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STUDY OF VENTILATION NETWORK USING VENTSIM

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ABSTRACT:

The air flow system in underground coal mines is extremely intricate due to the multiple joints and mechanisms that divide the underground air network into various zones or/and panels, hence enabling a variety of air flow techniques. A coal mine air flow study is required to comprehend the facility networks that are part of the system. Information gleaned from many sources is used to select the most dependable course of action for implementing any kind of suggested changes. For the underground workplace to be safe, healthy, and balanced, the air flow system must operate correctly and at peak efficiency. These systems need to be labelled to make sure that each working area receives enough aerating and divided air. In India, the majority of underground coal mines have an exhaust ventilation system. The air flow circuit's stress and quantity fluctuations are the subjects of this study. It has been demonstrated how to simulate using the data acquired by VENTSIM. Evaluation was performed using the simulation as a basis.

Keywords: VENTSIM, Network, Gas, dust

INTRODUCTION

The ambient air in an underground mine is contaminated by the activities that take place there, specifically by the blasting of explosives (gas, dust, etc.), the nature of the ore (presence of free silica, radon, release of methane, etc.), backfill products (ammonia, etc.), the presence of thermal stresses in deep mines, and the widespread use of motorised equipment, Diesel powered vehicles, and vehicles that release methane in modern underground mines. The control of these pollutants must be done as close to the source as feasible, namely by looking at how diesel engine machines operate, specifically the effectiveness of the engines and exhaust (filters, sensors, catalysts, etc.). However, dangerous gases of all kinds—whether they be irritants, toxins, or asphyxiants—appear; as a result, it is necessary to lower their level of concentration in the air while staying within exposure thresholds established by the applicable standards. Then, only a ventilation of the mine (ventilation) sufficient in terms of the flow rate and speed of the air that circulates in the different excavations of an underground mine (recipes, galleries, felling sites, fixtures, etc.) in accordance with the standards set by the law and the regulations in force or, failing that, the rules of art; the Regulation respecting occupational health; can be used to dilute and evacuate the pollutants present. [3]. Depending on the mode of operation, the size of underground structures, and the kind of equipment being used, different airflows may be needed. Production and airing have a strong interaction. It can consume up to 100 GWh of energy annually, which is a significant portion of the mine's overall energy use. [4] Diesel technology has allowed mining operators to reduce production costs and boost mineral reserves due to its productivity and adaptability in use. [5] Despite these benefits, the primary cause of air pollution in underground mines is these equipment. The Kinsenda underground mine has been dealing with a very difficult ventilation situation for more than two years. This situation is a result of the deposit's cessation of use since 2003 and the collapse of the inclined UOZ (Upper Ore Zone) and MOZ (Medium Ore Zone), which provided the mine with fresh air. After the mine was reopened in 2010, its sole purpose was to remove water, and to that end, three fans with a combined theoretical capacity of 75 m3/s were installed. This flow becomes insufficient through the employment of a wide variety of engines operated by engines given that the Kinsenda mine has started operation since 2017, and that the planning is for a monthly production of 50,000 tonnes of copper. diesel, therefore the ventilation circuit has presented several challenges compared to the amount of air the mine needs, which prevents the gases from being diluted quickly. In order to address this issue and increase thermal comfort inside the mine, the employer has planned to dig a new ventilation shaft that will support the Bigman 10 (only return air pit). This led to efforts to improve the ventilation system of the Kinsenda underground mine. As a result, there are two main problems: how to improve the ventilation system at the Kinsenda mine, and based on planning at the Kinsenda mine, how to choose the best design taking into account all kinds of equipment utilised in the mine.

VENTILATION NETWORKS

- A vital component in the design of a new underground mine or other subsurface facility is the quantified planning of the distribution of airflows, together with the locations and duties of fans and other ventilation controls required to achieve acceptable environmental conditions throughout the system.
- Ventilation network analysis is concerned with the interactive behavior of airflows within the connected branches of a complete and integrated network.
- The techniques of network analysis that are useful for modern industrial application must remain easy to use, and sufficiently rapid and flexible to allow multiple alternative solutions to be investigated. (Malcolm J. McPherson)
- Four highly important developments in the last three decades, two technological and two nontechnical, are responsible:
- The high-speed, electronic digital computer, permitting advanced solutions to ventilation circuits and networks heretofore unsolvable
- The systems approach, which optimizes complex industrial operations, permitting personnel, materials, and methods to be coordinated in the most efficient way
- Extensive legislation, embodying a strict code of regulations to improve the safety of mining operations
- The advent of socio-engineering, the applying of technology with full consideration of the social, political, economic, and environmental consequences

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as well as the technical benefits (Howard L. Hartman)

VENTSIM 3-D SIMULATOR

A below-ground ventilation system's branches can get timely or continuous information via Ventsim, a digital checking and control framework programme.

Accuracy and also accuracy in Ventsim Simulations have been influenced by the criterion. With the work's advancement, road modifications and the representation of the full mine air flow network both require repainting. Next, every branch is reallocated, and finally computation is done to simulate the current condition.

It is created and supplied by the Australian company Chasm Consulting, and Data Mine International Ltd. markets it in India. This framework simulates the version across all different branches while measuring the air quantity and stress changes in the air flow branches for the input values.

Ventsim simulates a genuine ventilation issue with the current mine. The version might produce inaccurate results for the purpose of intended future style if the current circumstances are not depicted in an exact manner. For which it is crucial to validate the design with precise data. The difference between data that were really gauged and data that were modelled to represent air quantity pressure is shown below in precision. Accuracy of the entire stress study is necessary for precise resistances. Depending on the quality of the data entered into the Ventsim model, this accuracy may range from 90 to 95 percent.

Theoretically, if the input data is perfect, the result simulation in a Ventsim version will be fantastic. The Hardy Cross Algorithm is used by Ventsim to achieve accuracy within the tolerance for simulation error. Ventsim designs using common style sizes, default rubbing components, and shock losses because the aforementioned criteria are never known with absolute certainty.

With stress surveys, this ensures 85–90% precision despite the inability to measure actual resistances.

For production purposes, Ventsim also permits attributes like heat, gas, and other pollutant levels.

Both appropriate air flow adjustments and well-managed splits are maintained.

Once the pressure amount research measurements have been obtained, an entire version of the air flow framework can be created.

Hardy Cross Method This formula is applied to complex air flow networks where the right quantities for various branches are taken into account while giving due consideration to Kirchhoff's first rule, the law of continuity of circulation.

The diversity of subsequent models is substantially less the closer the assumed numbers are to being accurate.

Hardy Cross, an instructor at the College of Illinois, created this algorithm in 1936 with the intention of using it in water circulation systems.

MODEL PREPARATION

Initially we created a network model as seen in the fig(1) A fixed flow fan of 120 m3 /sec quantity is added in one of the shaft to ventilate the network Mainly there are 17 air path ways which among three paths are working areas named as 11,13,15 Quantities of every single path can be seen in the below model and this

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values are prescribed in the chapter 5 in observation table

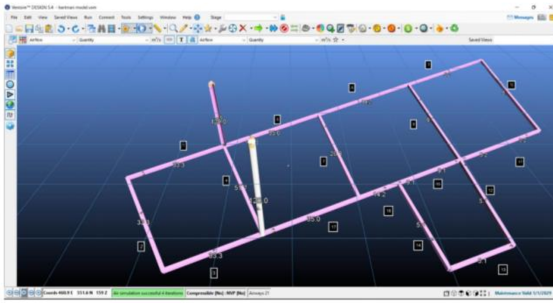

Fig 4.1 : Mine ventilation network before installing the ventilation devices

Addition of regulator

In working areas ventilation shall be provided in a sufficient manner, such that mine workers should feel comfortable in working areas. To provide better ventilation for working areas, ventilation for unnecessary paths shall be restricted or reduced. To reduce the ventilation for any path, regulator shall be added, Two regulators are added as shown in the fig(4.2) as to reduce the quantity of air. Thus influence the quantity to flow to working areas much more than the beginning

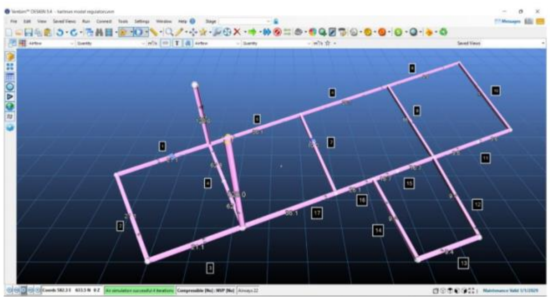

Fig 4.2 : Regulator in the ventilation network

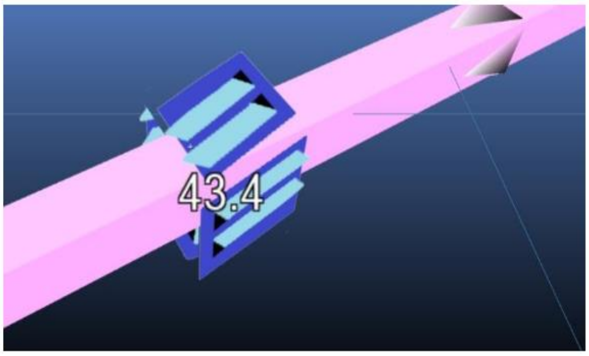

Fig 4.3 : Regulator symbol in ventsim

Symbol of the regulator that added in the air path way can be seen in above model Addition of doors Generally doors are added in between the intake and return air cause to reduce the quantity that flowing direct to the return Two doors are added in the below shown fig(4.5) to balance the pressure difference between the intake and return air way

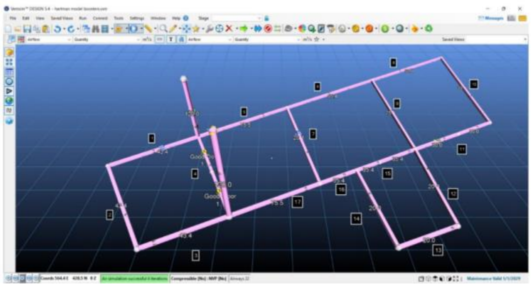

Fig 4.4 : Doors installation in the ventilation network

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Fig 4.5 : Doors symbol in the ventilation network

Addition of Booster fan To increase the pressure and quantity Booster fan is added in below model fig (4.6) Booster fan is used in high resistance split district where ventilation provided by main fan is not sufficient It controls the whole air flowing through the split and doesn't require any duct

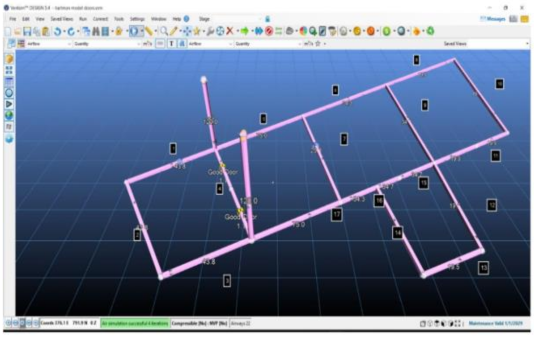

Fig 4.8 mine ventilation network after installation of ventilation devices

The below shown Fig(4.8) represents the final model after addition of ventilation devices We can see the great difference between values of quantity in initial table to final table as shown in the chapter 5 in a table form Fig (5.1)

PREPARATION

Create the model using 'pencil tool' in the ventsim software.

Assign the values of the pressure , quantity , resistance as per the field data.

Assign the network number to each roadway individual numbers.

Prepare the table based the resultant data using the ventsim models.

Analyse the data and finally preparation of the conclusion

RESULTS

Network	Before installation of ventilation devices	After installation of regulators	After installation of 2 doors	After installation of booster fan	Remarks
1	33.3	21.1	43.8	43.4	
2	33.3	21.1	43.8	43.4	
3	33.3	21.1	43.8	43.4	
4	51.7	62.8	1.1	1.1	DRASTICAL CHANGE
5	35	36.1	75	75.5	
6	14.2	26.1	54.3	55.4	
7	20.8	10	20.8	20.1	
8	5.2	9.6	19.9	30	
9	9.2	16.5	34.6	25.4	
10	5.2	9.6	19.9	30	
11	5.2	9.6	19.9	30	
12	5.1	9.4	19.5	20	
13	5.1	9.4	19.5	20	
14	5.1	9.4	19.5	20	
15	9.1	16.7	34.7	35.4	
16	14.2	26.1	54.3	55.4	
17	35	36.1	75	75.5	

CONCLUSION

The following analysis like ccalibration of pressure measuring instrument at regular interval is required for accurate periodic survey.

Removing the blockage if not necessary at the return airways.

Air should be properly coursed up to faces with the help of auxiliary ventilators.

The existing PV-200 fan is to be replaced by a fan of 100m3 /sec of air quantity.

Ensure that sufficient quantity of good air is coursed into all working places and reaches all workings belowground, and for this purpose, shall-

See that the ventilation stoppings, brattices, etc., are constructed as per specifications and are kept extended sufficiently;

See those measurements of air quantity, temperature and humidity are regularly taken as specified and bring up to date the entries on the check boards provided at each air measurement station;

Determine the Ventilation Efficiency Quotient(VEQ)

See that mine air samples are properly collected at the appointed time and place, and analysed within forty-eight hours of taking thereof; and

Make observations for inflammable and any other harmful gases.

Air should be properly coursed up to LVC (Last Ventilation Connection) of the district by strengthening the stoppings and doors (minimize the leakages).

In the district, air from LVC should be coursed up to the faces by auxiliary ventilators.

Leakage roots are large in numbers causing a decrease in volumetric efficiency which can be solved by increasing the pressure and minimize the leakages.

Maintenance of Air Measuring Stations at regular intervals.

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