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Increase of Efficiency of Extinguishing of Rock Dumps on the Surface of Coal Mines

S O Versilov¹, N A Vil'bitskaya¹, V M Kurdashov¹

¹Department of mining, Platov South Russia State Polytechnic University (NPI),
Prosveshcheniya St. 132, Rostov region, Novocherkassk, 346428, Russia

E-mail: versilov@bk.ru

Abstract. The most effective technical solutions have been those that provide for the supply of substances used for extinguishing to the combustion zone of the rock dump. When quenching rock on the rock dump is proposed injection (blowing) in a dry extinguishing agent, represented by crushed vermiculite (hereinafter referred to as the extinguishing agent), in pure form or in a mixture with alkaline substances. The problem of developing methods of extinguishing rock dumps, characterized by low cost and high efficiency, in the absence of additional environmental pollution is very relevant. The technology of suppression of waste rock dumps include the injection of suspended particles of vermiculite in contrast to the clay slurry or solution (suspension) of antipyrine. This allows to penetrate into the surface layer of the middle and upper part of the blade and insulate its lower part with non-combustible material.

1. Introduction

In the Russian Federation, the work on extinguishing and reclamation of burning dumps is carried out at the expense of the Federal budget within the framework of measures for restructuring the coal industry. Technological schemes, recommended by the main current regulatory document (instructions for the prevention of spontaneous combustion, extinguishing and dismantling of rock dumps), are characterized by the following shortcomings:

- high cost of work associated with the movement of significant amounts of rock mass in the reformation of rock dumps and large amounts of water used to cool the burning hearths and layers of rock dumps;
- the widespread use of water and its spreading will lead to additional pollution of the environment;
- preservation of conditions for self-ignition of rocks after rescheduling of rock dump and possible strengthening of the process of self-ignition and combustion due to the decrease in density and increase in the coefficient of loosening of processed rocks.

Existing technical solutions for rock extinguishing on rock dumps by injection of solutions or suspensions into it also have their significant disadvantages [1-10]. For example, cooling of rock pieces is uneven. After the termination of the fluid is heating up due to surviving the heat and continuing the physical-chemical reactions. The used lime suspension, which has an alkaline medium, is designed for deposition on the surface of the rock debris. Acidic environment favorable for the development of thionic bacteria is neutralized. They contribute to the activation of physical and



chemical processes in rocks, accompanied by their heating and spontaneous combustion. The use of lime can not neutralize the entire volume of acidic medium due to blockage and isolation of individual zones and cavities of different sizes.

Deposition (formation) on the surface of the debris of the clay crust will lead to cracking after drying and the absence of the effect of insulation of the debris. Therefore, the displacement of combustible gases and sulfur vapors from the inter-inlet space can not be achieved in full, that is, the foci can be partially extinguished, and after stopping the supply of solutions or suspensions, the combustion process will resume [11-24]. The attempt to extinguish the burning hearth with the help of drilling mud carried out on the rock dump at the pit № 5 of the Yuzhnaya mine of Rostovugol, JSC, proved to be ineffective. Thus, it can be argued that none of the above methods has not been fully tested and can not be considered reliable. Held in the Donetsk Polytechnic Institute experienced fighting dumps way download burning hearth water, solution of lime, mud reliable yielded no results and was discontinued. Redevelopment of the rock dump with simultaneous extinguishing of existing hot spots, will loosen the rock, and contribute to the emergence of new ones.

2. Problem's statement and methods of its solution

Currently, there are about 600 rock dumps formed over more than a century in the territory of Eastern Donbass. These rock dumps of coal mines and processing plants have a high ability of spontaneous combustion. It should be noted that in the Rostov region more than 40 dumps are in the combustion stage. This was facilitated by the fact that due to the mass liquidation of coal mines in the region, the work on the reclamation of rock dumps was stopped. The vast majority of dumps are not recultivated. Natural landscaping is very slow or not carried out at all.

The algorithm of works on extinguishing burning hot spots can be performed in the following sequence. Initially, a temperature survey is carried out on the burning rock dump, which aims to identify the boundaries and characteristics of hot spots of rocks. The survey is carried out by punching holes in the body of the rock blade, in which the temperature of the host rocks is measured by means of thermocouples. After establishing the boundaries of burning fires in them through the holes left from the shooting of the temperature and additionally completed, the injection of dry powdered extinguishing agents. Moreover, the injection begins with holes located on the border of the hearth and continues in the direction of the central part. This method will ensure the safe conduct of work. Please follow these instructions as carefully as possible so all articles within a conference have the same style to the title page. This paragraph follows a section title so it should not be indented.

At the initial stage, a non-studied substance is injected, which begins to swell under the influence of high temperature. Then, for additional impact on the hearth, the injection of the swollen substance is carried out, which will fill the void space in places with low temperature of the host rocks. On a number of foci, only the injection of the swollen substance is carried out, which allowed a comparative assessment of the effectiveness of different methods of extinguishing.

A distinctive feature of vermiculite is the ability to swell during firing, repeatedly increasing in volume. The essence of the phenomenon lies in the fact that under the pressure of the molecular water turning into steam, delamination and rapid swelling of vermiculite granules occur, and moreover, so significant that the worm-like columns or filaments (depending on the grain size in the cleavage plane) are formed with golden or silver color with a transverse division into the thinnest scales. In the process of heating the material of the rock pile vermiculite swells to form a fine-porous material. The size of the particles increases in the direction perpendicular to the mica layers by 20-30 times.

In this case, the swollen material fills the existing cavities, creating an obstacle to the movement of air, isolates the burning hot spots and, as a material with low thermal conductivity, prevents heat exchange between burning pieces of rock. The effectiveness of the proposed substance on the hearth depends on the behavior of the hearth – increased combustion of the hearth leads to a greater swelling of the extinguishing agent and increased impact on the hearth, i.e., the hearth extinguishes itself, and alkaline substances, reducing the acidity of rocks, have anti-pyrogenic effect. It should be noted that

the most common vermiculite in nature, formed from magnesium-ferruginous mica — phlogopite or biotite, will be of practical importance.

3. Discussion

To establish the effectiveness of work to extinguish the burning foci, repeated temperature surveys were carried out in the places of their conduct, after 5 and 10 days. In order to establish the nature of the interaction of the burning hearth of rocks and extinguishing agent, a subsequent opening of a number of hearths subjected to extinguishing is provided. For pilot-industrial work at the initial stage, vermiculite fractions of 0.5 mm and 2.0 mm were used, which have the lowest cost and at the same time differ in size.

The schematic diagram of the injection device consists of an air compressor, hoses, loading device, dispenser and pipe produced, lowered into the hole. As the experience of the use of swollen vermiculite in different areas of activity shows, it has a high moisture capacity. For complete elimination of foci of burning rocks, in the final stages of stewing in the hole pumped water, which is kept extinguishing material. The use of dry crushed substance instead of solution, eliminates the ingress (flow) of extinguishing and preventive substances into the soil, which reduces their negative impact on the environment and more saturated to process the surface layer of the rock dump, the most prone to spontaneous combustion.

In practice, the experimental work on extinguishing the burning hearths were made on one of the burning rock dumps of the coal mine of the Eastern Donbass. Burning hearths were located in the cracks of the rock pile formed during the subsidence (landslide) of the rock composing the blade. Extinguishing of burning foci was carried out by free filling of extinguishing substances into cracks before their appearance on the surface. No injection of substances into cracks or adjacent areas was carried out.

Extinguishing was carried out in seven points. After filling of the substance, the passage of gases along the walls of cracks was noted in places, which then faded out during the first hours after the beginning of the experiment. A day later, in three cases, there was a complete attenuation of the process, in three cases there was a significant decrease in the intensity of combustion.

4. Conclusions

If the free filling of the extinguishing agent in the cracks, where the combustion centers were located, showed a fairly high efficiency of the method, then the forced injection of the substance into the combustion centers will increase the reliability of their extinguishing. In addition, the substance will interfere with the development of new foci, swelling as they form. For prevention, alkaline reagents can be added to the extinguishing agent, which will prevent the formation of an acidic medium. Thus, the improvement and application of the above methods of extinguishing the burning hearths of rock dumps of coal mines will allow:

- significantly reduce the cost of work to extinguish them;
- reduce the risk of spontaneous combustion of rocks;
- increase the level of safety of work;
- improve the efficiency of fire extinguishing;
- exclude additional pollution of the environment by means of fire.

5. References

- [1] Zborshchik M P, Osokin V V, Paniotov Yu N 2001 *Izvestiya Vysshikh Uchebnykh Zavedenii, Gornyi Zhurnal* **6** 53-61
- [2] Lindström J, Försth M 2016 *Fire Technology* **52**(2) 309-319
- [3] Zhang D.-S, Liu Y.-D, Wang A, Wang Y 2007 *Journal of Coal Science and Engineering* **13**(4) 471-475
- [4] Hu Z, Xia Q 2017 *Applied Thermal Engineering* **122** 27-38
- [5] Versilov S O, Posyl'nyy Y V, Shurygin D N, Tretyak A Y 2017 *IOP Conference Series: Earth*

- and Environmental Science* **87(5)** 052033
- [6] Białecka B, Grabowski J 2016 *International Multidisciplinary Scientific GeoConference Surveying Geology and Mining Ecology Management, SGEM* **2** 561-568
- [7] Wasilewski S, Skotniczny P 2015 *Gospodarka Surowcami Mineralnymi / Mineral Resources Management* **31(1)** 155-182
- [8] Misz-Kennan M, Gardocki M, Tabor A 2014 *Coal and Peat Fires: A Global Perspective* **3** 350-385
- [9] Ciesielczuk J, Bzowska G, Paszkowski M 2014 *Coal and Peat Fires: A Global Perspective* **3** 476-491
- [10] Stetsenko I A, Shurygin D N, Grushko I S 2016 *Procedia Engineering* **150** 2392-2398
- [11] Ciesielczuk J 2014 *Coal and Peat Fires: A Global Perspective* **3** 464-473
- [12] Nádudvari A 2014 *International Journal of Coal Geology* **128-129** 47-54
- [13] Machacek Z, Hajovsky R 2013 *Elektronika ir Elektrotechnika* **19(7)** 53-56
- [14] Shurygin D N, Gorbatenko N I, Grechikhin V V, Shaykhutdinov D V 2016 *Journal of Engineering and Applied Sciences* **11(12)** 2764-2768
- [15] Kruszewski T 2013 *International Journal of Coal Geology* **105** 91-109
- [16] Biočanin R, Stefanov S, Urošević S, Mekić S 2012 *Ecological Chemistry and Engineering S* **19(4)** 609-616
- [17] Misz-Kennan M, Ciesielczuk J, Tabor A 2012 *Coal and Peat Fires: A Global Perspective* **2** 233-311
- [18] Knapp S, Gerth A, Klotz S *World of Mining - Surface and Underground* **64(4)** 253-261
- [19] Posyl'niy Y V, Versilov S O, Shurygin D N, Kalinchenko V M 2017 *IOP Conference Series: Earth and Environmental Science* **87(5)** 052022
- [20] Evans K G, Saynor M J, Willgoose G R *Land Degradation and Development* **10(6)** 507-522
- [21] Keim M F, Gassmann B, Markl G *American Mineralogist* **102(7)** 1482-1500
- [22] Shurygin D N, Kalinchenko V M, Tkachev V A, Tretyak Y A 2017 *IOP Conference Series: Earth and Environmental Science* **87(5)** 052026
- [23] Solovov D B, Merkusheva A E 2016 Novel active current transducers for diesel power stations *International Journal of Power Electronics and Drive Systems* **7(1)** 152-158. [Online]. Available: <http://dx.doi.org/10.11591/ijpeds.v7.i1>.
- [24] Ciesielczuk J, Kruszewski, Ł., Majka, J. 2015 *International Journal of Coal Geology* **139(1)** 114-141