VENTILATION SURVEY

Describe methods of pressure survey using barometer, gauge and pitot tube with manometer.

Pressure survey with Differential Barometers: A very suitable instrument for underground measurement of pressure differences is the differential barometer which has been successfully used in mines in the U.S.S.R. This is free from the errors due to creep and set commonly met with in aneroid barometers although its sensitivity compares well with that of aneroid. It does not require much skilled operation and can take 15 to 20 readings in a shift.

The differential barometer consists of a vessel connected to the atmosphere by a tube having a tap. Tube one end of which extends nearly to the bottom of the vessel is connected at the other end to a U-tube manometer. Tube is connected to an aspirator bulb through the tap. The vessel is encased in an insulting vacuum flask filled with ice and contains 50 cm^3 of alcohol.

At the base station, two taps are opened and the aspirator is squeezed until the alcohol rises in the tube and fills it as well as the manometer. First tap is then closed. The liquid level in the exposed limb of the manometer is the same as in the vessel. The ice is then charged into the vacuum flask and 15 to 20 minutes allowed for the air in to attain the temperature of ice. Second tap is now closed so that the air in the vessel is maintained at 273.15 K temperature and at the atmospheric pressure of the base station. The instrument is now moved to the next station of measurement. If there is a change of atmospheric pressure, there will be a change in the liquid level in the exposed limb of the manometer. This difference in level can be measured by a suitable scale placed alongside the U tube. The level difference gives the difference in absolute pressure between the two stations since the change in liquid level is negligible. If the scale be graduated in millimeters and if alcohol be assumed to have a specific gravity of 0.8, a sensitivity of 7.8 Pa can be obtained. To have an accuracy of $\pm$5% in the measurement, the minimum pressure difference to be measured should be 156 Pa.

Describe the method of measurement of cross-sectional area.

This is usually done by tapes. The work is simple if the airway cross-section is of a regular shape which can be divided into geometrical figures whose dimensions can be measured with a tape, but most commonly the shape of mine airways is irregular, where simple measurements by a tape will not do. In such cases any of the following methods can be used.

Tape Triangulation: In this method, a tape is stretched across the airway and with the help of another tape perpendicular offsets to the periphery of the airway on either side of the stretched tape are taken at regular intervals of 0.3-0.5 m. The measurements can be plotted to a certain scale and the area of the resulting diagram determined by a planimeter, or the area can be calculated using Simpson's rule for area as given below

Area = L / 3 (Sum of first and last ordinates + 4 times the sum of even ordinates + 2 times the sum of odd ordinates)

Where L=distance between ordinates.

A modification of this method is to have a wooden frame of a size a little smaller than the cross-section of the airway but more or less resembling it in shape. Offsets are taken from the periphery of this frame to the sides of the airway.

Plane Table Method: This utilizes a drawing board with a sheet of paper pinned on to it and mounted in the plane of the section of the airway to be measured. Measurements are taken

from a central point on the paper to various points on the periphery of the airway by means of a tape and the lengths are plotted on the paper to a suitable acale in the directions of measurement. The area of the resulting diagram can be estimated by a planimeter or by calculation (areas of individual triangles formed by adjacent rays can be calculated and added together to get the area of the cross-section).

The Profilometer: this consists essentially of the equipment used in the plane table method except for the incorporation of a mechanical scaling device similar to that in a pantograph so that the profile of the airway is automatically plotted on the paper mounted on the plane table. This makes the measurement quicker and obviates any personal error in the plotting of the rays.

Craven Sunflower Method: This utilizes a graduated brass rod which is adjustable in length and can be rotated about a central point in the airway through a full circle. Measurements from a central point in the airway to the periphery are taken at various angles, the rod being adjusted every time so as to read the lengths at these angles. The measurements can be plotted to scale and the area computed there form.

Photographic Method: the photographic method consists of marking the periphery of the section of the airway with white paint and photographing it with a scale placed in the plane of the section by means of a suitable photographic camera. Alternatively, the periphery can be marked out by moving along it a beam of light from a cap lamp while the camera shutter is kept open. In this method, computation of area can be done only after the photograph has been developed and printed. Computation of area can be done either from positive prints or from the image of the negative by screening it through a suitable projector. A wide angle lens obviates errors in rough airways.

Describe the method of velocity measurements by using anemometer, voltmeter, and pito-static tube and smoke & cloud method.

Methods of velocity Mesurement : The velocity of flow varies from point over the cross section of a mine airway and the variation is irregular in nature, particularly if the airway has rough sides is not straight. The following methods can be adopted for computing the average velocity in such airways.

(a) Single point Mesurement : In this method, the measuring instrument (anemometer, velometer or pitot-static tube) is held at a fixed point on the cross-section of the airway and the reading multiplied by a method factor to get the average velocity. The instrument has to be held well away from the body of the observer. That is why anemometers should preferably be mounted on shafts. Usually readings at the centre are taken and these are multiplied by a method factor of 0.8 for getting the average values of velocity.

(b) Continuous Traversing : This is an approximate but quick method adopted with anemometers in minor airway which are neither very straight nor uniform in cross-section. This method gives an average accuracy of within 5% when used with a suitable method factor. The anemometer is held by hand or on a shaft away from the body and is traversed continuously either up and down or form side to side. The distance between adjacent legs of traverses should be about 300 mm for reasonable accuracy in normal-size airways and this distance should be uniformly maintained. The duration of traversing varies with the area of cross-section. One minute is sufficient for an area of about 3 m^3 whereas 3 minutes may be necessary for an area of 9 m^2.

(c) Precise Traversing : This is a very highly accurate method of measuring air velocity by anemometers, velometers or pitot-static tubes. An accuracy of 2% can be obtained with this method of traversing by anemometers. However, this

method is more time consuming and hence should be confined to measurements in major airways only where a great deal of accuracy is needed. Precise traversing should be done in straight portions of airways of uniform cross-section and preferably in smooth lined portions away from any obstructions. The observer should stand at least 1.2m away from the instrument on the downstream side and the instrument should be mounted on a shaft. It is better if the observer stands in a suitable recess on the downstream side of the airway.

The Pitot-static Tube: The pitot-static tube, often erroneously referred to as the pitot tube consists essentially of a pitot tube or a total-head tube placed concentrically inside a static tube. It comprises a head which faces the air-stream and a stem bent at right angles to it. The pitot tube is nothing but a tube with an open end facing the air-stream so that it measures the total head whereas a static tube is one with its nose (which faces the air stream) closed and with a few holes on the side of the tube for recording the static pressure only. In the pitot-static tube there are two concentric tubes, the outer of which has a few holes on the sides. The annular opening between the two tubes at the nose end is sealed so that the inner tube records the total pressure and the outer, the static pressure only. The nose is suitably shaped so as to avoid undue turbulence and hence offer the least resistance to flow. The two component tubes of the pitot-static tube are connected to the two limbs of a manometer which reads the velocity pressure. The pitot-static tube may or not measure the true velocity pressure accordingly as it is designed. This deviation of a pitot static tube reading from the true value is due to the effect of flow around the nose and the stem which affects the static pressure reading.Pitot-static tubes are generally used for the measurement of air velocity in ducts. As the accuracy of the instrument is practically unimpaired for a large range of velocities, the minimum velocity that can be measured by a pitot-static tube is limited only by the sensitivity of the manometer that can be used under mining conditions.

Smoke-cloud Method: It consists essentially of a glass tube 125 to 150mm long and 12.5mm in diameter filled with granular pumice stone of 0.8-1.2mm size soaked with tin or titanium tetrachloride. The latter is often preferred as it is less corrosive. The two ends of the tube are plugged by glass wool and are sealed. When the tube is to be used, the sealed ends are broken off and the tube is attached to a rubber-bulb aspirator which, when squeezed, forces a current of air through the tube producing an atomized spray of the tetrachloride which coming in contact with the moisture of mine air, develops a thick cloud of white smoke. The tube normally has a charge to last for eight hours.

Under ordinary conditions, the tube is held in the airway and the smoke released across its axis at a suitable point in the cross-section. The taken by the smoke cloud to reach a distance of 8-10m is recorded by a stop-watch and the velocity computed thereform. However, this velocity may not represent the average velocity in the airway. The relation between the observed velocity and the average velocity depends on the position in the cross-section of the airway where the smoke cloud was released. The smoke cloud should not be released very near the sides lest it should be affected be eddy currents created by the rough surface of the airway. If it is released about quarter way from the side, it is found that the velocity obtained exceeds the average by 10% and this correction has to be applied to the observed velocity in order to get the average value.

Also, with very low velocities in airways of average cross section, the smoke cloud may thin out considerably so as not to be discernable at the normal distance of observation of 8-10m. In such cases a smaller distance of 4-5m may be used whereas with velocities ranging from 0.55-0.75 ms^{-1} and good lighting in the airways, the distance of observation can be increased to 15-20m,

A straight portion of the airway with uniform cross-section should be chosen for velocity measurement by this method and the average cross-section area of the test section should be obtained.

Determine % of Oxygen, Methane, Carbon monoxide, So_2 and H_2S

Oxygen :

Properties :

1. The gas is colourless, odourless & taste less in nature.
2. It is slightly soluble in water.
3. It is lightly heavier than air.
4. Its specific gravity is 1.1.
5. Its Critical temp. 119°C.
6. Its critical pressure 50 atoms.

Physiological effect : The physiological effects of breathing in oxygen depleted air are given below.

At 17% Oxygen : faster and deeper breathing.
15% Oxygen : dizziness, buzzing in ear, rapid heart beat.
13% Oxygen : Probable loss of consciousness with prolonged exposure. 9% Oxygen : Fainting and unconsciousness.
7% Oxygen : Life endangered.
6% Oxygen : Convulsive movement, death.

Carbon monoxide :

Properties :

1. It is also known as white damp.
2. It is colourless, odourless, tasteless, and non irritating.
3. It is slightly lighter than iar.
4. It's specific gravity is 0.967.
5. It is hardly soluble in water.
6. It is combustible but does not support combustion.
7. It burns with a light blue flame in air.
8. It's Critical temp is 140°C.
9. It's critical pressure is 35 atoms.

Physiological effect :

0.01 % CO : Tolerable for a whole shift. Slight headache may result for prolonged exposure on exertion.
0.02% CO : Slight headache after 4 hours at rest or 2 hours at work.
0.04% CO : Headache, nausea, possible collapse after 2 hours at rest or 45 min at work. 0.12% CO : Palpitation and giddiness after 30 min at rest or 20 min at work.
: Leg weariness and nausea after 2 hours at rest or 40 min at work.
: Complete collapse after 3 hours at rest or 1 hour at work.
0.2 % CO : Unconsciousness and death after 1 hour at rest or 10 min at work. 0.5-1.0% CO : Unconsciousness and death after 30 min at rest or 2 min at work.

Methane :

Properties :

1. It is also known as fire damp.
2. It is colourless, odourless and tasteless.
3. It is lighter than air.
4. It's specific gravity equal to 0.559.
5. It is combustible and burns with a pale blue flame but does not support combustion.
6. It is hardly soluble in water.
7. The gas is not poisonous but suffocates a person due to lack of Oxygen.
8. Its critical temp is 83°C.

Physiological effect :

1. When methane gas present in a large quantities of air can cause serious oxygen depletion.
2. There have been instances when men have put their heads in to cavities in the roof filled with methane and have become unconscious in no time.

Sulphur dioxide (SO_2)

Properties :

1. It is a colourless gas.
2. Its smell is sulphueous.
3. Its neither combustible nor a support a combustion.
4. It is 2.21 heavier than air.

Physiological Effect :

1. SO_2 is similar that of nitrogen oxide.
2. Owing to high solubility SO_2 produces sulphurous as well as H_2SO_4 acid on the mucous membrane.
3. The gas is very poisonous and extremely irritating to the eyes and respiratory passage.
4. Irritation of eyes, nose, throat and lungs start at a concentration of 20 ppm of SO_2.

Hydrogen sulphides or H_2S or strink damp:

Properties :

1. It is colourless & the smell of rotten eggs.
2. It is readily soluble in water.
3. It's specific gravity is 1.75
4. It is combustible but does not support combustion.
5. The gas burns in air with pale blue flame.

Physiological effect :

1. It is extremely toxic.
2. It causes irritation and inflammation of eyes and respiratory tracts at concentration of 50-100 ppm after one hour of esposure.
3. At high concentration of 200-700 ppm, it causes pains in throat and chest.

LEAKAGE OF AIR IN MINES

Describe the cause and preventive measures of leakage of air in mines the sources of leakage of air that goes down the mines are

1. Doors of the fan drift and air lock .if the air lock is provided with glass window to admits natural light at the top, a broken glass pane causes heavy leakage .

2.Where air lock is not provided, the space between the cage and shaft wall and also between the cage and shaft wall and also between the cage and pit top leading level is a sources of leakage .If the pit top landing level is a sources of leakage .If the pit top landing level is covered by wooden lid which is lifted by the ascending cage , the arrangement permits of substantial leakage and it is heavy when the lid is lifter by the winding rope capel and the cage is resting at the pit top .

3. Ventilation stopping, ventilation door and air crossing

4. In the longwall method of coal mining, the road side pack walls if the goaf is not solid stowed.

5. Broken or crushed pillars of coal.

6. Wrong siting of underground booster fan .

Because of leakage the total quantity of air that reaches the working faces is only 25 to 50% of that circulated by the main fan . The board and pillar method of coal mining is notorious for poor ventilation at the working faces compared to the long wall method .Under average condition 45 to 55% of air circulated by fan reaches the working face in the seam worked coal mines, slightly higher 55 to 65% in the case of coal mines worked by horizon mining ,and still higher in metal mines . Periodical ventilation survey for the quantity can give an idea of the leakage which can be reduced, if not completely avoided, by the following measures.

1. Air lock at the pit top should be of proper design.

2. Doors of the air lock and of the fan drift should have rubber lining for leakage proof closing.

3.Precaution should be taken to see that both the door of an air lock are not opened simultaneously and this point should be impressed upon the workers .if possible the door should be mechanically interlocked so that when one is open , the other cannot be opened.

4. Have the underground intake and return as far apart as possible and have very few connection between them .if possible, the main return and main intake of the mine should be kept in different seams.

5. All the underground ventilation doors, ventilation stopping and air crossing should be well constructed and maintained.

6. In longwall method of coal mining roadside packwalls should be well constructed to avoid leakage through them.

7. Where the pillars of coal seam are broken or cracked, sometimes due to heavy roof pressure as in the vicinity of depillaring area or near fault zones, they should be coated by a spray of cement mortar.

8. For reducing leakage it is preferable to use a large number of low pressure fans in series than a single fan producing high pressure.

A system of ventilation normally adopted in metal mines is the boundary ventilation system. This is possible where the DC and UC shafts are located at opposite ends of the property and the air from the intake to the return side is practically eliminated .The fresh and cool intake air goes to the lowest level where rock temperature is the hottest.