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Analysis of pressure drop variation due to obstacles in mine ventilation networks using simulation

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ABSTRACT: Appropriate ventilation in underground mines is one of the most important factors in deep mining. Mining engineers always pay attention to the design of the ventilation network during development and extraction of ore in underground mines. The ventilation network's efficiency depends on a variety of factors. The presence of barriers in mine ventilation networks is one of the important affecting factors. In this research, using the Monte Carlo technique, a probability distribution function is presented for the resistance of obstacles as the input to the model. For each simulated value, the ventilation network was analyzed and the air flow of all branches of the ventilation system of the NAKHLAK mine was determined. Reliability criteria were introduced. Results showed that branches 4, 6.7, and 13 have been failed. Branch 7 will be able to find its initial performance by changing the flow direction. Branch 13 was completely failed during the simulation process.

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1- Introduction

Initial modeling or development of an existing model of complex systems in the feilds of engineering, physical, environmental, social, and economic problems has always been the most important part of the planing. The complete adaptation of the modeled system to reality is often impossible. Therefore, simulation methods are used [1, 2]. The Monte Carlo technique is one of the most valuable simulation techniques that is used in solving engineering problems widely. This method, by generating random numbers, samples from the distribution of the probability density associated with each component of the system. Then putting these samples in the final model of the system, a distribution of the results may be produced.[1, 3, 4].

2- Methods

In this paper the variation of drop pressure due to obstacles in mine ventilation networks was analyzed. The research algorithm may be summarized through the followings six steps:

1. Prepare a graph of the mine network.
2. Calculate the resistance of each segment of the mine network.
3. Design the ventilation network by calculating the required intensity of the air flow (Q) to ventilate each segment of the mine network.
4. Introduce changes of the resistance of any segment as the input of the simulation process. Suppose that the change follows an Exponential distribution.
5. Calculate the intensity of the air flow according to various simulated values of each segment resistance. Consider it as the output of the simulation process.
6. Verify the network reliability using simulation results.

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3- Findings and Argument

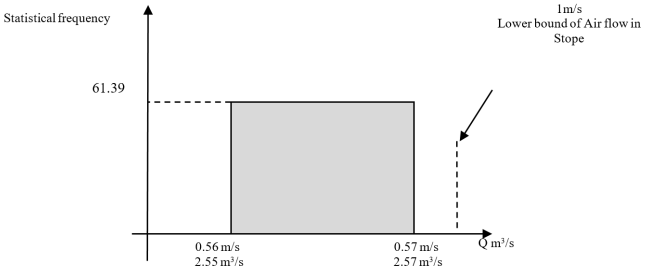
The model was run for NAKHLAK mine ventilation network. As mentioned in step 4, the input of the simulation process follows an exponential distribution. The distribution of output of the simulation process was checked out and shown in Table 1:

Table1. Probability distribution of output of the simulation process for NAKHLAK mine ventilation network

No. Segment	Min	Max	Mean	Standard deviation	Probability distribution
1	1.24	2.09	1.85	0.175	No distribution function
2	1.27	2.12	1.51	0.175	Beta(1.85, 3.47)
3	0.82	1.67	1.06	0.175	Beta(1.85, 3.47)
4	0.03	0.88	0.64	0.175	No distribution function
5	0.13	0.66	0.51	0.115	No distribution function
6	0.03	0.56	0.41	0.115	No distribution function
7	0	0.41	0.26	0.115	No distribution function
8	1.55	1.68	1.61	0.036	No distribution function
9	0.72	0.85	0.79	0.036	No distribution function
10	0.25	0.39	0.32	0.036	No distribution function
11	2.18	2.21	2.19	0.006	Uniform(2.18,2.22)
12	3.01	3.07	3.09	0.006	Uniform(3.07,3.09)
13	2.58	2.55	2.57	0.006	Uniform(2.55,2.77)

Results showed that branches 1 and 4 to 10 do not follow a standard probability distribution. According to introduced reliability criteria, it was found that branches 4, 6.7, and 13 had been failed. Branch 7 was able to find its initial performance by changing the flow direction. Branch 13 was completely failed during the simulation process, as shown in Figure 1.

Figure 1. The allowable range of flow based on air speed in the Tunnel 13



4- Conclusions

In this research, pressure drop variation due to obstacles in mine ventilation networks was analyzed, using the Monte Carlo technique. The NAKHLAK mine ventilation network was designed with Hardy Cross method. Variation of air flow corresponding to branch resistance changes was saved. Probability distribution of air flow was defined. Satisfactory criteria according upper bound and lower bound of air flow was introduced. Reliability for each branch was defined.

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