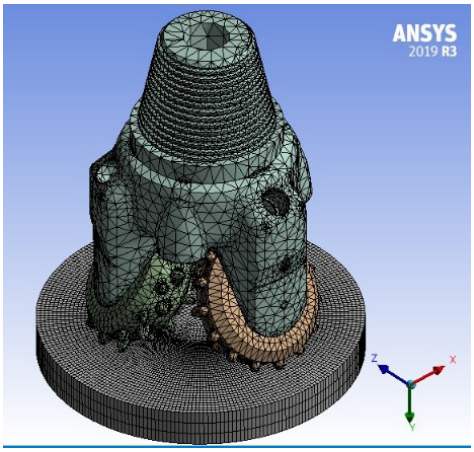

Fig. 1. Mesh scheme of the simulation object

The efficiency of the optimized bit was determined in a comparative analysis with the work of a serial bit. To analyze this experiment, that is, to optimize the rate of penetration of a tricone bit into the rock, the ANSYS Explicit dynamics module is used. The simulation analysis process took about 26 hours. On fig. 2, you can see how the rock is destroyed due to penetration into it, that is, the percussive-rotational action of the bit teeth. The destruction of the rock is explained by the fact that by the penetration of the elements of the bit into it, it loses its structural structure and reaches the tensile strength.

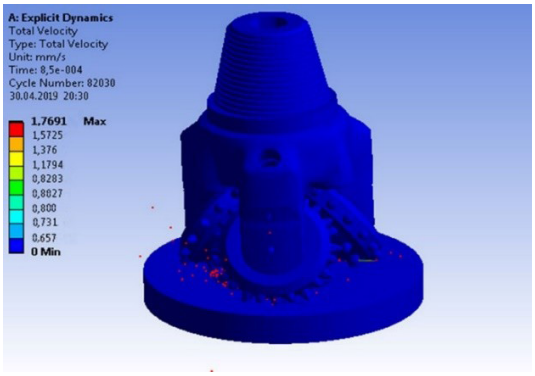

Fig. 2. Interaction model of a serial bit with rock in the analysis of penetration rate

The total penetration rate of a commercial drill bit into a 70 mm rock depth is 7.697 mm/s. The development of speed is observed from the end of the second half, which means the beginning of the removal of fragments from the surface of the rock by the penetration of the bit teeth into it deeper. The speed peak can be seen in the final period of the simulation.

Results

The results of the analysis of equivalent stress during the interaction of a serial tricone bit with rock show that, in addition to rock and bit teeth, stress is observed in the reverse cone part of the cones, but it does not have a deformable effect on the bit design. When the teeth of a serial bit penetrate into the rock, tensile forces in the clockwise direction can be observed along the traces of the rotational movement of the bit (Figure 3). Small fragments of red color on the surface of the rock mean that the rock in these zones is stretched to the tensile strength and loses its structural form, which contributes to the destruction of this part of the rock. A detailed view of the fragmentation process can be seen in Figure 3.

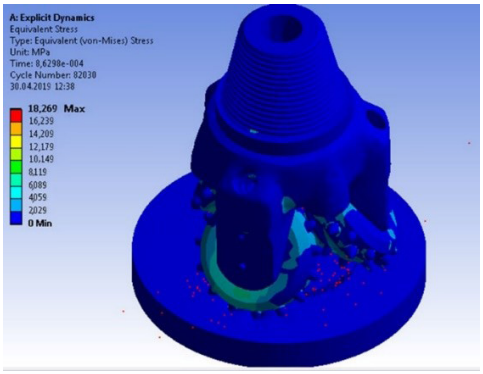

Fig. 3. Interaction model of a serial bit with rock in the analysis of equivalent stress

A high equivalent stress is observed, as in the experiment of the interaction of the cone elements of a serial bit with the rock, in the first milliseconds of interaction. In this

case, the maximum stress occurs at the depth of contact between the teeth and the rock, and further, as the fragmentation is removed, the stress value decreases (Fig. 4.). The decrease in the value of the equivalent stress continues after reaching the second peak, but in a less intense form.

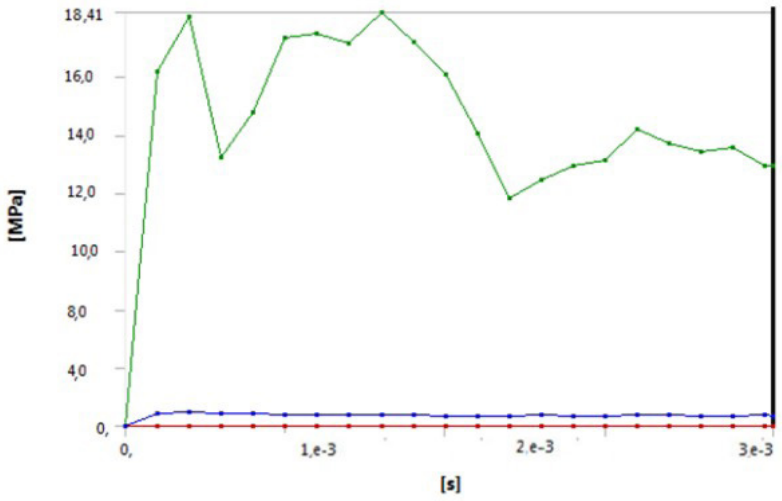

Fig. 4. Graph of the change in the equivalent stress of the rock by the cone elements penetration into it through time

At the end of the analysis of the overall velocity of the bit and the stress-strain state of the rock in the study of a serial drill bit, an optimization process can be carried out. For this study, the optimization of the drill bit is based on design features, namely: the location of the teeth on the peripheral cone crowns, which are vulnerable to wear faster than other crowns in 215.9mm TKZ bits. The serial bit has 42, 37, 37 pieces of teeth on three cones. To demonstrate the relationship between modified design and penetration rate, numerous tests were carried out with various design features. The number of teeth was regulated from 30 to 45 pieces and their location also varied.

Consider an example of a change in the overall velocity of an optimized tricone bit when interacting with rock. Based on the test analyzes obtained as a result of the simulation, the optimal design for a tricone bit was selected, which consists of 32, 33, 37 pieces of teeth. The optimized drill bit was again modeled using ANSYS Explicit Dynamic to measure its performance.

Setting the parameters and analyzing the optimized bit is carried out similarly to the serial one. After entering the necessary data, the analysis was carried out.

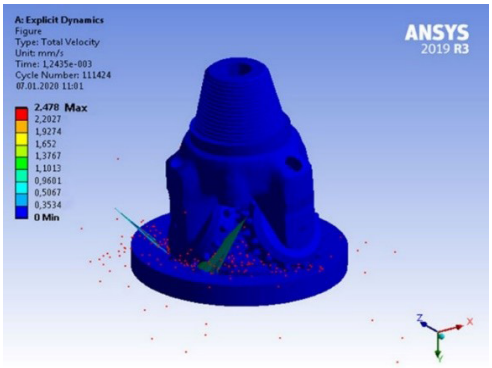

Fig. 5. Penetration of the teeth of an optimized tricone bit into the rock when analyzing the overall bit velocity

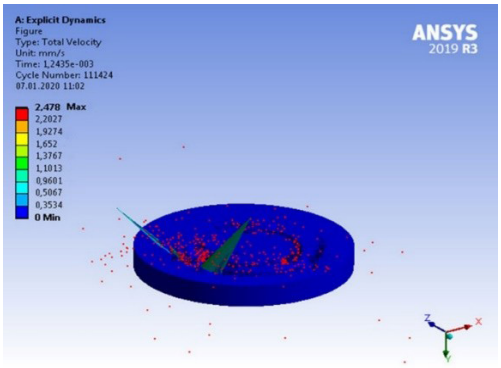

Fig. 6. The process of rock fragmentation under the influence of an optimized drill bit in the analysis of the total velocity of the bit

On figures 5 and 6, fragmentation can be seen, that is, the elements of the tool are pressed into the rock, and the rock under the influence of the tool is destroyed into small fragments, forming cracks. The results of the overall velocity of the optimized tricone bit when interacting with the rock (Fig. 5) in the program show that the bit with a pair of teeth on the rims moves faster than the production cone bits (see Fig. 3), and in a more aggressively oscillating form. Starting from the second half of the simulation, the overall speed of the model develops rapidly and reaches its peak at the end of the simulation period. For a complete comparison of the performance of the two bits, below we also consider the analysis of the equivalent stress during the interaction of the optimized tricone bit with the rock in ANSYS Explicit Dynamics (Fig. 7 and 8).

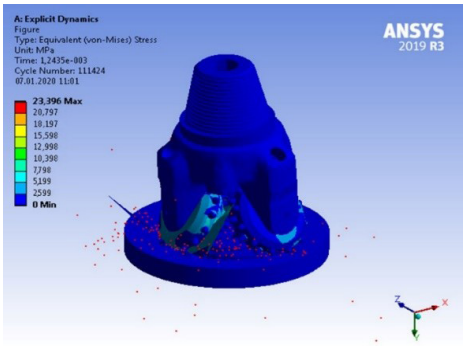

Fig. 7. Interaction model of the optimized bit with the rock in the analysis of the equivalent stress

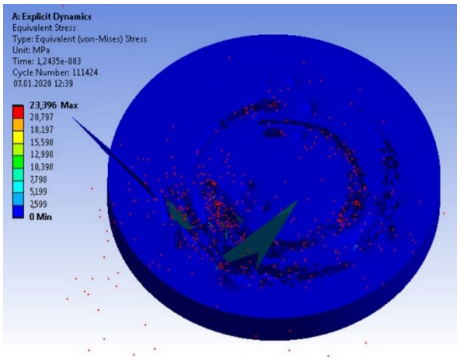

Fig. 8. Model of destroyed rock under the influence of a new bit

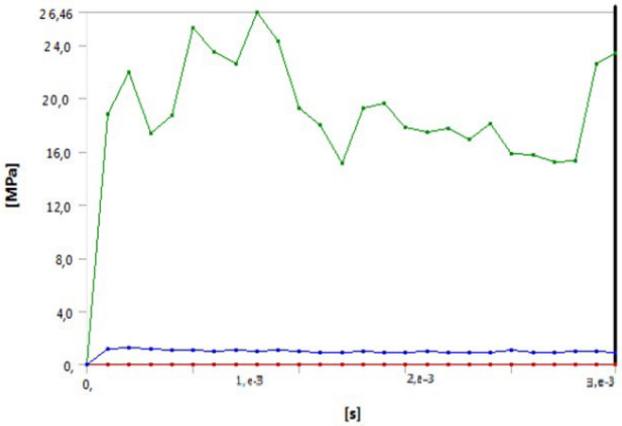

Fig. 9. Graph of the change in the equivalent stress of the rock by the penetration of the cone elements into it through time

During the analysis, the oscillatory equivalent stress is observed from the very beginning of the interaction. The maximum tensile stress occurs in the first half cycle. The value of the von Mises stress decreases after reaching the peak (Fig. 9.), but at the same time it retains an oscillatory shape and by the end of the period the rock receives

a newly increasing stress-strain state. This signals the penetration of teeth into a new undamaged surface. In general, the value of the equivalent stress fluctuates throughout the entire period, but a less intense state is observed after the first half-cycle.

Conclusion

A highly efficient rock destroying tool was developed and modeled using the ANSYS software package, which allows getting results faster, more economical in terms of time and resources, and achieve no less reasonable results than experiments in the fields or in the laboratory. Graphs of changes in the equivalent stress of the rock by the penetration of the cone elements into it depending on time for both drilling tools were obtained. The results obtained in the study of the interaction of a rock-breaking tool with rock during drilling make it possible to determine the optimal parameters for placing teeth on the cone body at the design stage of tricone-type drilling tools when developing energy-efficient bits with a decrease in the number of teeth to 12%. It is recommended to use a numerical modeling method through a comprehensive analysis of the process of interaction of the drill bit with the rock in order to identify and eliminate the weak points of the structural model at the initial design stage.

REFERENCES

Arystanov Z., *Togizbayeva B.*, *Karazhanov A.*, *Alipbayev Z.*, *Burkanova K.* (2022). Investigation of the impact of operating conditions on the service life of locomotive wheelset tyres. Journal of the Balkan Tribological Association., 2022, — 28(6), — Pp. 882–896

Anatoliy Protosenya, Pavel Verbilo (2016). Forecast Jointed Rock Mass Compressive Strength Using a Numerical Model 1 National Mineral Resources University, 199106 St Petersburg, Russia/ MATEC Web of Conferences 73040067, (2016). — Pp.1–9.

Benavides-Serrano A.F., Peña-Sabogal A.S., León O.M., Sánchez-Acevedo H.G., González-Estrada O.A. (2019). Optimization of parameters in material selection of tricone drill bit head design IOP Conf. Series: Journal of Physics: Conf. Series — 1159 (2019). — Pp. 1–7.

Che D., Han P., Guo P., Ehmann K. (2012). Issues in polycrystalline diamond compact cutter-rock interaction from a metal machining point of view-part I: Temperature, stresses, and forces // Journal of Manufacturing Science and Engineering, Transactions of the ASME. — 134(6), — Pp. 1–10.

Carpinteri Alberto, Luciano Dimastrogiovanni, and Nicola Pugno (2005). Fractal coupled theory of drilling and wear // International journal of fracture. — 131.2. — Pp.131–142.

Dudak N., Itybayeva G., Kasenov A., Mussina Zh., Taskarina A., Abishev K. (2019). Multi-ute 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.).

Gerbaud L., Menand S., Sellami H. (2006). PDC bits: all comes from the cutter rock interaction [C] // IADC/SPE Drilling Conference. 2006, — Pp. 1–9.

Kryukov G.M. (2006). Physics of destruction of rocks during drilling and blasting / — M., Publishing House "MB", 2006. — P. 329.

Kou S.Q., Liu H.Y., Lindqvist P.A., Tang C.A., Xu X.H. (2001). Numerical investigation of particle breakage as applied to mechanical crushing-part II: Interparticle breakage // Int J Rock Mech Min Sci 38(8). — Pp. 1163–1172.

Kassenov A.Zh., Abishev K.K., Absadykov B.N., Yessaulkov V.S., Bolatova A.B. (2022), News of the National Academy of Sciences of the Republic of Kazakhstan. Series of geology and technical sciences. — Volume 1. — Number 451. — Pp. 63–68. — *https://doi.org/10.32014/2022.2518-170X.141*

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.).

Liu Hongyuan et al. (2004). Numerical simulation of shear fracture (mode II) in heterogeneous brittle

rock // International Journal of Rock Mechanics and Mining Sciences 41.Suppl. — 1 (2004). — Pp. 14–19.

Mannanov U., Toshov J.B., Toshniyozov L.G., (2019). Perspective Solutions for the Design of Drilling Tools. / IVth International Innovative Mining Symposium. E3S Web of Conferences 105, — 03027 (2019). — Pp. 1–8.

Ruwan Rajapakse P.E., (2016). CCM, CCE, AVS, Engineering Geological Calculations and Thumb Rules, Book, 2nd edition, 2016. — P. 508.

Shakhmov Z., *Zhussupbekov A.*, *Tleulenova G.*, *Togizbayeva B.* (2020). Frost susceptibility of soil ground and its impact in Kazakhstan. 16th Asian Regional Conference on Soil Mechanics and Geotechnical Engineering, — ARC 2019, 2020

Toshov J.B., Malikov Sh.R., Ergashev O.S., Sherov A.K., Esirkepov A. (2023). Improving the efficiency of the process of drilling wells in complex conditions at geological prospecting sites // NEWS of the National Academy of Sciences of the Republic of Kazakhstan. Series of geology and technical sciences. — Volume 3. — Number 459 (2023). — Pp. 282–294. — *https://doi.org/10.32014/2023.2518-170X.313*

Toshov J.B., Toshov B.R., Baratov B.N., Haqberdiyev A.L. (2022). Designing new generation drill bits with optimal axial eccentricity | Вопросы проектирования буровых долот нового поколения с оптимальным межосевым эксцентриситетом // Mining Informational and Analytical Bulletin, 2022, (9). — Pp. 133–142. — *DOI: 10.25018/0236. — 1493_*

Zhou Yaneng, and Jeen-Shang Lin (2014). Modeling the ductile–brittle failure mode transition in rock destroying // Engineering Fracture Mechanics — 127 (2014). — Pp. 135–147.

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