# LECTURE – 1

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**1.0 VENTILATION SURVEYS**

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## 1.0 VENTILATION SURVEYS

A ventilation survey can be defined as a systematic method of gathering data that can express the quantity of pressure, quantify airflow distribution and air quality throughout the major paths/roadways of a ventilation system or network.

Though a ventilation survey may involve measurements of temperature, humidity, barometric pressure, gas and dust concentrations, the term ventilation survey is generally used in case of pressure-quantity surveys.
Reasons for carrying out ventilation surveys:

- To obtain the efficiency of the existing ventilation system i.e., to ensure that there is an acceptable quantity of air supply to any working face-particularly in hot and humid mine workings
- To identify the extent of air leakages, if any, and to repair the same
- To plan for further efficiency of the existing ventilation networks
- To keep the ventilation plans as updated as possible
- To measure size of airways and to identify high resistance airways
- To identify suitable locations for booster fans in case required
- To obtain data to plan for ventilation of extended/modified workings
- To obtain data which will help control emergencies like mine fires, explosions, roof falls etc.
- To ensure that the direction and quantity of air in the airflows is maintained well within limits set by concerned authorities.

Indian mining laws require that ventilation surveys be conducted in 1$^{st}$ degree gassy mines at least once every 30 days while air quantity surveys in 2$^{nd}$ and 3$^{rd}$ degree gassy mines are required to be conducted at least once every 14 days.

## 2.0 AIR QUANTITY SURVEYS

The quantity of air passing through any point in a duct every second, **Q,** is generally given by the expression

$$Q = U \times A \; (m^3/s)$$

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

**A** = Area of roadway ($m^2$)

Thus, most of the methods employed to calculate quantity of air actually calculate average air velocity and area of the roadway which indirectly help in calculating the airflow quantity.

There are various instruments/methods available for velocity calculation of the airflow. Depending on the degree of accuracy required and the range within which the velocity is expected to be, a particular instrument/method may be chosen.

The instruments are generally designed based on at least one of the following principles:

- Mechanical effect of air on the instrument in contact with it: The **vane anemometer** is an instrument which uses this principle to indirectly calculate air velocity by calculating distance rotated by the vanes within a fixed time period. Another less commonly used instrument using this principle is the **smoke tube**.
- Pressure associated with moving air: The **Pitot-static tube** makes use of this principle for calculating the velocity of air at a point in the duct. **Orifice plates** and **venturi meters** are other instruments which make use of this principle.
- Influence of air velocity on the rate of cooling of an object placed in the air stream- The **Kata thermometer** and **hot wire anemometer** are designed based on this principle.

## 3.0 VANE ANEMOMETER

This is one of the most popular air velocity measurement devices used in mines. When placed in an airstream, the lightweight metal vanes present in the device rotate due to the flow of air through it. This rotation speed of the vanes is proportional to the speed of air flow through the anemometer. A gearing and clutch mechanism that exists in the device records the number of rotations of the vanes or distance traversed by the vanes in metres. This setup is used along with a stop watch and gives the number of metres of airflow through the vanes in the given period of time (as recorded by the stop watch). A clutch mechanism is provided to start or stop the pointer that records the distance covered and a reset lever is also provided in most vane anemometers to reset the distance to zero before any measurement. A simple arithmetic calculation of distance covered divided by time taken gives the average air velocity recorded by the vane anemometer. Low range anemometers typically have 8 vanes (Fig. 1), jeweled bearings and the capacity to record air speeds between 0.25 and 15m/s while high range anemometers come with 4 vanes, low friction ball bearings and a capacity to record velocities up to even 50m/s. Digital vane anemometers are also available which give the velocity directly on a small LED screen.

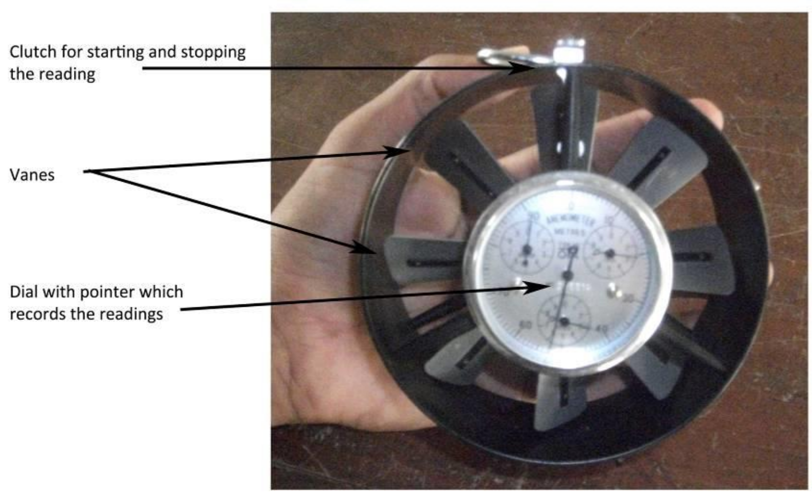


**Fig. 1 Vane anemometer with 8 vanes for low velocity measurements**

**Fig. 2  Right way to hold vane anemometer during traversing**

**Fig. 3  Vane anemometer with reset pin at its right**

To obtain reasonably accurate average velocity readings from the vane anemometers it is desired to traverse the anemometer throughout the section of the airway where velocity measurements are to be recorded.  Fig. 2 shows the correct way of holding a vane anemometer. A reset pin shown in Fig. 3 is used to set the pointer (needles) to zero except the larger pointer which can be initially set to zero by blowing air into the vane anemometer. The traversing must be done keeping the anemometer perpendicular to the airflow direction and care should be taken to ensure that there is free movement of air through the anemometer and that the surveyor or the person taking the measurement is not blocking the airflow path. Fig. 4 shows a typical traverse of vane anemometer for a rectangular cross-section of roadway.

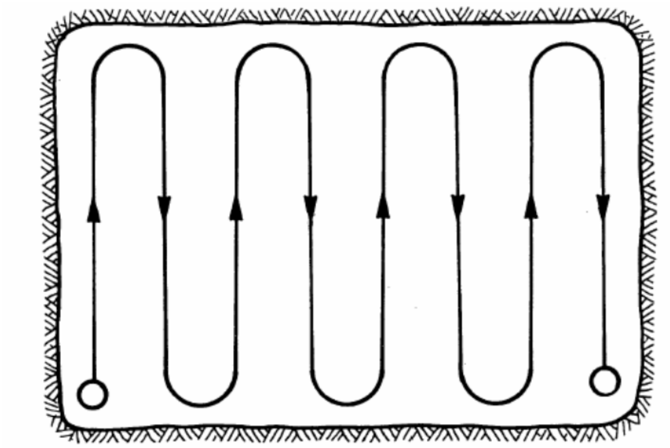

**Fig. 4 Typical traverse of vane anemometer for a rectangular cross-section roadway**

Fig. 5 shows the manufacturer's name and other details printed on an anemometer. The velocity calculated from the information collected using a vane anemometer is generally different from the actual or true value of velocity for the airway by about 10%. This is especially observed during calculations of extremely low velocities. This is because of the friction offered by the anemometer itself and the obstruction of airflow caused by the dial in it. Though these effects oppose each other there is a difference between the true and calculated values of air velocities. This is given by the equation

$$V_a = C_1 + C_2 v_c$$

Where, $v_a$ is the actual/true velocity

$v_c$ is the calculated velocity

$C_1$ and $C_2$ are constants for a given vane anemometer

(How to obtain the values of C1 and C2)

The popularity of the anemometer can be attributed to the fact that the readings given by anemometers are almost completely independent of fluctuations in air density, temperature and non-parallel airflow of the order and range generally observed in mines. This independence is noticed only when the anemometer has been carefully calibrated. The instrument needs to be recalibrated from time to time, especially before and after the undertaking of large-scale and important ventilation surveys in mines. When used inside ducts, anemometer readings are taken by keeping the instrument at the centre of the duct and a ‘method factor’ is multiplied to the reading obtained to correct the velocity. This method factor’s value depends on the duct size and is generally around 0.85.


**Fig. 5 Manufacturer’s name and other details printed on anemometer**

Anemometers are extremely sensitive to dusty and wet environments where their calibration is affected and the readings are erroneous. This is due to dust accumulation on the vanes of the anemometer which increases their frictional resistance.

Anemometers are suitable for airways/ducts whose diameters are approximately 6 to 8 times of that of the anemometer.

## REFERENCES


Banerjee S.P. (2003); "Mine Ventilation"; Lovely Prakashan, Dhanbad, India.

Deshmukh, D. J. (2008); "Elements of Mining Technology, Vol. – II"; Denett & Co., Nagpur, India.

Hartman, H. L.,_Mutmansky, J. M. & Wang, Y. J. (1982); "Mine Ventilation and Air Conditioning"; John Wiley & Sons, New York.

Le Roux, W. L. (1972); Mine Ventilation Notes for Beginners"; The Mine Ventilation Society of South Africa.

McPherson, M. J. (1993); Subsurface Ventilation and Environmental Engineering"; Chapman & Hall, London.

Misra G.B. (1986); "Mine Environment and Ventilation"; Oxford University Press, Calcutta, India.

Vutukuri, V. S. & Lama, R. D. (1986); "Environmental Engineering in Mines"; Cambridge University Press, Cambridge.