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ANALYSIS OF LEAKAGES IN MINE VENTILATION SYSTEM"

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Abstract - Leakages is one of the major problems in underground mine ventilation. It is caused mainly due to fan drifts, main doors. leakages occur mainly near to the surface of the mine. Underground coal mine ventilation systems are particularly complex because of multiple seams working methods which splits the underground air network into different districts or/and panels thereby allowing multiple ventilation methods. In order to gain an understanding of the complex networks incorporated in the system, a coal mine ventilation survey is required. The information obtained from this survey is used to determine the most efficient techniques to accomplish any proposed improvements. The proper operation of the ventilation system at maximum efficiency is essential for providing a safe and healthy underground working environment. These systems should be designed to ensure that adequate amounts of ventilating and numerous split air reach each working area. Most underground coal mines in India employ an exhaust (i.e., negative pressure) ventilation system.

Key Words: (ventilation , underground mine , split)…

1.INTRODUCTION*)*

In underground mines, production, productivity, health and safety of workers rely upon environmental conditions existed at the work place. Polluted environment reduces the environment efficiency of work persons and machinery which ultimately reflects on the economy of the mine. Proper ventilation of mine workings can lead to safe and efficient operation in mines. So it's essential to conduct a ventilation survey at frequent intervals to monitor the change in environmental conditions and improving it for working.

A ventilation survey is a framework of collecting data that measure the distributions of airflow, pressure and air quality all through the principal stream ways of a ventilation framework which involves a detailed precision of measurement. The examination is generally done for finding the efficiency of a ventilation system, types and the extent of leakages and the steps indispensable.

1.1 OBJECTIVE

A major objective of ventilation surveys is to obtain the frictional pressure drop, P, and the corresponding airflow, Q, for each of the main branches of the ventilation network. From these data, the following parameters may be calculated for the purposes of both planning and control:

- Distribution of airflows, pressure drops and leakage
- Airpower (P x Q) losses and, hence, distribution of ventilation operating costs throughout network
- Volumetric efficiency of the system
- Branch resistances (R = P / Q2)
- Simulating an effective model for the exiting ventilation system.

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1.2 INDIAN STANDARDS

The Indian Coal Mining Regulations (CMR-2017) , regulation no. 152 (2) requires that:

In every ventilating district no less than six cubic meters per minute of air per person employed in the district on the largest shift, or no less than 2.5 cubic meters per minute of air per minute of air per daily tone output, whichever is larger passes along the last ventilation connection in the district.

At every place in the mine where persons are required to work or pass, the air does not contain less than 19% oxygen, and or more than 0.5% CO_2 or any noxious gas in the quantity likely to affect the health of any person.

The percentage of inflammable gas does not exceed 0.75 in the general body of the return air of any ventilating district, and 1.25 in any place of the mine.

The wet bulb temperature in any working place does not exceed 33.50C, and where the wet bulb temperature exceeds 30.50C, arrangements are made to ventilate the same with a current of air moving at a speed of not less than one meter per second.

Indian mining laws sub regulation 133(4) of the CMR requires that ventilation surveys be conducted in 1st degree-I gassy mines at least once every 30 days while air quantity surveys in degree-II & degree-III gassy mines are required to be conducted at least once every 14 days.

Sub regulation 130(2) (v) requires that concentration of noxious and inflammable gases and temperature and humidity to be determined at the working places in mines at least once in 30 days

Under sub regulation 145(2), the Regional Inspector of mines may require the mine management to take measurements of temperature, humidity and other environmental conditions as may be specified once at least in every 30 days.

2. AIR FLOW PRINCIPLES

The fundamental principles of airflow may be set out as follows:

Air flow in a mine is induced by pressure difference between intake and exhaust openings

The pressure difference is caused by imposing some form of pressure at one point or a series of points in a ventilating system. The pressure created must be great enough to overcome frictional resistance and shock losses.

Airflows flows from point of higher to lower pressure.

Mine ventilating pressures, with respect to atmospheric pressures, may either be positive (forcing) or negative (exhausting).

TYPES OF VENTILATION SYSTEM

Depending on the relative position of intake and return airways, ventilation systems in mines can be broadly divided into the following:

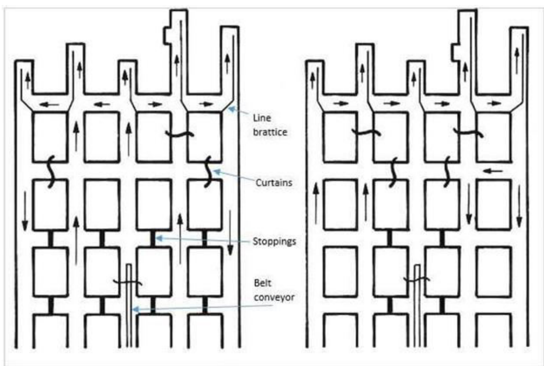

Figure 1 Room and pillar development with line brattices to regulate airflow in conveyor belt

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entry: (a) bi-directional system; (b) uni-directional system. (McPherson, 1993)

2.1AIR QUANTITY SURVEYS

The quantity of air passing through any airway every second, Q is generally given by the expression

Q= U x A (m3/s)

Where, U = Velocity of air passing through that point (m/s

A = Area of roadway (m2

Thus, to calculate the quantity of air flowing past any particular measuring station, it is necessary-

To ascertain the cross-sectional area of the passage =A sq. meters. To measure the velocity of air current= V meters per second

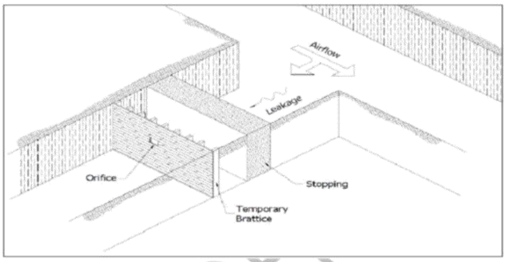

Fig -2: Leakage and resistance in stoppings (After Vinson, 1977; from Oswald, 2008)

2.2 PRESSURE SURVEYS

In Incline, we observed ventilation system in underground mine.total number

of seams are 8. In those 5 seams are closed, presently 3 seams are working. Working

seams are 2,2A,5 are working. In 5 seam we observed working system of

ventilation. Total quantity of air supplied in 5 seam is 7000 m3 /min. m3

Total number of districts = 4

Each district	=1500 m3 /min
For sub station	= 200 m3 /min
For main sump	= 200 m3 /min
Air crossing	= 100 m3 /min
Stoppings	= 100 m3 /min
Main doors	=100 m3 /min
Fan drifts	=300 m3 /min

EQUIPMENTS REQUIRED FOR A PRESSURE-QUANTITY SURVEY

1 Rotating vane anemometer

The vast majority of airspeed measurements made manually underground are gained from a rotating vane (windmill type) anemometer. When held in a moving airstream, the air passing through the instrument exerts a force on the angled vanes, causing them to rotate with an angular velocity that is closely proportional to the airspeed. A gearing mechanism and clutch arrangement couple the vanes either to a pointer which rotates against a circular dial calibrated in meters (or feet) or to a digital counter.

The instrument is used in conjunction with a stopwatch and actually indicates the number of "metres of air" that have passed through the anemometer during a given time period. The clutch
device is employed to stop and start the pointer or digital counter while the vanes continue to rotate. A zero reset lever is also incorporated into the instrument. Low range vane anemometers will typically have eight vanes, jeweled bearings and give repeatable readings for velocities in the range 0.25 to 15 m/s. High range instruments may have four vanes, low-friction roller or ball bearings and can be capable of measuring air velocities as high as 50 m/s. Digital vane anemometers indicate directly on an odometer counter, an illuminated screen, or feed an electronic signal into a data gathering system. Modern handheld instruments may also be fitted with a microprocessor to memorize readings, dampen out rapid variations in velocity or into which can be entered the cross-sectional area for the calculation of volume flow.

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Figure 3 Instrument's needed to conduct a ventilation survey

3. CONCLUSIONS

From the results obtained, correlation analysis, comparison of the field data and simulation values the followings points are observed.

Maximum leakage is observed to be 4.94 m3/sec at the nodes 28-29 in EP-IV panel near the goaf area and zero leakage is observed at nodes 2-3, 5'-6', 15-16 and 39-40.

The field readings and simulation results have a positive correlation of 0.9895.

The Relative Humidity (R.H) is maximum of 95.1 % at node 25-38.The Relative Humidity (R.H) is minimum of 78.4 % at node 7-8.

Least velocity of air in field survey is observed at node 31-32 with a veloity of 0.21 ms-1 and maximum velocity at node 3-4 (intake air) with a velocity of 12.95 ms-1.

Least velocity of air in Ventsim simulation is also observed at node 31-32 with a velocity of 0.21 ms-1 and maximum velocity at node 3-4 (intake air) with a velocity of 13.64 ms-1 Differential Pressure is observed least to be at nodes 11/2-13, 29-30 and 35-30 with a value of 0.2 Pa and maximum to be at nodes 5-23 and 5'-22 with a value of 151 Pa and 103.5 Pa. Also, at node 39-40 beyond MMV with a value of 319 Pa.

Simulation results and Field readings differs overall with an average of 13.145 % as a result of resistances faced during field survey due to movement of tubs, leakages, working hours of the personnel, instrumental errors and faulty Air Measuring Stations.

It is also observed that at nodes 31'-33 and 31-32 (working faces) of district WP I & II the velocity of air is flowing at 0.32 and 0.31 ms-1 which is below the DGMS recommended level for air velocity of 0.5 ms-1 (Table 3.4). This problem can be solved by-

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