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INCREASING THE LEVEL OF ENVIRONMENTAL SAFETY DURING THE BLASTING OPERATIONS FORMING THE RESOURCE-SAVING CHARGE

The extraction of non-metallic mineral has been a major source of pollution to the environment due to the various techniques involved in the process. In open pit and underground mining' Blasting is the main technique of cracking theses rocks out of their rock mass which involves the use of explosives. This blasting procedures generates great amount of dust and gases into the environment, which is highly detrimental. This research work tends to reducing the level of environmental pollution during the application of advanced charge design using zeolites to create a buffer zone between borehole and rock mass.

Keywords: Blasting operation, environmental safety, gaseous emission, dust generation, environmental hazards zeolite, mining.

Introduction. Quarrying is a type of land use process involved in the extraction of non-metalic minerals from the earth crust. Rock. sand, gravels and limestone are obtained through quarrying for building houses and other civil construction [1]. Regrettably, these activities cause significant impact on the surrounding environment. In fact, the extraction process normally relies on heavy machines and explosives, where both processes are normally associated with air pollution, noise pollution, damage to biodiversity and habitat destruction in addition to water as well as soil [2]. Extraction of mineral is broadly divided into three basic methods know as, open-pit or surface mining, undergone mining and solution mining. However, Open-pit or surface mining and Underground mining, makes use of extensive blasting[3]. Mining Complex (COD) as one of the economic types of activity, is a serious polluter of the natural environment. An open method of mining leads to water and air pollution, changes, disturbance of structure and deterioration of quality of fertile soil layer, to significant landscape disturbances. This causes, in turn, death or degradation of flora and fauna [4]. Open-pit mining is described as surface mining methods for exploitation of the ore-bodies starting from or near the ground surface. Surface mining activities often cause environmental pollution by producing and emitting dust, toxic fumes or gases. These pollutants can be produced during blasting, loading, hauling, and crushing processes, mineral processing and tailing disposal, waste dumping, and access road construction and development. It is not usually possible to avoid the production of pollutants; they must, however, be controlled [5]. Moreover, the potential impacts of a certain technological phase in mining to the environment depend on a wide range of local factors such as the nature of ore and rock mass, geological and geotechnical parameters, extraction methods, generated and natural waste, nature and vulnerability of local constituents of the environment. The quantity of gases produced during blasting at the open pits is about 1000 dm3 /kg of explosives. In gaseous mining products, the toxic gases are also encountered, such as: carbon monoxide, sulfur dioxide, nitrogen oxides, sulfur dioxide, and others depending on the blasting conditions [6].

Blasting generates tremendous amount of dust particles and gases, these particles can cause greater harmful effects to human health, which depends on the compositions of the dust as the main diseases are related to asbestos and silica, in other cases the dust contains heavy metals susceptible to produce specific diseases such as lead. This occurs when it is made up of dioxide of crystalline silica in the form of alpha-quart, cristobalite and tridymite, due to its carcinogenic nature. It has been that particles less than 10 μm in diameter pose the greatest problems, because they are not retained by barriers in the nose, such as cilia and mucus, and they penetrate through the respiratory tract; the coarse fraction tends to lodge in the tracheobronchial tree, while the fine particles are settled in the bronchioles and the alveoli and some may even get into and some may even get into the

bloodstream [7].

Table 1: Dust sources in mineral sites (Gonzalo Morera and Vall González, 2018)

Operation and equipment	Emission mechanism	Primary source	Secondary source	Relative potential contribution to total site dust levels
Drilling and blasting	Air flush from drilling and from force of blast	+	−	Small
Loading and dumping	Dropping material from height	−	+	Moderate
Draglines	Dropping material from heights	−	+	Large
Crushing and preparation	Impact, abrasion and dropping from heights	+	−	Large
Conveyors	Dropping from heights	0	+	Small
Haulage roads	Raised by Tyres, exhaust and cooling fans	0	+	Large
Storage piles	Wind blow, high wind speeds	0	−	Small

The table above shows that the primary source of dust in mining sites is from drilling, blasting and crushing preparations while the secondary source is from loading, dumping haulage roads, draglines and conveyors.

In the process of blasting, the gaseous detonation products of explosives would consist of water (H_2O), carbon dioxide (CO_2), and nitrogen (N_2). Due to the kinetics of the chemical reaction, the detonation of explosives in a blasting operation also produces toxic nitrogen dioxide (NO_2), nitric oxide (NO), and carbon monoxide (CO) [8].

The NO_x is a group of highly reactive gasses, They are toxic chemicals that help form acid rain and hamper the growth of plants. They also contribute to the creation of ground-level ozone. In combination with some other substances, NO_x can cause major human respiratory problems, and may lead to shortness of breath, irritated nose and eyes, nausea and fluid forming in lungs. A high amount of NO_x can cause visual impairment, reduced oxygen intake, a larger buildup of fluids in lungs, swelling of throat, rapid burning spasms and even death [9].

Presently, a prevailing technique in the development of mineral resources is the open technique, which is described as the most cost effective and efficient. It is the development of mineral resources using open technique that causes the highest damage to the components of the environment. Specifically, pollution with the micro dispersed dust and harmful gases, which relies on both natural factors and the technology for carrying out mining operations [10].

Purpose and objectives of the research. Increasing the level of environmental safety during the blasting operations forming the resource-saving charge using zeolites to form the damper zone between borehole and rock mass. Process of environmental pollution as a result of mass explosions in the quarries of non-metallic minerals.

Research materials and results. Zeolites are microporous hydrated aluminosilicates with exchangeable cations, and open channel systems in their lattice structure. They are made up of infinitely extending three dimensional networks of SiO_4^{4-} and AlO_4^{3-}tetrahydra linked by shared Oxygen atoms (1-4). The frameworks form cages and channels in which the exchangeable cations can enter. Caused by the substitution of tetravalent silicon by trivalent aluminium charge deficiency this has to be balanced by incorporation of loosely bound monovalent and divalent cations of alkali and alkaline earth element [11].

The diagram below is a Developed Charge structure, there is gap between the charge device and the rock mass where the research material zeolite will be placed before the detonation of the explosive.

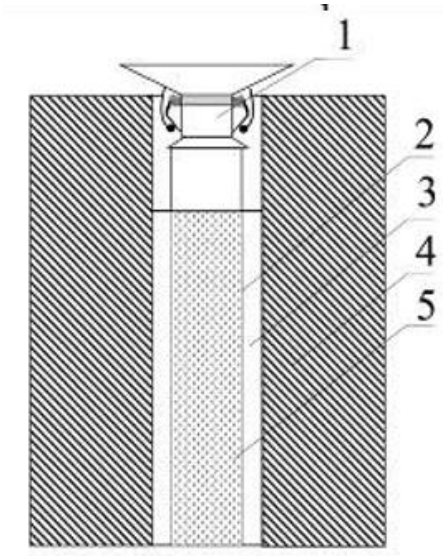

Diagram 1. Developed charge Structure [O. Tverda]
1-device for feeding a plastic sleeve; 2.- plastic sleeve; 3- gap between the charge and the wall of the borehole; 4-rock mass; 5-explosive

Clinoptilolite will be used for this research due to the following reasons:

1. Thermal stability,
2. Structural rigidity,
3. Adsorption efficiency.
4. Good Ion exchange capacity
5. Affordability and availability.

Although the best choice of Zeolite would have been the synthetic, because of their engineered channel networks, controlled pore shape and size as well. as calculatingly modified surfaces [12], but the cost implication is a hug disadvantage.

Table 2. Zeolites and their properties [Ersin P, Mehmet K, et al]

Zeolite	Porosity [%]	Heat stability	Ion exchange capacity [meq/g]	Specific gravity [g/cm^3]	Bulk density [g/cm^3]
Analcime	18	high	4.54	2.24-2.29	1.85
Chabezite	47.45	high	3.84	2.05-2.10	1.45
Clinoptilolite	34	high	2.16	2.15-2.25	1.15
Erionite	35	high	3.12	2.02-2.08	1.51
Heulandite	39	low	2.91	2.18-2.20	1.69
Mordenite	28	high	4.29	2.12-2.15	1.70
Philipsite	31	moderate	3.31	2.15-2.20	1.58

The above table shows the name of some natural Zeolites and their properties of porosity, heat stability, ion exchange capacity, specific gravity and bulk density.

Conclusion. It is expected that the use of zeolite in the resource saving charge would significantly reduce the amount of gases, dust and fines generated and emitted during blasting. If this is achieved the rate of pollution cursed by these particulate matters and gases to the environment and the inhabitants both within and far will drop. If enterprises use the resources saving charge

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