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

ҚАЗАҚСТАН РЕСПУБЛИКАСЫ
ҰЛТТЫҚ ҒЫЛЫМ АКАДЕМИЯСЫНЫҢ
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 (446)

MARCH – APRIL 2021

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)

Меншіктенуші: «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 және техникалық ғылымдар бойынша мақалалар жариялау.***

Мерзімділігі: жылына 6 рет.
Тиражы: 300 дана.

Редакцияның мекен-жайы: 050010, Алматы қ., Шевченко көш., 28, 219 бөл., тел.: 272-13-19, 272-13-18

http://www.geolog-technical.kz/index.php/en/

Типографияның мекен-жайы: «Аруна» ЖК, Алматы қ., Муратбаева 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: ***публикация статей по геологии и техническим наукам.***

Периодичность: 6 раз в год.
Тираж: 300 экземпляров.

Адрес редакции: 050010, г. Алматы, ул. Шевченко, 28, оф. 219, тел.: 272-13-19, 272-13-18

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: ***publication of papers on geology and technical sciences.***

Periodicity: 6 times a year.
Circulation: 300 copies.

Editorial address: 28, Shevchenko str., of. 219, Almaty, 050010, tel. 272-13-19, 272-13-18,

http://www.geolog-technical.kz/index.php/en/

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

N E W S
OF THE NATIONAL ACADEMY OF SCIENCES OF THE REPUBLIC OF KAZAKHSTAN
SERIES OF GEOLOGY AND TECHNICAL SCIENCES
ISSN 2224-5278
Volume 2, Number 446 (2021), 167 – 173 **https://doi.org/10.32014/2021.2518-170X.49**

UDC 622.831.322

N. M. Suleimenov[1], Sh. K. Shapalov[2], G. S. Sattarova[3], B. O. Sapargaliyeva[4], S. B. Imanbayeva[3], V. N. Bosak[5]

[1] M. Auyezov South Kazakhstan University, Shymkent, Kazakhstan;
[2] SILKWAY International University, Shymkent, Kazakhstan;
[3] Karaganda Technical University, Kazakhstan;
[4] Abai Kazakh National Pedagogical University, Almaty, Kazakhstan;
[5] Belarusian State Agricultural Academy, Republic of Belarus.
E-mail: bonya_sh@mail.ru

NUMERICAL SIMULATION MODELLING OF TEMPERATURE DISTRIBUTION IN THE PROCESS OF COAL SELF-HEATING IN THE MINED-OUT SPACES

Abstract. Researches of thermodynamic processes of oxidation, self-heating and self-ignition of coal are necessary for studying of dependence of terminal parameters on a set of the influencing factors. In practice of coal mining by the underground method cases of coal self-ignition in the mined-out spaces of production units (lavas) are frequent. In this case one of the tasks consists in determination of temperature in arbitrary point of the nubbly-porous medium of the mined-out space. Need of the solution of this difficult task is caused by the probability of emergency situations in places with the explosive concentration of methane. It is possible that for each seam and grade of coal it is necessary to develop, substantiate and accept an individual indicator for assessing the state of fire hazard. It is proposed to systematize and methodically process the results of field measurements and observations on the analyzed and investigated cases of endogenous fires in problem areas of mines in order to create basin databases for subsequent operational decisions in emergency situations.

Keywords: mined-out spaces, oxidation, self-heating, coal self-ignition, temperature distribution, heat conductivity, partial differential equations, numerical simulation, application program package.

Of course, the most reliable results can be received in the process of physical modeling in natural conditions. In laboratory conditions these researches are almost impracticable for a number of reasons. In particular, the known laboratory researches on oxidation and self-heating of coal are carried out with small amounts of initial material and are directed, mainly, to determination of tendency to self-ignition or quantitative analysis of the gases which are emitted in the process of oxidation. For example, in one of the latest works on physical laboratory modeling [1-5] "the method of thermal effects assessment of oxidation process of solid carbon substances in the conditions of the constant speed of heating is offered". Authors set the purpose definition of quantitative power characteristics of theoretic-chemical justification of oxidation process and self-ignition of coal.

The large-scale natural experiment which completely simulate conditions of the mined-out space and directed to instrumental measurement of temperature in all volume is very difficult, demands the installation of thermal sensors network on the area and on height of the left coal congestion [2]. Besides danger and the high cost of similar experiments they are quite labor-consuming in terms of the change at the different levels even of the most significant operating external factors (heat efflux by air flows, heat transfer in the adjacent strata, thermal characteristics of coal and refuse stones).

Having regard to the above said, nowadays mathematical methods of thermal processes modeling of self-heating and self-ignition including the coal get larger value and application. Here, two directions are mainly developed.

The first is based on the basic equations of thermal balance of a heat transfer with the use of empirical dependences in the process of heating in the result of oxidation and is focused on engineering approach to a problem. For the first time in this direction the problem of distribution of the thermal field in the result of self-heating in volume of nubbly-porous congestion of the goafed coal was solved in works [5-9] within the research works of group of scientists of the Karaganda department of the All-Union Research Institute of Mine-rescue Work (AURIMRW) under the direction of the Doctor of Engineering Science Chekhovskikh A.M. More general approach to such modeling of thermodynamics of the endogenous fires is offered in the work of the famous scientist in this question of Pashkovskiy P.S [10].

Other direction, more strict, is developed with the use of classical partial differential equations of heat conductivity, allowing to realize numerical models of a non-stationary heat transfer in solid bodies. One of the first works describing mathematical model of coal self-ignition by the system of the isolated partial differential equations in relation to endogenous fires in coal mines, it is possible to mention works of Gluzberg E.I. [11-13]. In the subsequent, along with a number of works devoted to theoretical researches of self-ignition processes of solid combustible materials (for example [10]), fundamental work of Vengerov I. R. [14-16] on thermophysics of mines and excavating plants was published.

However, difficult partial differential equations practically impossible to solve in a general view that makes them inaccessible for wide use in practical applications. There are works which offer numerical methods of modeling for the solution of various model problems of heat-mass-transfer by grid method with justification of convergence and stability of various schemes [18-20].

Nowadays difficulties with numerical realization of mathematical models described by partial differential equations are almost overcome that is connected, in our opinion, with two moments. The first is development and improvement of numerical methods of the model equations solution of any complexity. These methods are proved theoretically and focused on the numerical solution with the obtaining of model output parameters. Nevertheless, their implementation is quite labor-consuming and demands certain mathematical preparation from specialists in modeling.

The second moment is an emergence of powerful computers with large random access memory and speed, development of universal application computer programs of the differential equations solution including in partial differential equations. Such packages of application programs allow to model many physical processes, without demanding profound knowledge of subtleties of a mathematical apparatus. The most known of them MATLAB, MATCAD, COMSOL and others are widely applied for the solution of difficult tasks of physical processes modeling in many fields of science.

Methodical approach to a problem of numerical modeling of temperature field distribution in the process of coal self-heating in the mined-out lava space with the use of the integrated MATLAB software package focused on the solution of scientific tasks is presented in this article.

Process of non-stationary temperature field distribution in the solid or porous medium is described by the classical differential equation of heat conductivity [21-22]

$$\rho \cdot C \cdot \frac{\partial T}{\partial \tau} - \nabla \cdot (k \nabla T) = Q + h \cdot (T_{\text{вс}} - T),$$

where T is the current temperature in the investigated medium point, °K; ρ – density of the medium material, kg/m^3; C – specific heat of the medium material, J/kg ·°K; k – coefficient of heat conductivity of the medium material, W/m ·°K; h – coefficient of convective heat exchange, J / · °K; $T_{\text{вс}}$ – temperature of the external environment, · °K; Q – external source of heat, J; ∇ – differential operator.

For modeling of processes of temperature field distribution from coal self-heating the package of application programs MATLAB intended especially for scientific research is used [15]. The solution of the equation of temperature distribution from self-heating in a coal congestion is made with the use of the «Heat Transfer and Diffuzion» module (Heat conductivity and diffusion) of a MATLAB package [16].

The problem of temperature distribution in the above-noted module is solved on the basis of use of a finite element method which theoretical and methodical provisions are stated in [22-23]. In this article temperature change from self-heating of a coal congestion in the isolated mined-out space of the mine working area in the process of development of flammable coal layer is modelled. The design diagram of temperature distribution modeling of self-heating of coal congestion by a finite element method is provided on figure 1.

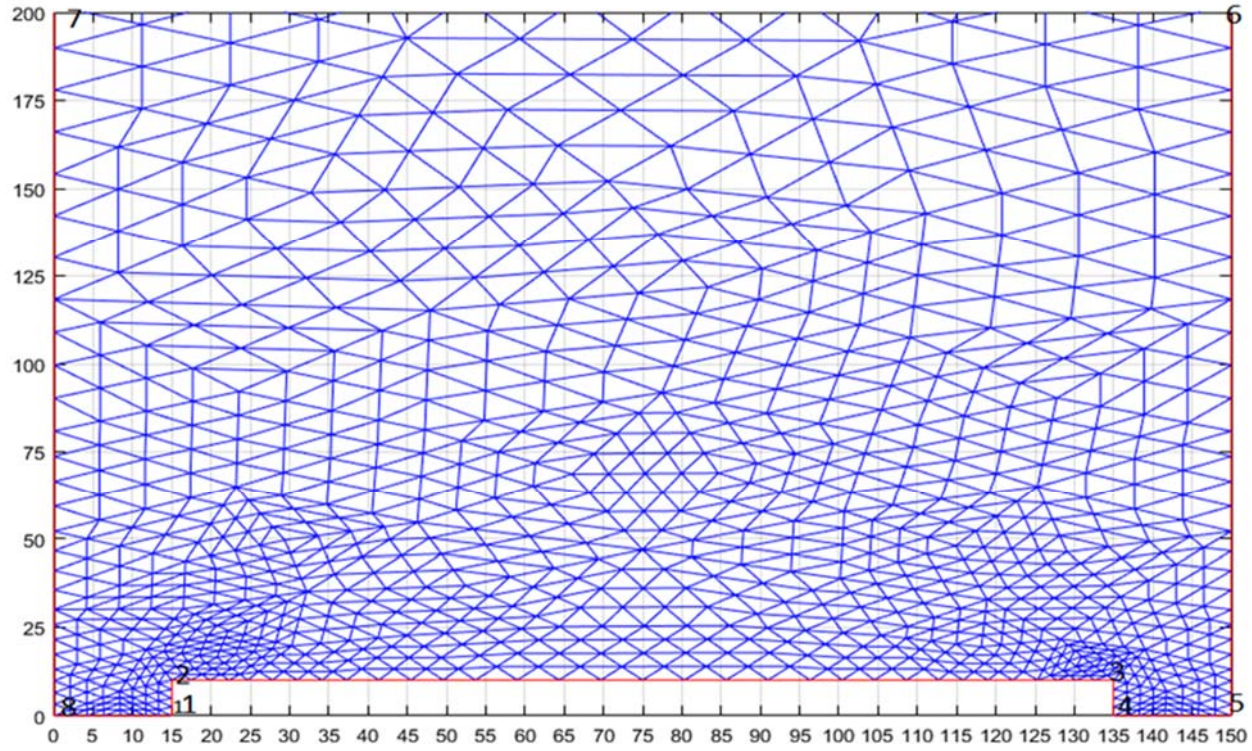

Figure 1 – The design diagram of temperature distribution modeling of self-heating of coal congestion by a finite element method

On the given scheme the mined-out space of a mining lava is conditionally shown in the plan. Length of a wide place is 120 m, the extension of the robbed-out part is 200 m. The situation of self-heating of the goafed coal in the mined-out space as a result of penetration of ventilation loss is modelled. Basic data: density of the nubbly-porous medium is $\rho = 0.011 Mn/m^3$ (1100 kg/m^3); the specific heat of the medium is $C=1.4 \cdot 10^{-3}$ mJ/kg ·°K; heat conductivity is $k = 0{,}1 \cdot 10^4$ W/m ·°K; coefficient of convective heat exchange is h = 0.5 J/°K. The insignificant external source 20 mJ, which models the transfer of heat flux by means of leaks through the isolating constructions is accepted. Temperature of the external environment (surrounding massif) on the border of the mined-out space is constant and is 20°C. On figure 2 the dialog box of the MATLAB programming environment with basic data for the solution of a task is shown.

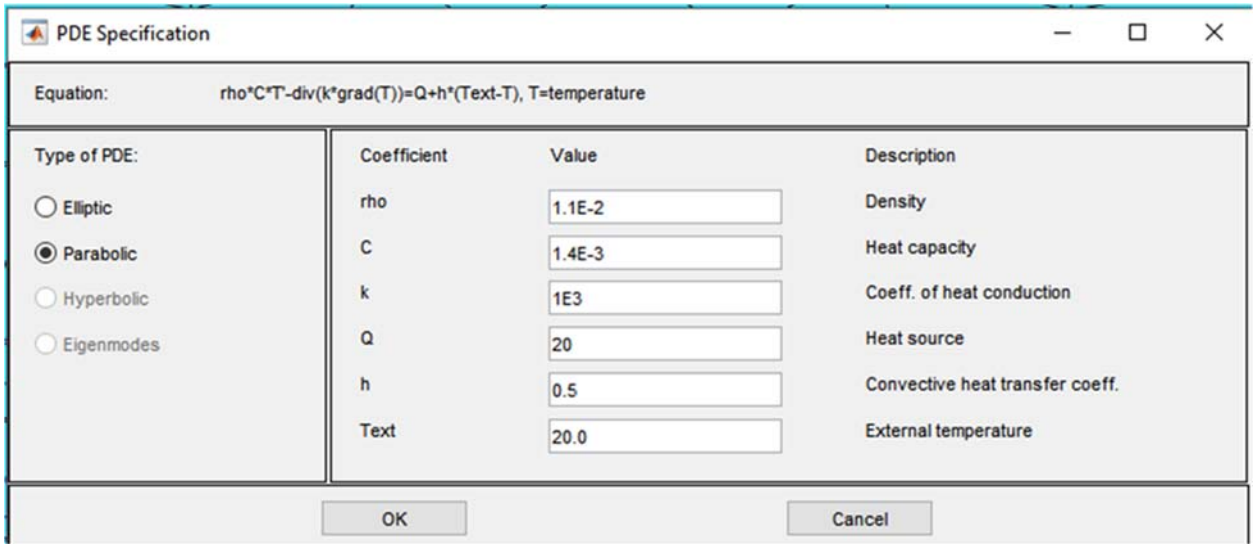

Figure 2 – The dialog box of task of environment initial parameters for the solution of heat conductivity equation

The field of design temperature distribution received in the result of numerical modeling of self-heating of coal congestion on the border 2-3 and its distribution from border into the depth by means of heat conductivity is presented on figure 3.

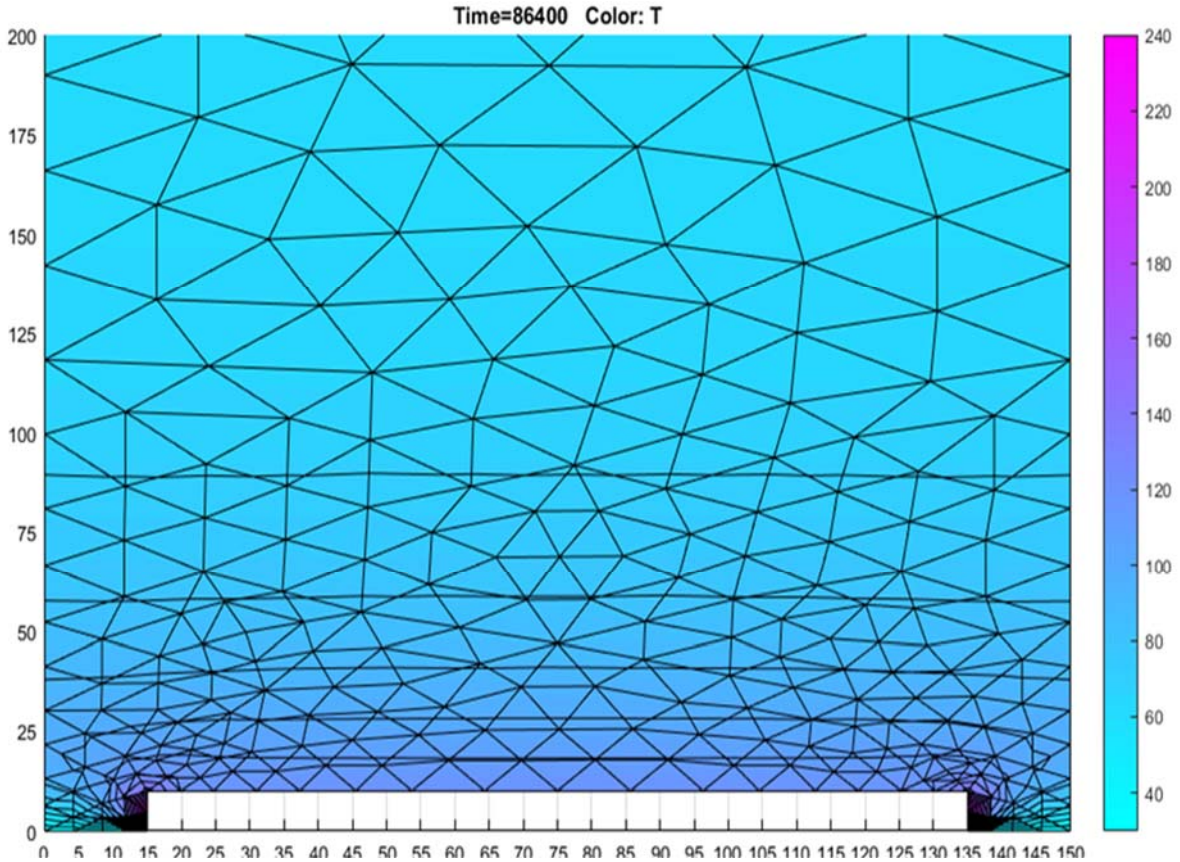

Figure 3 – Graphical representation of the field of design temperature distribution in the process of self-heating of coal congestion.

On a color temperature scale it can be seen that its size decreases with distance from the border of area of coal self-heating. In the interactive mode in the process of modeling it is possible to receive the numerical size of temperature in any point of the explored area of the mined-out space.

Numerical values of design temperature in the process of modeling and research of temperature change of coal congestion in course of time are given in table.

Numerical values of design temperature in the process of modeling by a finite element method

Distance from the border of self-heating, m	Temperature (°C) within time τ		
	τ = 1 hour	τ = 1day	τ = 5 days
1	119	117	111
10	110	103	101
25	101	93	87
50	82	72	63
100	66	51	40
125	65	47	30
150	63	44	26
175	61	42	24
200	59	41	22

Results of numerical modeling show that in the absence of inflow of thermal energy by means of oxidation process continuation (atmospheric oxygen access termination) temperature quickly enough decreases to safe, close to temperature of the surrounding massif. This process of temperature distribution by means of heat conductivity from a self-heating zone into the depth of the mined-out space substantially depends on heat physical parameters of the environment and quality of isolation. As the coefficients of heat conductivity and thermal diffusivity of the nubbly-porous medium modeling the goafed coal congestion is substantially less, than of monolithic coal, transfer of thermal energy and temperature in the environment occurs very slowly.

The given example shows that processes modeling of heat transfer in the environment of special package of application programs allows to receive fuller problem solution of temperature distribution on the basis of the classical equations of heat conductivity.

Conclusions:

1. The main objective of mathematical modeling of thermal processes and calculations by numerical methods in the theory and practice of prevention of the endogenous fires consists in the possibility of finding the places of spontaneous combustion for their localization and elimination.

2. In practice of the research of coal self-heating and self-ignition engineering and empirical techniques for calculations and forecasting of distribution of fire-explosive zones are often used.

3. For process modeling of temperature distribution from coal self-heating in the mined-out space of lava it is more expedient to apply the approved software packages specially focused on the solution of difficult physical tasks and allowing to receive more exact and full decisions.

Н. М. Сулейменов[1], Ш. К. Шапалов[2], Г. С. Саттарова[3],
Б. О. Сапаргалиева[4], С. Б. Иманбаева[3], В. Н. Босак[5]

[1] М. Әуезов атындағы Оңтүстік Қазақстан университеті, Шымкент, Қазақстан;
[2] SILKWAY Халықаралық университеті, Шымкент, Қазақстан;
[3] Қарағанды техникалық университеті, Қазақстан;
[4] Абай атындағы Қазақ ұлттық педагогикалық университеті, Алматы, Қазақстан;
[5] Беларусь мемлекеттік ауыл шаруашылығы академиясы, Горьки, Белоруссия Республикасы

ӨҢДЕЛГЕН КЕҢІСТІКТЕ КӨМІРДІҢ ӨЗДІГІНЕН ҚЫЗУЫ КЕЗІНДЕ ТЕМПЕРАТУРАНЫҢ ТАРАЛУЫН ИМИТАЦИЯЛЫҚ САНДЫҚ МОДЕЛЬДЕУ

Аннотация. Аннотация. Термодинамикалық тотығу, өзін-өзі қыздыру және көмірдің тұтану процестерін зерттеу терминал параметрлерінің көптеген әсер етуші факторларға тәуелділігін зерттеу үшін қажет. Көмірді жерасты тәсілімен өндіру практикасында өндірістік агрегаттардың (лавалардың) қазылған кеңістігінде көмірдің өздігінен тұтану жағдайлары жиі кездеседі. Бұл жағдайда міндеттердің бірі-өндірілген кеңістіктің түтікшелі-кеуекті ортасының еркін нүктесіндегі температураны анықтау. Бұл күрделі міндетті шешу қажеттілігі метанның жарылыс қаупі бар шоғырлануы бар жерлерде авариялық жағдайлардың туындау ықтималдығына негізделген. Көмірдің әрбір қабаты мен сорты үшін өрт қауіптілігінің жай-күйін бағалаудың жеке көрсеткішін әзірлеу, негіздеу және қабылдау қажет болуы мүмкін.

Авариялық жағдайларда кейінгі жедел шешімдер үшін бассейндік деректер базасын құру мақсатында шахталардың проблемалық учаскелерінде эндогендік өрттердің туындауының талданатын және зерттелетін жағдайлары бойынша заттай өлшеулер мен бақылаулардың нәтижелерін жүйелендіру және әдістемелік өңдеу ұсынылады.

Түйін сөздер: өңделген кеңістіктер, қышқылдану, көмірдің өздігінен қызуы, көмірдің өздігінен жануы, температураның таралуы, жылу өткізгіштік, сандық модельдеу,жартылай туындылардағы дифференциалдық теңдеулер,численное моделирование, қолданбалы бағдарламалар пакеттері.

Н. М. Сулейменов[1], Ш. К. Шапалов[2], Г. С. Саттарова[3], Б. О. Сапаргалиева[4], С. Б. Иманбаева[3], В. Н. Босак[5]

[1] Южно-Казахстанский университет им. М. Ауезова, Шымкент, Казахстан;
[2] SILKWAY Международный университет, Шымкент, Казахстан;
[3] Карагандинский технический университет, Казахстан;
[4] Казахский национальный педагогический университет им. Абая, Алматы, Казахстан;
[5] Белорусская государственная сельскохозяйственная академия, Горьки, Республика Белорусь

ЧИСЛЕННОЕ ИМИТАЦИОННОЕ МОДЕЛИРОВАНИЕ РАСПРОСТРАНЕНИЯ ТЕМПЕРАТУРЫ ПРИ САМОНАГРЕВАНИИ УГЛЯ В ВЫРАБОТАННОМ ПРОСТРАНСТВЕ

Аннотация. Исследования термодинамических процессов окисления, саморазогрева и самовоспламенения угля необходимы для изучения зависимости терминальных параметров от множества влияющих факторов. В практике добычи угля подземным способом нередки случаи самовозгорания угля в выработанных пространствах производственных агрегатов (лав). В этом случае одна из задач состоит в определении температуры в произвольной точке бугристо-пористой среды выработанного пространства. Необходимость решения этой сложной задачи обусловлена вероятностью возникновения аварийных ситуаций в местах с взрывоопасной концентрацией метана. Не исключено, что для каждого пласта и сорта угля необходимо разработать, обосновать и принять индивидуальный показатель оценки состояния пожарной опасности.

Предлагается систематизировать и методически обрабатывать результаты натурных измерений и наблюдений по анализируемым и расследуемым случаям возникновения эндогенных пожаров на проблемных участках шахт с целью создания бассейновых баз данных для последующих оперативных решений в аварийных ситуациях.

Ключевые слова: выработанные пространства, окисление, самонагревание самовозгорание угля, распределение температуры, теплопроводность, дифференциальные уравнения в частных производных, численное моделирование, пакеты прикладных программ.

Information about authors:

Suleimenov Nurlan Muhtarovich, PhD student in 6D073100 “Life safety and environmental protection”, Southern Kazakhstan state university named after M. Auyezov, Shymkent, Kazakhstan; sunumu@mail.ru; https://orsid.org/0000-0001-8875-2204

Shapalov Shermakhan Kuttibaevich, PhD, Departments of Chemistry and Biology SILKWAY International university, Shymkent Kazakhstan; shermakhan_1984@mail.ru; https://orsid.org/0000-0002-3015-5965

Sattarova Gulmira Saparovna, Candidate of Technical Sciences, Associated Professor of the Department of «Mine aerology and a labor safety» NAO " Karaganda Technical University» Kazakhstan; sattarovags@mail.ru; https://orsid.org/0000-0002-9764-2311

Sapargaliyeva Bayan Oralkhanovna, PhD, Postdoctoral, Abai Kazakh National Pedagogical University, Almaty, Kazakhstan; bonya_sh@mail.ru; https://orcid.org/0000-0001-7119-2466

Imanbayeva Sveta Bakhytovna, PhD student l student the Department of «Geology and exploration of mineral deposits», Karaganda technical university, Kazakhstan; svetakaz77@mail.ru; https://orsid.org/0000-0003-0049-2642

Bosak Viktor Nikolayevich, Candidate of Technical Sciences, Associated Professor of the Department “Life safety and Environmental protection”, Belarusian state Agricultural Academy, Gorky, Republic of Belarus; bosak_1tyt.bu; https://orsid.org/0000-0001-7197-2315

REFERENCES

[1] Tregubov D.G., Bondarchuk M.G. Modeling of processes of thermal self-ignition // Problems of fire safety. 2009. Issue 25. P. 185-189.

[2] Yemelin P.V., Iskakov K.Z. Pilot studies of the process of heatmass transfer in the mined-out space of stope ores // Materials of the II International scientific and practical conference "Наукататехнологii: крок в майбутне-2007". Vol. 7. Dnipropetrovsk, 2007. P. 74-79.

[3] Chekhovskikh A.M., Davydov E.G., Kalyakin G.V., Yemelin P.V. Calculation of the temperature field in the mined-out space // Works of the XI symposium on burning and explosion. Chemical physics of processes of burning and explosion. Chernigolovka, 1996. Vol. 1. P. 192-195.

[4] Calculation of temperature and concentration fields and their distribution in the mined-out spaces // Report on academic research work. Head is Chekhovskikh A.M. Karaganda, 1993. 62 p.

[5] Research of processes of gases filtration and coal self-heating in the mined-out spaces of production units of coal mines. Emelin P.V. Dissertation of Candidate of Technical Sciences. Karaganda, 1998. 116 p.

[6] Pashkovskiy P.S. The endogenous fires in coal mines. Donetsk: Knowledge, 2013. 791 p.

[7] Gluzberg E.I. Mathematical model of process of coal self-ignition // News of Higher Education Institutions. Journal of mining. 1971. No. 4. P. 62-66.

[8] Gluzberg E.I. Theoretical bases of the forecast and prevention of the mine endogenous fires. M.: Nedra, 1986. 159 p.

[9] Bayev Kh.A. Main differential equations of processes of coal self-ignition. – In: Safety issues in coal mines: Collection of research papers of MakSRI. M.: Nedra, 1969. P. 77-88.

[10] Vengerov I.R. Thermophysics of mines and mining plants. Mathematical models. Vol. 1. Analysis of paradigm. Donetsk: Nord-press, 2008. 632 p.

[11] Vengerov I.R. Thermophysics of mines and mining plants. Mathematical models. Vol. 2. Basic models. Donetsk: «Donbass» publishing house, 2012. 684 p.

[12] Paskonov V.M., Polezhayev V.I., Chudov L.A. Numerical modeling of processes of heat-mass-transfer. M.: Science, 1984. 284 p.

[13] Tikhonov A.N., Samarskiy A.A. Equations of mathematical physics. M., 1966.

[14] Potemkin V.G. Matlab – the system of engineering and scientific calculations. In 2 volumes.

[15] Ryndin E.A., Lysenko E.A. The solution of problems of mathematical physics in the Matlab system: Textbook. Taganrog, 2001. 162 p.

[16] Partial Differential Equation. Toolbox Documentation. Official publication.

[17] Zenkevich O. A finite element method in engineering. M.: Mir, 1975. 539 p.

[18] Khojayev R., Gabaidullin R., Lis S., Shapalov Sh., Akimbekova N., Ivahnuk G. Wave properties of coal-bearing strata // News of the National academy of sciences of the Republic of Kazakhstan. Series of geology and technical sciences. 2019. Vol. 4, No. 436. P. 145-150. ISSN 2518-170X (Online), ISSN 2224-5278 (Print), https://doi.org/https:/10.32014/2019.2518-170X.108

[19] Khojayev R., Gabaidullin R., Lis S., Shapalov Sh., Medeubayev N., Ivahnuk G. Regularities of rock pressure distribution under safety pillars and coal stratum edges // News of the National academy of sciences of the Republic of Kazakhstan. Series of geology and technical sciences. 2019. Vol. 3, No. 435. P. 225-230. ISSN 2518-170X (Online), ISSN 2224-5278 (Print), https://doi.org/https:/10.32014/2019.2518-170X.108

[20] Suleimenov N.M., Shapalov Sh.K., Khodzhayev R.R., Shaikhova G.S., Kaliyaskarova A.Zh., Kakenova M.Zh. Computerized Analytical System for Assessing Fire and Environmental Safety of Mines in the Karaganda Coal Basin // International Journal of Engineering Research and Technology. 2020. Vol. 13, No. 6. P. 1133-1136. ISSN 0974-3154, doi.org/https:/0000-0001-8875-2204 © International Research Publication House. http://www.irphouse.com

[21] Bosak B.N., Suleymenov N.M., Gabaydullin R.I., Naukenova A.S., Aitureyev M.Zh., Junusbekova S.Sh., Shapalov Sh.K. Recognition of stages of emergence and development of the endogenous fire in coal mines // Bulletin of NAS RK. 2018. Vol. 3. P. 107-112. ISSN 2518-1467 (Online), ISSN 1991-3494 (Print).

[22] Shapalov Sh.K., Khodzhayev R.R., Suleimenov N.M., Naukenova A.S., Khuangan N., Rakhimberlina A.A., Altybaev Zh.M. Cumulative influence of informative features on the assessment of the condition of the fire situation in the sealed areas of coal mines // News of NAS RK. Series chemistry and technology. 2018. Vol. 2, No. 428. P. 56-60. ISSN 2518-1491 (Online), ISSN 2224-5286 (Print).

[23] Sapargalieva B., Naukenova A., Alipova B., Illari J.R., Shapalov Sh. The Analysis of Heat And Mass Properties of the Fire Extinguishing Powder in Effectiveness Criteria" // Bulletin of the National academy of sciences of the Republic of Kazakhstan. Series of Geology and Technical Sciences. 2018. Vol. 4(430). P. 51-61.

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 сайте:

www:nauka-nanrk.kz

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

http://www.geolog-technical.kz/index.php/en/

Редакторы *Д. С. Аленов, М. С. Ахметова, Р. Ж. Мрзабаева*
Верстка *Д. А. Абдрахимовой*

Подписано в печать 15.04.2021.
Формат 70x881/8. Бумага офсетная. Печать – ризограф.
13,0 п.л. Тираж 300. Заказ 2.

Национальная академия наук РК
050010, Алматы, ул. Шевченко 28, т. 272-13-19, 272-13-18