

idents occurring in Western Lignite Corp. in Turkey, where underground and surface production methods are applied, between 2005 and 2018. It is the first time MPI is used to examine the change of occupational accidents over time. The DEAP 2.1 computer program written by Coelli [1] was used in the solution of the models [2].

Summary of findings

In the current analysis, it was found that the MPI value of 1.038 for openpit mining was not significantly different from that of 1.056 for underground mining (Fig. 1). Production amount decreased with the expected 10-year economic life of the mechanized system operating in underground mining as of 2007. The reduction of underground production amounts is generally attributed to the inefficiency of the mechanized system. In addition, flooding during the commissioning of an underground panel in 2009 caused delays in the commencement of production in another panel. Furthermore, a flood that took place in early 2017 led to an increase in the number of accidents by reducing the amount of production. All these adversities have led to decreases in the efficiency of underground mining during the years considered. However, as a result of the elimination of damage caused by flooding and a change in management level, the production amount increased by 121 percent in 2018 compared to the previous year. As a result of this increase, the underground MPI value reached the level of surface MPI value.

During the years taken into consideration, the elevation of the surface mining level, slope and overburden stockpile distances was increased, the dragline failed for a long time, and excavation was started for the coal reserve under the



Fig. 1 MPI values of surface and underground mining.

overburden spoil heap over the preparation panel. Despite these severe working conditions, it is observed that the technical efficiency does not change. This result indicates that despite the accidents occurring in the surface mining, an appropriate amount of output can be produced and production can be made at an appropriate scale when compared with the underground operation.

When the results obtained are analyzed, the importance of the analyses made over the past years in the mining sector, which contains many risks and uncertainties, emerges. In the light of these analyzes, each enterprise will be able to take appropriate measures for working conditions. Thus, as a result of the measures taken, a reduction in accidents can be achieved as well as the ability to produce on an appropriate scale. ■

References

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Underground mine air and strata temperature change due to the use of refuge alternatives

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To read the full text of this paper (free for SME members), see the beginning of this section for step-by-step instructions.

Special Extended Abstract

Heat and humidity buildup within refuge alternatives (RAs) may expose occupants to physiological hazards such as heat stress. U.S. Mine Safety and Health Administration (MSHA) regulations require RAs in underground coal mines to provide a life-sustaining environment for miners trapped

underground when escape is impossible. RAs are required to sustain life for 96 hours while maintaining an apparent temperature below 95 °F (35 °C). The U.S. National Institute for Occupational Safety and Health (NIOSH) tested a 10-person tent-type RA, a 23-person tent-type RA, and a six-person metal-

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type RA in its underground coal mine facilities to investigate the thermal environment over a 96-hour period. The test results showed that mine air and mine strata temperatures surrounding an RA occupied by simulated miners increased over the 96-hour test period. The test results suggest that RA manufacturers should consider this increase in temperatures when calculating and evaluating RA components during surface and laboratory tests. The findings can equip stakeholders with additional considerations for calculating the interior heat and humidity temperature profiles for occupied RAs not tested in situ.

Background

One of the major considerations for integrating RAs in underground mines is the thermal condition inside the RA and the impact that the surrounding mine environment has on the temperature and humidity buildup. The resulting internal thermal conditions, if not controlled, can subject miners to conditions that can lead to heat exhaustion, heat stroke or even death, depending on the duration and magnitude of exposure. MSHA regulations require that RAs must be designed to ensure that the internal apparent temperature does not exceed 95 °F (35 °C) when the RA is fully occupied. A component of the overall thermal environment surrounding an RA is the initial mine air and strata temperatures. The NIOSH research discussed in this paper focuses on investigating the RA thermal response in an in-mine environment by conducting 96-hour tests on three types of RAs in NIOSH's underground coal mine facilities.

Approaches

Tests were conducted using three different mobile RAs: a 10-person tent-type RA, a 23-person tent-type RA and a six-person metal-type RA. The temperature of mine air and mine strata were recorded during the tests. During the tests, a certain amount of power was delivered to all the simulated miners to represent human metabolic heat and heat generated by equipped device. The mine air temperatures at the start and the end of the test were recorded for each type of RA. Also, the mine roof, rib and floor temperatures at the start and end of the 96-hour tests were recorded.

The test data show that the mine air and mine strata surface temperatures increased almost immediately after the simulated miners were powered, while the temperatures deeper into the strata did not increase for several hours, or

even days. The results indicate that the mine strata temperature at a depth of 4 ft is nearly constant over the test period. For the 10-person tent-type RA test, the average mine air temperature increased by about 3 °F, the average mine strata surface temperature — averaged over roof, rib and floor measurements — increased by about 8 °F, and the average mine strata temperature at a depth of 12 in. increased by about 3 °F. During the 23-person tent-type RA test, the average mine air temperature increased by about 4 °F, the average mine strata surface temperature increased by about 8 °F, and the average mine strata temperature at a depth of 6 in. increased by about 6 °F (Fig. 1). Finally, for the six-person metal RA test, the average mine air temperature increased by about 2 °F, the average mine strata surface temperature increased by about 5 °F, and the average mine strata temperature at a depth of 6 in. increased by about 4 °F.

Conclusion

The test results suggest that RA manufacturers should consider the temperature increase of the air surrounding the test RA by adjusting conditions during their tests conducted on the surface to account for the mine air and strata temperature increases observed in these underground tests. Instead of actual exterior air temperature adjustments, the RA manufacturers can also account for the temperature increase by using calculations based on these test data. However, it is worth noting that the temperature increase will vary with the type of RA, its maximum occupancy and the surrounding environment.

The test results — temperature rise of the mine air and mine strata — can also be used to determine the derated occupancy of the related refuge alternatives to improve the post-disaster survival and rescue of mine workers. ■

Disclaimer

Mention of a company name or product does not constitute an endorsement by the National Institute for Occupational Safety and Health (NIOSH). The findings and conclusions in this paper are those of the authors and do not necessarily represent the views of NIOSH.

References

A list of references is available in the full-text paper.

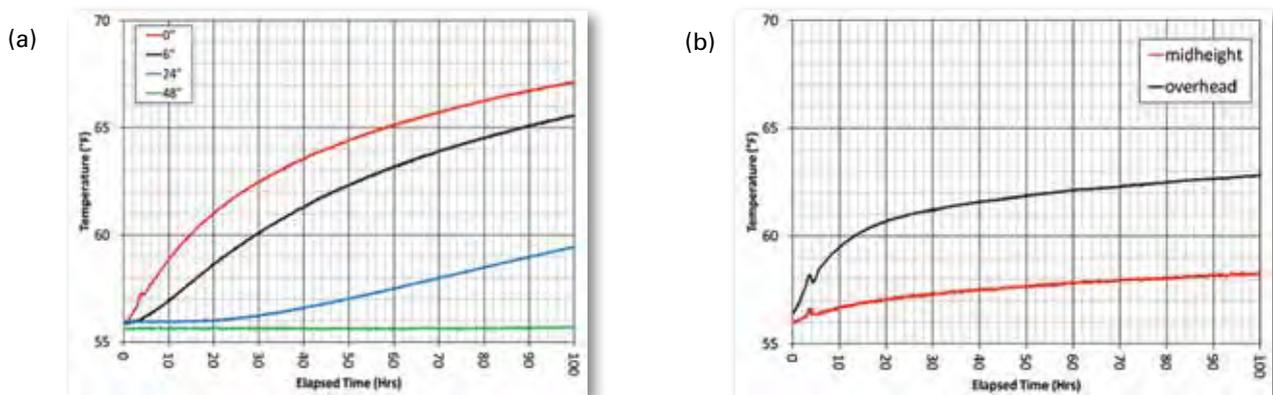


Fig. 1 (a) Mine floor strata temperature (various depths) and (b) mine air temperature (averaged) profiles for the 23-person tent-type RA.

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