відношення максимального поєднання навантажень цієї будови до мінімального і не повинно перевищувати 1,7, що необхідно враховувати при розрахунку зусиль в елементах прогонової будови для визначення його міцності , стійкості і довговічності.

Список літературы

1. Руководство по проектированию транспортерных галерей / **Липницкий М. Е. Пасынков Б. П, Ним А. Д.** и др.// - М.:Стройиздат, 1979.-131 с.

2. Пособие к СНиП 2.09.03-85 - Пособие по проектированию конвейерных галерей. Стройиздат, 1989.

3. СН 245-71 Санитарные нормы проектирования промышленных предприятий. – М. Стройиздат, 1972.

4. ДБН В.1.2-14-2009. Общие принципы обеспечения надёжности и конструктивной безопасности зданий, сооружений, строительных конструкций и оснований. /Минрегионстрой Украины. 2009

5. **Диллон Б.** Инженерные методы обеспечения надежности систем / Диллон Б., Сингх Ч. -М.: Мир, 1984. 318 с.

6. **Томаков В.И.** Прогнозирование техногенного риска с помощью "Деревьев отказов": Учебн.пособие / Курск.гос.техн.ун-т. Курск, 1997. -99 с.

7. Нормативні документи з питань обстежень, паспортизації, безпечної та надійної експлуатації виробничих будівель і споруд. Затв. спільним наказом Державного комітету будівництва, архітектури та житлової політики України та Держнаглядохоронпраці України від 27 листопада 1997 р. за №32/288. – К.: НДІБВ, 2003. – 145 с.

8. Правила оцінки фізичного зносу житлових будинків КДП 75.11 – 35077234. 0015 :2009 Київ – 2009. Затв. наказом №21 від 03.02.2009. – 50 с.

9. **Перельмутер А.В., Сливкер В.И.** Расчетные модели сооружений и возможность их анализа. – К.: ВПП «Компас», 2001. – 448 с..

10. **Болотин В.В.** Применение методов теории вероятностей и теории надёжности в расчётах сооружений. -М.: Стройиздат, 1971.

11. НПАОП 45.2-1.01-98 Правила обстежень, оцінки технічного стану та паспортизації виробничих будівель і споруд.

12. ДБН В.1.2-14-2009. Загальні принципи забезпечення надійності та конструктивної безпеки будівель, споруд, будівельних конструкцій та основ. К. 2009. 45 с

13**. Мельчаков А.П.** Расчет и оценка риска аварии и безопасного ресурса строительных объектов. (Теория, методики и инженерные приложения): учебное пособие. – Челябинск: Изд. ЮУрГУ, 2006. –49 с.

14. **Борджес Дж.Ф., Равара А.** Проектирование железобетонных конструкций для сейсмических районов. – М.: Стройиздат, 1978.

15. **Мартемьянов А.И.** Проектирование и строительство зданий и сооружений в сейсмических районах. - М.: Стройиздат, 1985.

16. **Курмаев А.М.** Сейсмостойкие конструкции зданий. Справочник. – Кишинев: Картя Молдовеняска, 1989.

Рукопись поступила во редакцию 14.04.16

UDC 661.52: 662. 2

I. L. KOVALENKO[1], Ph.D., Assoc.Prof., N.I. STUPNIK[2], Doctor of Science, Prof., Rector,
V. Z. NEBOGIN[3], Director, M. K. KOROLENKO[4], General Director, I. A. KARAPA[4], Head of Technical Department, E. P. ONOPRIYENKO[5], Director, V. S. RYCHKO[6], Technical Director
[1] Ukrainian State Unversity of Chemical Engineering, [2]Kryvyi Rih National University,
[3] Co.Ltd "NTT Tehnotron", [4] PrJSC "Zaporiz'kyi Zalizorudnyi Kombinat", [5] Co.Ltd "Ukrvzryvtehnologiya", [6] PJSC "Kryvoriz'kyi Zalizorudnyi Kombinat"

DEVELOPMENT OF NATIVE EQUIPMENT AND TECHNOLOGY OF DRILLHOLES CHARGING WITH EMULSION EXPLOSIVES OF MARK UKRAINIT

The absence in Ukraine of native technology and compact mixing-charge equipments restrains the use of bulk emulsion explosives in the tunnel faces in underground mining. The solution to this problem is the relevance of this work. The aim is to develop technology and native mixing-charge equipment for charging drillholes with emulsion explosives of mark Ukrainit. A special feature of the emulsion explosive Ukrainit is peroxide gas generation of "cold" emulsion, which ensures its high detonation characteristics and operability as well as minimum harmfulness of explosion gases. Gas filling time of the emulsion is reduced to 15-25 minutes due to the introduction of the catalyst in the structure of gas-generating additive, and the detonation velocity is increased to 5000-5200 m/s. Portable mixing-charge equipment "СЗС-1", compact chargers "ЗЭП-15", "ЗЭП-10" and self-propelled charger "ЗЭВС-1", equipped with dosing pumps of the original design, which provides a balanced dosage (within 0.8-1.2% in the gas-generating additive) and high-quality mixing in the necessary proportions, are developed. A distinctive feature of the self-propelled charger "ЗЭВС-1" from the existing analogs is the usage of an additional low-power diesel engine providing the work of dosing pumps wile charging drillholes in poorly ventilated faces. This reduces fuel consumption and waste gases emissions, which is extremely important for conducting blasting work in dead-end faces.

Completely standalone and does not requiring connection to the mine pneumatic and electric grids, self-propelled charger "ЗЭВС-1" should occupy a niche in conducting tunnel blasting works in mines with section 9-15 m^2 and charging 2-3 faces per shift.

Keywords: emulsion explosives, mixing-charge equipment, drillholes.

The problem and its connection with scientific and practical tasks. Improvement of blasting works using bulk emulsion explosives (BEE) for mining with underground method is one of the most promising trends, which has gained significant spread in the global mining practice [1-3] in the last decade. Bulk emulsion explosives most fully satisfy all the modern requirements to the explosive materials used in underground conditions.

Analysis of studies and publications. An analysis of scientific, technical and patent information on the technics and technology of underground mining with the use of bulk emulsion explosives as well as visiting foreign mines implementing the technologies of emulsion explosives charging in underground conditions have shown that the creation of mechanization means of such blasting works is a long and complicated process requiring joint efforts of scientific, engineering, industrial and technological structures.

The world's leading companies – «Orica», «AEL», «BME» – have designed self-propelled and portable chargers, which are successfully used by foreign mining companies for charging drillholes with emulsion explosives. There were no such equipment and technology in native practice of underground mining and the problem of implementation of BEE in underground conditions due to the acquisition of made mixing-charge equipment cannot be solved.

The success of the application of any emulsion explosives is enabled due to the effectiveness of the whole complex, which includes: "*The explosive and the principle of its sensabilization*" and "*mixing-charge equipment and charging technology*". In this case, the components of this complex are so interrelated that it is meaningless to talk about the acquisition of mixing-charge equipment separately from technology of emulsion explosives.

Therefore, in the world practice company developers sell manufacturing technology of emulsion base and its sensabilization to obtain explosives and, as a rule, pass charging equipment to the rent (leasing).

Another factor in Ukraine limiting the development of emulsion technology for underground application is significantly smaller volumes of explosives consumption (from 1.5 to 3.5 thousand tons/year) compared with the open pit mining with significant financial costs at the initial stage.

The group of companies "Turstroy" together with Co. Ltd "Ekkom" and Co. Ltd "NTT Tehnotron" has successful experience in complex implementation of bulk emulsion explosives technology Ukrainit and mixing-charge trucks of series "Ukrainit" on mining and processing combines of Kryvbas (annual volume of about 45.0 thousand tons) [3]. This allowed these companies to initiate in terms of domestic iron ore and uranium mines the implementation of BEE Ukrainit as an alternative to toxic TNT-containing materials.

The main advantages of emulsion explosive Ukrainit are:

the use of an aqueous solution of non-organic peroxides as the gas-generating additive (GGA) that provides emulsion gas filling with microbubbles of oxygen;

the absence of toxic products of explosion due to the balanced composition and to almost 100% completion of all chemical reactions of explosive decomposition of emulsion explosives;

the possibility of a "cold" gas-generation and weakly alkaline nature of the emulsion, which provide a sufficient safety level of the use in sulfide-containing rocks [4, 5];

high detonation velocity (at least 4500 m/s), and as a consequence – the powerful destruction of the rocks of any hardness with a qualitative fragmentation (the complete absence of oversized and defects of the soles);

the formation of water vapor in the gas composition after the explosion that precipitates the harmful emissions, which is particularly important for underground conditions.

Modern mixing-charge machines (MCM) for the producing of emulsion explosives using gas-generation offered by foreign manufacturers [1, 2] have various design features, but the concept schemes usually assume the following equipment: a screw pump of emulsion supplying with feed of gas-generating additive with screw pump into a suction tract of a screw pump of emulsion supplying, a

static mixer of emulsion explosives components, a control system of components dosing (according to the number of rotations of screw pumps), a control system of dosing process, etc.

The screw pumps are widely used in MCM due to their high reliability, the ability to change the productiveness of the components feeding over a wide range, the presence of "dry run" (body heat) sensors and so on. However, screw pumps have significant drawbacks. In applied schemes the exact dosing of the components is provided through the matching and control of rotations of the emulsion feeding screw pump and the GGA feeding screw pump. This requires the use of expensive system of proportional hydraulics and quite complex system of control and automation of MCM. Despite the high cost of MCM attached equipment, reaching 500 thousand dollars, the use of screw pumps does not provide complete safety in the producing of emulsion explosives since GGA is fed into the suction pipe of the emulsion pump. In this time explosive, which remains in the system when the pump is switched off, already begins to form in the pump.

In addition, screw pumps according to weight and dimensions are not suitable for the creation of a compact self-propelled mixing-charge equipment for the forming of drillholes charges. It is also necessary to note that the systems of deposits development and mining technologies in underground mining are fundamentally different from the work in the quarries and the conditions of application of mixing-charge equipment is much stronger and tougher.

Statement of the problem. Develop the technology and native mixing-charge equipment for charging the drillholes with emulsion explosives of mark Ukrainit.

The material and results. The GGA task dosing when mixing with the emulsion in a portable charger is resolved on a principally new scheme of piston pump with hydraulic control and rigid mechanical connection of the main emulsion pump and dosing pump of gas-generating additive feed with the possibility of its smooth regulation [6]. At the first stage the prototype of the proposed piston pump of “simple” action with ability of GGA insertion directly into the emulsion at the outlet of the pump with high quality mixing of emulsions and GGA is designed.

Later the specialists of “NTT Tehnotron” have developed the design of the piston dosing pump of “double” actions “НД-200”, on its base the prototype of the portable experimental mixing-charge stand of model “СЗС-1” is produced. It should provide high quality of automatic dosing and mixing of the components with mechanized feeding the resulting emulsion explosives into drillholes.

The basic mining enterprises for industrial testing of drillholes charging technology with stand “СЗС” are PrJSC “Zaporiz’kyi Zalizorudnyi Kombinat”and SE “VostGOK” – the companies with the most advanced technologies of mining having self-propelled tunneling complexes and significant amounts of use of regular TNT-containing explosives (Ammonite No. 6 ZhV and Grammonite 79/21).

In March 2009 at the mining shaft “Operational” for the first time in the history of Ukraine's mining operations there were conducted experimental explosions of bulk emulsion explosive Ukrainit-PP-2B, as a result, the commission noted the following: full detonation of borehole charges, high efficiency (at the level of Ammonite No. 6 ZhV) and water resistance of emulsion explosive Ukrainit, uniform crushing of the rock mass and compliance of mine contour line with the project, coefficient of borehole use is about 0.9-0.95 on shales, quartzites and hematite-martite and martite ore (with a hardness on scale of prof. Protodyakonov from8 to 18), low level of seismic action and gas contamination of the mine after the explosion, high productiveness and safety of drillholes charging as well as the reliability of the mixing-charge stand. Later the process of testing was continued at the VostGOK’s mines “Ingul’s’ka” and “Smolinski” on rocks with hardness up to f = 20.

According to test results it was initiated complex of research and development works to eliminate the identified deficiencies. In particular, there arose a question of increasing the velocity of gas-generation of “cold” emulsion under conditions where the time from the drillholes charging till the explosion is 15-20 minutes. Tests at VostGOK’s mines also showed the need to increase the detonation velocity of drillholes emulsion explosive charges up to 5000-5200 m/s, which can be achieved by increasing the rate of chemical reaction of explosive transformation of explosive’s components [7].

The conducted studies have shown that the solution to this problem can be achieved due to the change of the composition of both the emulsion composition and the gas-generating additive (“ГГД-У”) [8] by introducing into its composition a catalyst (hydrochloric acid). Fig. 1 shows the data on the degree of gas-generation (GG) of emulsion explosive Ukrainit-PP-2 in presence of catalyst.

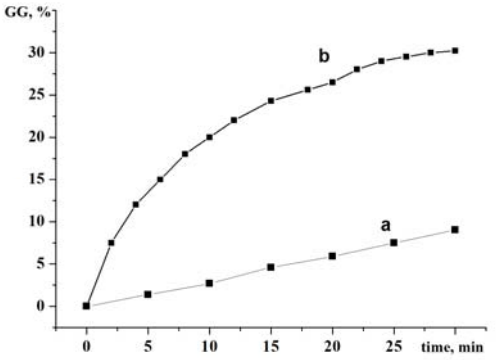

Fig. 1. The dynamics of peroxide gas-generation of emulsion Ukrainit-PP-2: *a* – without catalyst; *b* – in presence of catalyst

Researches have shown that the introduction of the hydrochloric acid into the gas-generating additive "ГГД-У" both increases the rate of gas-generation and ensures the formation in the system (at the initial moment of explosion) the nitrosonium chloride (NO_2Cl), which has a catalytic effect on the thermal decomposition of ammonium nitrate and emulsions based on it [9].

According to the research complex there are modified compositions of emulsion (ТС U 24.6-19436711-006: 2006) and the gas-generating additive (ТС U 24.6-19436711-005: 2006) applying to the underground conditions

The next step was the development of compact borehole chargers "ЗЭП-15" made by specialists of 'NTT Tehnotron", "Ukrvzryvtehnologiya" and "Zaporiz'kyi Zalizorudnyi Kombinat".

Compact charger of model "ЗЭП-15" [10] has the original water drive of dosing pump connected to the shaft water supply. This almost silent unit in 2009-2010 years had several complex industrial tests in various hydro and geological conditions at the mines "Heading" and "Operational" (PrJSC "Zaporiz'kyi Zalizorudnyi Kombinat", Dniprorudne), "Smolinski" and "Ingul's'ka" (SE "VostGOK"), "New" (LLC "East-ore", Zhovti Vody), "Kryvoriz'kyi Zalizorudnyi Kombinat" and "Sukha Balka" (Kryvyi Rih).

Totally during the period of industrial tests (from 2009 to 2013 year) eight chargers of model "ЗЭП-15" (ТС U 28.9-23647075-016:2012) prepared and charged in mechanized way into drillholes over 220 tons. of emulsion explosive of Ukraine-PP-2 (ТС U 20.5-32613399-002:2012). In 2013 charger "ЗЭП-15" was allowed to constant use and exploitation by State Service of Mining Supervision and Industrial Safety of Ukraine.

Further development of the native line of mixing-charge equipment for mine workings sinking was the development of two modifications of charger of model "ЗЭП-10" [11]. In the period from 2011 to 2015 years the design documentation has been developed, prototypes have been successfully produced and full-scale industrial tests have been successfully held under conditions of iron ore mines of "Zaporiz'kyi Zalizorudnyi Kombinat" and "Kryvoriz'kyi Zalizorudnyi Kombinat" as well as uranium mining plant VostGOK

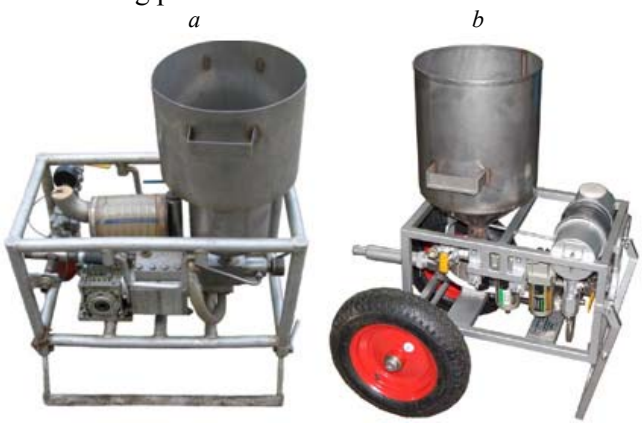

Fig. 2. Compact portable charges: *a* - model "ЗЭП-10"; *b* - model "ЗЭП-10-01"

The four-years experience in prototypes testing of mixing-charge stand "СЗС" and portable chargers of models "ЗЭП-15" and "ЗЭП-10" showed that along with the advantages and benefits of a small-sized portable mixing-charging equipment for mechanized charging of bore holes this direction has a number of drawbacks. So, small size and minimal weight of chargers also cause low power of their drives. In addition, the use of such chargers places high demands on the pressure stability, on the flow rate and the degree of contamination of the mine compressed air (process water), on the accuracy of components and parts manufacturing, on the stability of emulsion explosives components by the rheological and physico-chemical parameters.

In 2010-2012 years with financial and technical support from manufacturers of components of emulsion explosives Ukrainit-PP-2 (Co. Ltd "Ukrvzryvtehnologiya", Kharkiv) further development work for the implementation of the underground bulk emulsion explosives has led to the design of the self-propelled mixing-charge machine of model "ЗЭВС-1" (Fig. 3).

Fig. 3. Self-propelled charger of model "ЗЭВС-1м"

Self-propelled charger of model "ЗЭВС-1" [12] as standard has two-stage waste gas cleaning system, automatic fire-extinguishing system of the running diesel engine, the compartment for transportation of cartridges and initiation means.

The design of the self-propelled charger of model "ЗЭВС-1" for charging drillholes with emulsion explosives without significant increasing of the cost and with maintaining the small size has two mixing-charge circuits with two becomponent piston dosing pumps of double action of the original design of model "НД-30". Construction of these dosing pumps provides balanced dosing (within 0.8-1.2% by GGA) and high quality mixing of emulsion and GGA in the required proportion. Mixing is realized in a special chamber at the inlet of the static mixer and the charging hose and dosing principle allows to eliminate expensive proportional hydraulic equipment and programming electronics. Automatic blocking of the process takes place in case of absence of GGA supply, heating and pressure increase in the paths of preparation-filing emulsion explosive.

The second distinguishing feature of the charger "ЗЭВС-1" from the existing analogs is the use of additional low-power diesel engine providing the work of dosing pumps when loading drillholes in poorly ventilated faces. In existing analogs of mine MCM the oil station drive is actuated by diesel of running gear, which is in an order more powerful than the oil station diesel of attached pumping equipment.

Application in the "ЗЭВС-1" design of additional low-power diesel engine reduces the consumption of diesel fuel and emission of waste gases, which is extremely important for conducting blasting works in dead-end faces.

Preliminary tests conducted in the hardest conditions of the mine under construction of "Zaporiz' kyi Zalizorudnyi Kombinat" (Pereverzevskoe ore field) confirmed the compliance of the design of the prototype to requirements of "Uniform Safety Rules". During the nine months of exploitation of charger of model "ЗЭВС-1" 60 tons of emulsion explosive Ukrainit-PP-2 were produced and charged in extremely flooded drillholes. It was noted the effectiveness of the catalytic neutralizers of the running engine and the engine of pump equipment oil station and the water scrubber for neutralization of waste gases.

Completely standalone and not requiring connection to the mine pneumatic and electric systems the modernized self-propelled charger of model "ЗЭВС-1м" due to the relatively low cost, ease of maintenance and small size must occupy a niche of conducting tunnel blasting works in mines with section 9-15 m^2 and charging 2-3 faces per shift.

The table shows the characteristics of the developed native mixing-charge equipment for charging drillholes with emulsion explosives compared with foreign models.

Comparative characteristics of the mixing-charge equipment for tunneling using emulsion explosives

Characteristics	The name and model of mixing-charge equipment						
	Stand "СЗС"	ЗЭП-15	"ЗЭП-10	ЗЭВС-1	Mini Loader	PCU	PP-4
Manufacturer, country	Co.Ltd "NTT Tehnotron", Ukraine				ORICA,	AEL, RSA	BME, RSA
Mark of emulsion explosive	Ukrainit-PP-2				Subtek, Civec	UG100, UG200	Mega-pamp TM
Productivity, kg/min.	20,0-80,0	10,0-15,0	10,0-15,0	30,0x2=60,0	15,0	27,0	20,0
Volume of the emulsion tank, l	7,0-150,0	15,0	20,0	360,0	from 600,0 of cubic containers	n/d	12,0x2=24,0
Volume of the GGA tank, l	up to 5,0	1,4	2,0	up to 10,0	n/d	n/d	~1,0

Drive unit	Electrohydraulic/ pnevmohydraulic	water /pnevmo	pnevmo	disel-hydraulic	pnevmo	hydro/ pnevmo	pnevmo
Dimensions, LxWxH, mm	1100x1000x 1200	800x700 x600	500x990x 850	4500x1900x 2300	900x510x 560	n/d	700x420 x 290
Mass, kg	from 300,0	up to 40,0	from 37,0	3400,0	48,0	n/d	14,0

Conclusions and directions for further research: An effective technology as well as native and portable self-propelled mixing-charge equipment for charging drillholes with emulsion explosive brand of markUkrainit are developed.

Further studies involve the development of technology and native equipment for charging drill-holes with emulsion explosive Ukrainit in underground conditions.

Список литературы

1. **Guang, Wang Xu** Emulsion explosives / **Wang Xu Guang**. – Beijing: Metallurgical Industry Press, 1994. – 388 p.
2. **Колганов, Е. В**. Эмульсионные промышленные взрывчатые вещества. В 2 кн. Кн. 1. Составы и свойства./ **Е. В. Колганов, В. А. Соснин**. — Дзержинск.: ГосНИИ «Кристалл», 2009. — 592 с.
3. Розробка і впровадження емульсійних вибухових речовин на кар'єрах України / під ред. **В. П. Купріна, І. Л. Коваленка**. — Дніпропетровськ: ДВНЗ УДХТУ, 2012. — 243 с.
4. Взаимодействие эмульсионных взрывчатых веществ и их компонентов с сульфидными минералами/ **И. Л. Коваленко, В. П. Куприн** //Взрывное дело. – 2010. – Вып. №103/60. – С. 154-170. – ISSN 0372-7009.
5. Ингибирование взаимодействия пирита с аммиачноселитренными ВВ/ **И. Л. Коваленко, В. П. Куприн** // Сучасні ресурсоенергозберігаючі технології гірничого виробництва. – 2013.– Вип. 1 (11).– С.84-91. – ISSN 2074-1537.
6. Пат. 19784 Україна МПК7 F04B 13/00. Пристрій для дозованої подачі одного компоненту в потік іншого / **Крисін Р. С., Колєсаєв М. Б., Купрін О. В., Небогін В. З., Савченко М. В.** (Україна). - № u200610277; заявл. 26.09.2006; опубл. 15.12.2006, Бюл. № 12.
7. Физика взрыва: в 2 т. [под ред. **Л. П. Орленко**].-Т.1 - М.: Физматлит, 2002. — 832 с.
8. Пат. 82960 Україна МПК C01B 15/00, C06B 31/00. Газогенеруюча добавка до емульсійних вибухових речовин/ **Коваленко І. Л., Купрін В. П.** (Україна). – № u201301321; заявл. 04.02.2013; опубл. 27.08.2013, Бюл. №16.
9. Влияние хлоридов феррума (III) и купрума (II) на термическое разложение энергонасыщенных систем на основе аммиачной селитры/ **И. Л. Коваленко** // Праці Одеського політехнічного університету.— 2013.— Вип. 3(42).— С. 233—237. – ISSN 2076-2429.
10. Пат. 62192 Україна МПК F42D 1/10, C06B 21/00. Зарядник емульсійних вибухових речовин ЗЕП-15/ **Зубко, А. М., Карапа, І. А., Колєсаєв М. Б., Небогин В. З.** (Україна). - № u201105501; заявл. 29.04.2011; опубл. 10.08.2011, Бюл. № 15.
11. Пат. 67340 Україна МПК F42D 1/10, C06B 21/00, F04B 9/00. Пневмонасос-зарядник емульсійних вибухових речовин ЗЕП-10/ **Колєсаєв М.Б., Небогин В.З., Онопрієнко Є.П., Савченко М.В.** (Україна). - № u201111226; заявл. 21.09.2011; опубл. 10.02.2012, Бюл. № 3.
12. Пат. 82519 Україна МПК F42D 1/10, C06B 21/00. Зарядник емульсійних вибухових речовин самохідний ЗЕВС-1/ **Небогин В. З., Онопрієнко Є. П., Шкарін В. В.** (Україна). - № u201111226; заявл. 21.09.2011; опубл. 10.02.2012, Бюл. № 3.

A manuscript entered release 18.04.16

УДК 622.831

А.В. СОЛОДЯНКИН, д-р техн. наук, С.В. МАШУРКА, инженер
ГВУЗ «Национальный горный университет», г. Днепропетровск

ОЦЕНКА ИНТЕНСИВНОСТИ РЕМОНТНЫХ РАБОТ И УСТОЙЧИВОСТЬ ПРОТЯЖЕННЫХ ГОРНЫХ ВЫРАБОТОК

Показано, что с увеличением глубины разработки и отработкой запасов в сложных горно-геологических условиях, существенно ухудшилась геомеханическая ситуация при ведении горных работ. В статье делается анализ подходов к оценке устойчивости протяженных горных выработок и общих затрат при их строительстве и эксплуатации. Учитывая стохастическую природу выработки, как сложного подземного объекта, рассматривается вероятностная модель выработки. Для оценки состояния конкретного сечения выработки предлагается использование коэффициента устойчивости. В качестве параметра для оценки состояния протяженного участка выработки рассматривается показатель устойчивости. На основе обобщения данных об объемах ремонтных работ по выработкам шахт объединения «Добропольеуголь», показана возможность определения показателя устойчивости ремонтируемой выработки на каждом этапе ее эксплуатации. Вводится понятие интенсивности ремонтных работ в выработке. Получены зависи-