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Review

Examining the effect of physical, chemical and biological harmful factors on miners

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ABSTRACT:

Mining is considered as a difficult and harmful job as it is done in a very difficult physical and environmental condition. In addition to that, miners are exposed to the dangers, damages and even death because of the bad condition of mines. The dangers of mines are different in accordance with the kind of mine which may be underground or surfaces. The dangers may be a bit different in different cities and mines. Main harmful factors in mining are the physical damages, hyperthermia, hearing loss, lung diseases, musculoskeletal diseases and facing with dangerous gases and beams. The purpose of this essay is to examine the effect of physical, chemical and biological harmful factor on miners. This survey has adopted descriptive method and data are collected by library method. The results showed that the exposure of chemical factors such as dust, methane and silica, and physical factors such as noise, radiation, and biological factors may have great danger for miners.

Keywords:

Harmful factors, Miners, Physical-chemical dangers.

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INTRODUCTION

Factors that cause death, serious damages, and disabilities of miners are the hygienic issues to be considered. The mentioned factor may be dust; mine gases, noise, and other similar factors which their slow influence is not identifiable at first and the victim adopt himself with the hearing, vision, and respiratory defective system. Therefore, the victim will not notice the disease in himself until his visual or hearing system be examined by a doctor. Facing the dust almost exist in most of the construction operations such as urban tunneling, constructing, demolition of old buildings and cleaning the old buildings. Dust may contain different amount of free silica particles in terms of the nature of the used materials in the industry of constructing. The free crystalline silica (SiO_2) exists in three forms such as Quartz Crystal, Tridymite, and Cristobalite. The most important common type of silica particle is Quartz (Neghab and Choobineh, 2007). Reports about facing with free silica in construction industry showed the outbreak of problems in facing with the Quartz in the process of mining and steel production (Amandus *et al*., 1995).

According to the database of Iran mines, 6208 surface mine exist in the country and many people are working in mines and dependent on industries. Working in mines have too many difficulties and miners face with many kinds of dangers and diseases. Unlike what it seems, the amount of accidents in mines are not more than the accidents in other parts of the industry. Based on the revealed report of the social security organization, the number of accidents happened for the insured workers working in mines in 2012 was 20532 which 735 of them were working inside the mines. Study about preventing accidents in mines is seriously continued in parallel with surveys about the method of work and applying advanced tools and technologies. Happening of accidents and diseases which are caused from working in mines requires evaluating risks and dangers existed in mines with a better perception and prevent further accidents by using previous experience (data base of Iran mines).

Harmful factors in mines and their effect on workers' health

Particulate matter in the atmosphere is one of the main harmful factors in the workplace of surface mines just like the dust of stones, gases, the vapour of chemical substances, high sound, vibration, heat stress and ergonomic problems. Workers who are in touch with them for a long time will face health diseases.

Chemical harmful factors

At the end of 19^{th} century, the crystalline silica which has the most severe risk of Silicosis was used in dry drilling for a long time. Long-term exposure with crystalline silica may lead to chronic obstructive pulmonary disease. Some evidence exists that the silicosis will intense and facilitates the rheumatoid arthritis and kidney failure in case of facing with silica for a long time. There are some evidences that showed that silicosis may intense and facilitate the rheumatoid arthritis and renal disease in case of long term facing with silica. Now there is enough evidence to the fact that long-term facing with crystalline silica will increase the risk of lung cancer. In developed countries this risk has decreased in a significant amount by depositing particles, air conditioning system, and respiratory protection, yet care and vigilance are necessary for effective control. According to the long history in developed countries, mining and asbestos mill led to lots of diseases dependent to asbestos. This task is continued by facing the particles of diesel engines in underground mines because of applying drilling tools and mobile transportation with diesel fuel. In the classification of carcinogens, the particle comes from diesel motors are placed in group A_2 which are probably carcinogens for a human. Many epidemiology studies have offered that these particles increase the risk of cancer. Control prevention consists of using diesel fuel

with a low density of sulfur, fixing and maintaining motors, and conditioning. Arsenic is a part of metal ores and it will be obtained during copper smelting for commercial purposes which the danger of cancer existence. It is reported that facing with Nickel composition in some of the Nickel refinery increased the risk of lung cancer and Nasal septum cancer. These risks are decreased to a significant level by the improvement of health. Other metal ores such as lead, cadmium, manganese, platinum, and cobalt have health effects. Usually there are more risks during the process of casting and it needs proper control prevention. According to the reports, facing with volatile substances caused from coal tar in aluminum casting increased the risk of lung and bladder cancer. Occupational asthma is also another problem of aluminum casting (Chan-Yeung *et al*., 1982).

Cyanide is used as a solvent in the process of hydrometallurgy of some metals such as copper and gold. Facing with hydrogen cyanide gas can happen during the preparation of cyanide solution. A spray of cyanide solution on the surface of the skin in considered as dangers, although its risk is minimized by the dilute solution. In some gold mining operations, especially in developing countries, still the mercury is used for the separation of gold by creating mercury-gold amalgam. Poisoning can happen because of the breathing mercury vapours during the preparation of amalgam, melt, or distillation. Hydrofluoric acid was used in analyzing the main samples during the drilling and exploration operation. Melting sulfide ore will create sulfur dioxide which will cause acute bronchospasm. Facing with skin irritation in mine is common and mostly lead to dermatitis. Most gases which are diffused in mines consist of methane, carbonic anhydride (carbon dioxide), hydrogen sulfide (density of this gas should be less than 0.01 per thousand before the drilling operation), sulfur dioxide, nitrogen oxides, and carbon monoxide which are the results of using explosive materials. Moreover, a large amount of carbon monoxide and carbon dioxide enter the atmosphere of mine as the result of underground firing or explosion, because of the oxidation of mineral coal and wood, the oxygen consumption is too high in a coal mine which may be more than the consumption oxygen of workers. About the poisoner gases we should pay attention to the proper conditioning and try not to let the amount of each gas go further the allowed threshold. The possibility shortage of oxygen should be considered and by exact calculation of oxygen consumption of all parts, adjusts the permittivity of the atmosphere. So that the different part of the mine will not face a lack of Oxygen (Hashemi *et al.,* 2010).

Dust

Particles suspended in the atmosphere are produced like the dust of rocks mostly in drilling, extracting mineral materials, loading, breaking, and explosion operations. Workers who are in touch with mineral dust for a long time are suffered from a lung disease such as silicosis.

Avoid touching dust especially in the areas that the atmosphere is static if it is possible. The explosion of coal dust and methane in the underground coal mines still remain as a serious problem which needs management and monitoring. Some underground coal mines have the problem of carbon dioxide and hydrogen sulfide. There are a large amount of dust in all mountains slicing operations such as digging gallery, extracting mineral substance, and the spots of loading. The size of the dust is different; this can be varied from 1 micron to 1 millimeter, it is due to the buoyancy of the dust as it is suspended (William *et al*., 2004).

The centers of producing dust are as below

- All digging operation (auguring, trial hole)
- Workplace of extraction machine or tunnels
- Blasting
- Workshop destruction

- Places of loading and docking
- Transportation (because of the collision of wagons).
- Material preparation factory
- The main part of dust is produced during the drilling that it will be maximized about the dry drilling

Methods for controlling and stopping dust in mining operations

- Using humid digging techniques
- Using water spray during the extraction, loading, and breaking operation

In general, mine workplaces should be kept wet and humid for reducing dust.

Gases and chemical substances vapour

Gases are created during the blasting operation and consist of poisonous substances such as sulfur dioxide, nitrogen monoxide, and nitrogen oxide. Workers should not go to the workplace immediately after the end of blasting. They should wait until the complete sedimentation of gases and dust to happen. The gases that come out from the motor of diesel car consisted of harmful fumes and tiny reparable particles. Constant touch with the gases of diesel fuels are harmful to workers' health. Diesel static facilities should not work in a static environment or they are enclosed if it is possible (Walle and Jennings, 2001).

Gritzo gas

It is the most dangerous gas in the atmosphere of mine. The grizo gas is a mix of pure methane and a small degree of hydrocarbons such as ethane, ethylene, hydrogen, carbon dioxide, and nitrogen.

Methane

Methane is colourless, odorless, and lighter than air. The relative density of this gas is burnable and it is equal to 0.554 than the air. Methane was the charred product of plant materials and mostly is created in the geochemical reactions during the formation of coal. Ways of entering methane to the atmosphere of mine is by the continual diffusion of gas from the pores of lateral coal that are hidden and from the holes that are obvious. The gases will be finished soon. Sometimes the diffusion of methane can be felt by putting a hand in front of the gap. A sudden outburst of gas in the impact of collision of tanks and bags of methane are ways of entering methane to the atmosphere of mine. Based on the safety in mine code, the amount of Methane should be less than 1-1.5 percent in mines. The methods for preventing the excess standard of this gas in mine are as below: sucking methane from inside of the layers by the trial hole and extracting methane by drilling gas collector gallery over the gallery extraction. 9.5 percent methane and 90.4 percent air are the best amounts of methane and air in the atmosphere of mines that cause an explosion. The dangerous cutie for the explosion of methane is between 5-12 percent. The reasons of the explosion may be because of lack of attention (turning on matches), the existence of open flame lights, disrespect the regulation of fire working and others. (Zarei *et al*., 2013) the damages are not compensable in all cases. About the damages of dust, if the workplace of patient changed from the dusty environment may make the situation even worse. Those who worked with talc, asbestos, lead, and coal dust particles are exposed to diseases such as lung cancer, mesothelioma, bladder cancer, leukemia, blood cancer, talcosis, chronic bronchitis, nervous system disorders, kidney failure, damage to the male reproductive system function, and etc. the above-mentioned diseases which are called occupational diseases are diagnosed less than often. Sometimes these diseases are inseparable in terms of clinical and laboratory with other chronic diseases that have non-occupational causes. For example, lung cancer which is caused from asbestosis is totally similar to lung cancer which is caused by smoke in term of clinical and pathology. A causal relationship between occupational exposure and disease can be diagnosed in some rare cases, less diagnose about the job diseases reflects the requirements of conducting more courses in the field of occupational medicine (Glynn *et al*., 2008).

B) Physical harmful factors

Noise

Often there is noise in mining. This noise is due to the drilling, blasting, cutting, material handling, conditioning, crushing, transmission and processing of ore. Controlling the noises of mine is very difficult and the problem of sound-induced hearing loss is common in mining.

The heat and humidity

Heat and humidity are prevalent in tropical areas and deep underground mines, where the heat of air and rocks increases with the increase of depth due to geothermal gradient and contraction of the air column. The main problem of South African underground gold mines was fatal heatstroke and heat exhaustion which even survives today. Moisture can cause skin thinning and slimming and may lead to skin disease especially fungal skin disease named tinea versicolor (in some cases about 20% of miners were affected). In addition, muggy mines have a suitable condition for the growth and development of parasites, fungi, and various microbes and the worst is ancylostomiasis (hookworm).

The vibration

The miners experience the whole body vibration while working with portable devices like dump trucks, truck, scraper, and drilling machines. Vibration can lead to spinal disease or aggravate existing disorders. Poor road and equipment maintenance can also aggravate these problems. Hand-arm vibration syndrome is another disadvantage of using vibrating equipment such as pneumatic drills.

The radiations

Exposure to radon in underground mines increases the risk of lung cancer, but today it is controlled using mine ventilation. Exposure to solar UV radiation in shallow mining operations most probably involved in basal cell carcinoma and squamous cells. This is inferred from studies on outdoor workers of other industries but has not shown the risk of melanoma in outer space. Exposure to infrared radiation in the foundry and thermal processes cause heat stress and cataracts. carcinogenic risk of some metal mines have been obvious since long time ago. Also, radium and uranium mines produce exceeded radiations. Radon gas emitted from the surface of mineral stones are very dangerous for lungs and respiratory system. In order to prevent and in addition to considering proper ventilation of mines, workers medical health should be monitored accurately and equipped with personal dosimeters and appropriate personal protective equipment. In some hematite ore mines, a significant quantity of mortality rate from lung cancer has seen which can be the result of receiving exorbitant activity by workers.

Barometric pressure

The barometric pressure increases in deep underground mines and decreases in elevated mines. Chronic intermittent hypoxia (due to physiological adaption) and symptoms of acute mountain sickness are reported. But, High Altitude Pulmonary Oedema (HAPO) and High-Altitude Cerebral Oedema (HACO) are not reported. The increase of barometric pressure increases the air temperature, convective changes and also reduces the amount of sweat evaporate. The pressure of atmosphere also affects the middle ear and annoys the miners. Especially at the time of leaving work and after it, listening congestion occurs, however, the ear pain and inflammation due to the pressure change is not observed. In elevated mines, the person who is not yet compatible may suffer from the lack of oxygen and the reduction of atmosphere pressure that cause the decrease of work efficiency and increase of pulmonary ventilation (breathing); in this case, the threshold value of dust must be decreased.

The darkness

Working in the dark underground increases the nystagmus disease in the miners. Fortunately, the lighting system of underground mines are improved and the use of personal electric lights have reduced the risk

of explosion. A proper lighting system, in addition, to meliorate the working condition, decreases the risks of accidents. Totally, it can be said that in the most modern mines the risks of the natural condition are controlled and the major risks are related to the type of work and applied equipment (Hustrulid *et al.,* 2013).

Biological harmful factors

The risk of tropical diseases such as malaria and dengue are common in some of the remote mines. In the past, leptospira and leptospirosis were rampant in mines, but in developed countries, by eradication of rats and sanitation have controlled the risk environments effectively. There are some cooling towers that are found commonly in the mining sites. Regular microbiological analysis of water is necessary for determining the frequency of *Legionella* infection with a high concentration of heterotrophic microorganisms. In addition to items mentioned above, there is a possibility of accumulation of rodents and reptiles in worn woods and other devices that the mice are a major one and can cause the bloody diarrhea diseases. The colony of insects such as bees that are observed in the woods of mines, snakes, scorpions, and other blood-sucking creatures must not be ignored. In the developing countries, mining is yet an intolerable work and the lack of suitable nutrition is extremely harmful to miners' individual health. The individual health of miners who work in the humid mines is one of their major difficulties. In developed countries, further actions are taken to improve the condition of this working class. These actions include some activities in order to raise the health level, prevention of occupational accidents, ventilation, control of heat and dust, noises, vibration and other harmful factors, and also the use of protective clothes and other safety equipment. The accurate medical cares is an important factor of the timely detection of occupational diseases of miners and taking action to their job changing and avoiding the progression of the disease. In this regard, regular checking up the health of their lung and chest are very effective, this is essential in areas where tuberculosis is common (Hustrulid *et al*., 2013).

Case studies

Taheri and Sereshki (2013) studied the increase of safety and economic efficiency by producing the energy from methane fuel of gas extraction operation in Tabas coal mine. The result showed that with methane gas extraction from Tabas coal mine, where there is the largest volume of supply of Iran's coal, the amount of 8.10 million cubic meters of gas is extracted annually. In addition to producing a huge volume of methane gas as a fuel, this operation helps to solve problems such as social (the death caused by suffocation and gas explosion), safety and environmental problems (greenhouse gas emissions).

Majdi *et al*. (2009) on investigating the occupational lung diseases of turquoise mine workers concluded that age average of workers investigated was 42.9 and the average of their work duration was 11.5. Seven staffs were come down with simple silicosis and one with progressive pulmonary fibrosis; all of them were retired of turquoise mine. Among the 30.3 percent of miners who had abnormal spirometry test, 25% had an obstructive pattern, 4% had a restrictive pattern, and 1.3% had mixed patterns. Results stated that exposure of workers to silica dust, in addition to silicosis disease, lead to increasing of other respiratory problems especially obstructive pulmonary disease. Due to the incurable problems and permanent disability originated from this disease, preventive measures in mines, specifically primary preventive measures are the most effective preventions methods which must be considered by employees, workers, and experts in professional health.

Neghab *et al.* (2011) in a study about the cross-sectional evaluation of the respiratory system in inhalation of amorphous carbon found out that the concentration of respirable dust and carbon respectively

were calculated as 2.302 ± 0.287 and 6.235 ± 1.734 milligrams per cubic meter. Results showed that exposure to the high level of dust and amorphous carbon can cause the significant increase in the prevalence of respiratory symptoms and significant reduction of the average of pulmonary function test parameters with a similar pattern restrictive lung disease.

CONCLUSION

According to the results of studies available on the literature, it was concluded that coal is a valuable export product. But despite its importance in the economic development of countries, health problem of miners is one of the main concerns of those who involved in this profession. Coal is a stone combination of carbon, hydrogen, oxygen, and sulfur along with a large number of rare elements. But the most occupational exposures in the coal mine are to mineral dusts which emerge due to cutting the rocks and handling the waste dust during the coal mining. The relationship between mine industry and various diseases are well-known. The factors such as chemicals like dust, silica, and methane gas increase the risk among the workers. The coal dust is also a serious danger in mining which leads to pneumoconiosis or black lung and chronic obstructive pulmonary disease of coal miners. Respiratory disease symptoms such as cough, sputum, wheezing lungs and shortness of breath were common among the exposed people rather than the reference group and today, the most frequent occupational diseases are lung disease. If lung disease combines with dust and silica, more danger threatens the miners' health. Also, physical factors such as noise, vibration, radiation, heat, and humidity affect the miners' health; for instance, the explosive sound of drilling can lead to hearing loss. Solar UV radiations in shallow mining most probably cause lung cancer. Working in dark underground environment develops nystagmus disease in miners.

REFERENCES

Amandus HE, Shy C, Castellan RM, Blair A and Heineman EF. (1995). Silicosis and lung cancer among workers in North Carolina dusty trades. *Scandinavian Journal of Work, Environment and Health,* 81-83 p.

Chan-Yeung M, Lam S and Koener S. (1982). Clinical features and natural history of occupational asthma due to western red cedar (*Thuja plicata*). *The American Journal of Medicine,* 72(3):411-5.

Glynn JR, Murray J, Bester A, Nelson G, Shearer S and Sonnenberg P. (2008). Effects of duration of HIV infection and secondary tuberculosis transmission on tuberculosis incidence in the South African gold mines. *Aids,* 22(14):1859-67.

Hashemi A, Abdolzadeh A and Sadeghipour HR. (2010). Beneficial effects of silicon nutrition in alleviating salinity stress in hydroponically grown canola, *Brassica napus* L., plants. *Soil Science Plant Nutrition,* 56(2): 244-253.

Hustrulid WA, Kuchta M and Martin RK. (2013). Open Pit Mine Planning and Design, Two Volume Set and CD-ROM Pack. 3rd ed. CRC Press. 1308 p.

Majdi M, Rafeemanesh E, Ehteshamfa SM, Fahool MJ and Masoodi S. (2009). Analyzing occupational lung disease among turquoise miners. *Iran Occupational Health*, *6*(2): 31-37.

Neghab M and Choobineh A. (2007). Work-related respiratory symptoms and ventilatory disorders among employees of a cement industry in Shiraz, Iran. *Journal of Occupational Health,* 49(4): 273-278.

Neghab M, Mohraz MH and Hassanzadeh J. (2011). Symptoms of respiratory disease and lung functional impairment associated with occupational inhalation

exposure to carbon black dust. *Journal of Occupational Health.* 53(6): 432-438.

Taheri A and Sereshki F. (2013). Estimate the optimum horizontal well depth for gas drainage using numerical method in Tabas coal mine. st International conference on Mining, 2013 Sep 16-21; University of Zanjan, Iran, 381 p.

Walle M and Jennings N. (2001). Safety & health in small-scale surface mines: A handbook. 01 January 2001, International Labour Organization. 51 p.

Williams GC, McGregor HA, Zeldman A, Freedman ZR and Deci EL. (2004). Testing a self-determination theory process model for promoting glycemic control through diabetes self-management. *Health Psychology,* 23: 58 – 66.

Zarei M, Ibarretre-Bilbao N, Compta Y, Hourgh M, Jungue C, Bargallo N. (2013). Cortical thinning is associated with disease stage and dementia in Parkinson's disease. *Journal of Neurology, Neurosurgery and Psychiatry,* 84: 875-881.