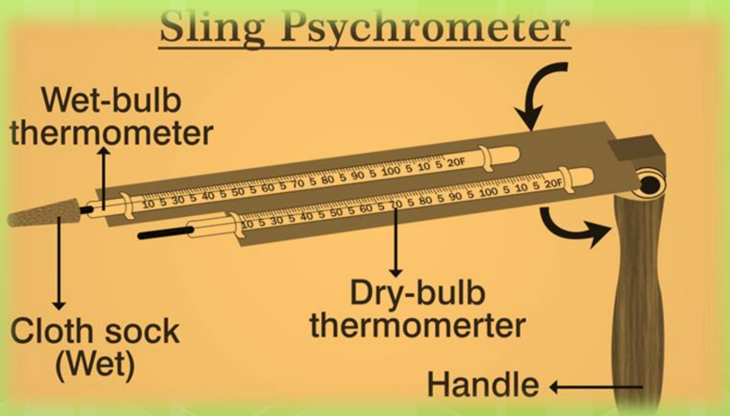

ENVIRONMENTAL & SAFETY OF MINES SUBJECT

Ventilation Measurements and Surveys

College of Petroleum & Mining Eng.

Mining Engineering Dept.

4th Class

Lecture No.1 – Chapter 6-Part-I

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Overview-PART-I

- Introduction
- Importance of Measurements
- Temperature Measurement
- Air Specific Weight Measurement
- Velocity Measurement
- Air Quantity Measurement

Introduction

- Measurements are important to obtain data which used in ventilation system design analysis for best selection and proper operating for the system.
- In a Quantity Control two most important properties to calculate are
- 1. Air Velocity
- 2. Air Pressure (Head)

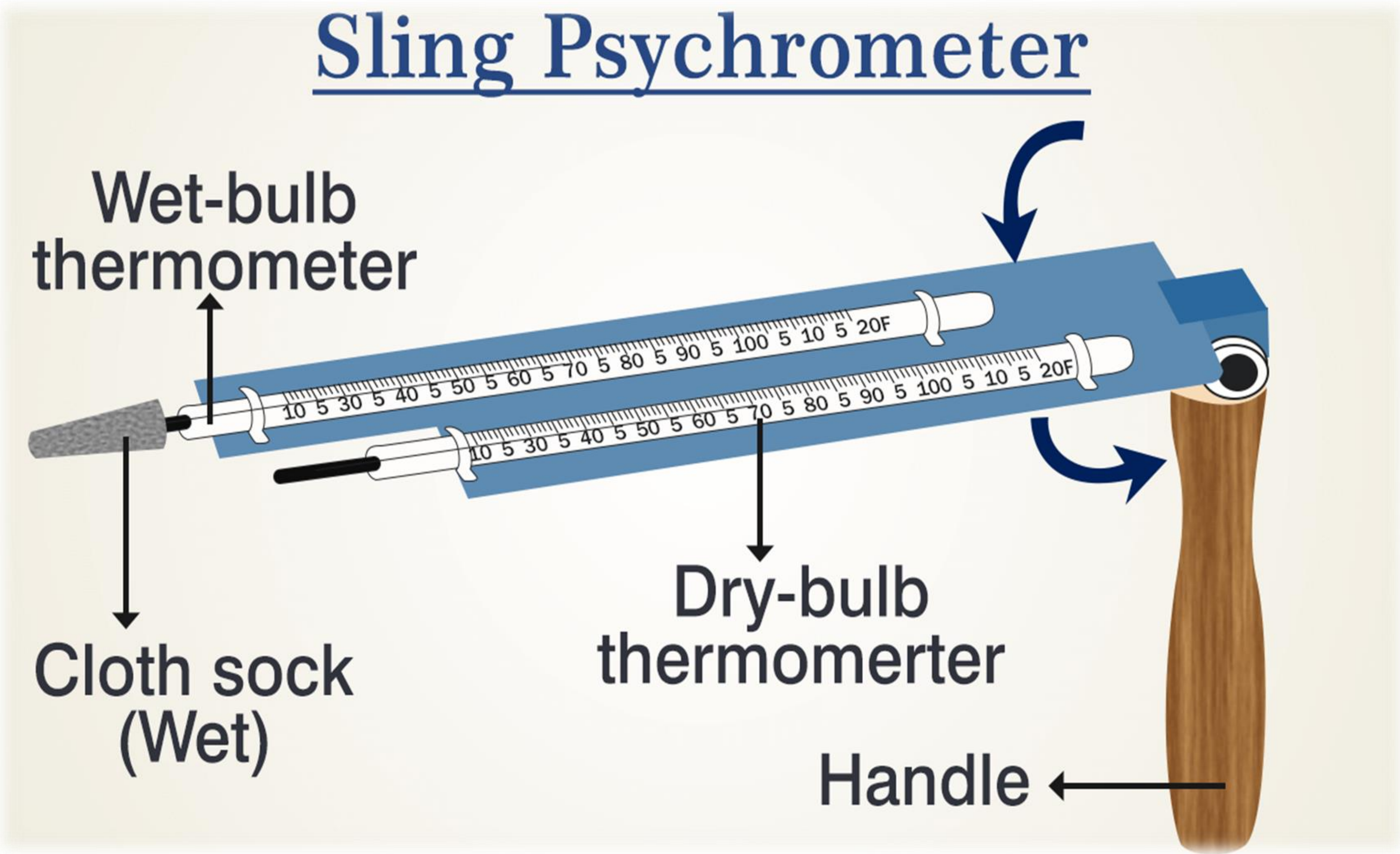
Importance of Measurements

- Obtain knowledge of the extent of ventilation system in meeting specification needs, standards, and regulators.
- Provide information for use in emergencies or disasters such as fires, explosions.
- Improvement of present environmental conditions or efficiency of the ventilation system.
- Make provisions for mine expansion or modifications, new installations, change in airways or circuits and new air shafts.

Temperature Measurement

- The major purpose of temperature measurements in mines is to assess the specific weight, humidity, and cooling power of the air.
- To determine the heat input from the surrounding rock into the mine atmosphere.
- Thermometers conventional type to measure (Tdb & Twb) sling Pyschrometer and Hygrometer is also used in mines to measure the temperature.
- Sling Psychrometer (two thermometer), (the rang is in between -18 to 49°C)

Sling Psychrometer



Hygrometer

Rock Temperature Measurement

- Knowledge of the rock temperature is important for temperature-humidity air conditioning
- To find the geothermal gradient in the rock mass and the rate of heat flow from the wall rock to the airways, it is necessary to determine the temperature distribution in the rock adjacent to the opening, including the *virgin-rock temperature*.

Rock Temperature Measurement

- Devices that used to measure the temperature:

1. Mercury in Glass thermometer
2. Resistance thermometer (metallic conductor such as copper)
3. Thermocouple (Most Wide use)

- The virgin rock temp. can be found through this equation:

$$t_r = \frac{t_{z/2}^2 - t_z t_0}{2t_{z/2} - (t_z + t_0)} \qquad (6.1)$$

- Tr : virgin rock temperature
- To: temp. at rock surface
- Tz: temp. at depth

Air Specific Weight Determination

- It can be calculated from the below equation:

$$w = \frac{1.325}{T_d}(p_b - 0.378p'_v) \qquad (6.2)$$

- W: specific weight (Ib/ft3)
- Td: dry bulb temp. (R or K)
- Pb: barometric pressure (in Hg)
- P'v: vapor pressure at Tdp (in Hg)

Velocity Measurement

- Air velocity is the property most frequently measured in mine airways and workplaces. Several instruments are currently available for determining air velocity.
- Error in instrument design occur mainly as a result of the inertia of the gears.
- If there is variations in airflow that's mean differences of specific weight and non-uniform velocity distributions.

Velocity Measurement

TABLE 6.2 Instruments for Measuring Velocity in Mines

Instrument	Velocity Range, fpm	Sensitivity, fpm	Accuracy	Features
Smoke tube	20–120 (low)	5–10	70–90%	Indirect, approximate
Vane anemometer	150–2000 (intermediate to high)	10–25	80–90%	Needs calibration, needs maintenance
	2000–10,000 (very high)	50–100		
Velometer	30–3000 (low to high) multirange	5–10 25–50	3% of upper-scale reading	Rapid, direct reading, delicate, needs maintenance
Thermoanemometer Thermometer	10–500 (low to intermediate)	2–10	80–95%	Slow, delicate, requires power (6 V), safe
Hot-wire	10–300 100–3000 (low to high) multirange	1–2 10–20	90–95%	Rapid, direct reading, delicate, requires power, needs maintenance
Kata thermometer	100–1500 (intermediate to high)	10–25	70–90%	Indirect, slow, delicate
Pitot tube	750–10,000 (high)	10–25	90–98%	Slow, indirect, accurate

Conversion factor: 1 fpm = 0.00508 m/s.

Velocity Measurement

Smoke Tube

Vane anememometer

Velocity Measurement

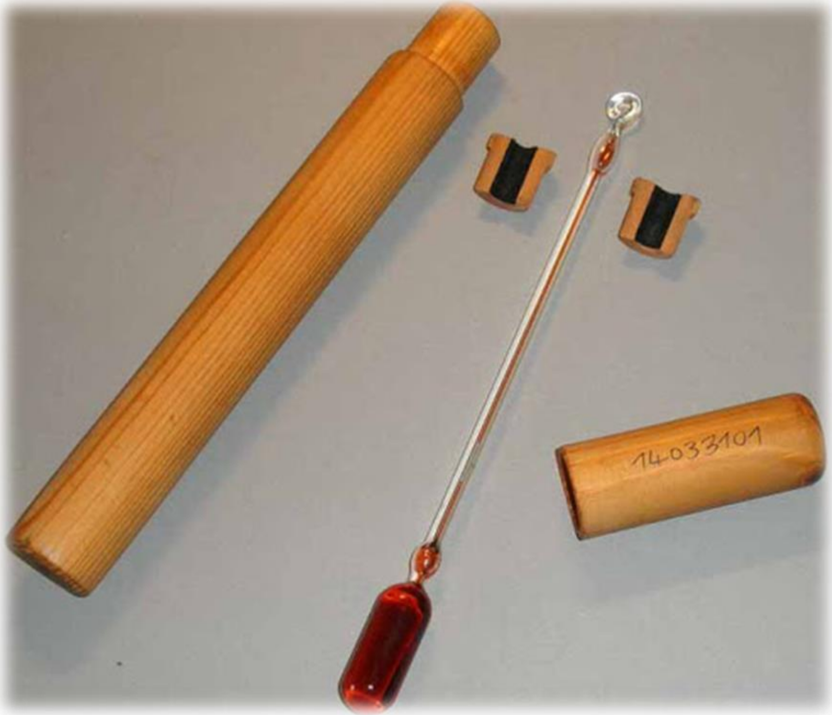
Velometer

Thermo anememometer

Velocity Measurement

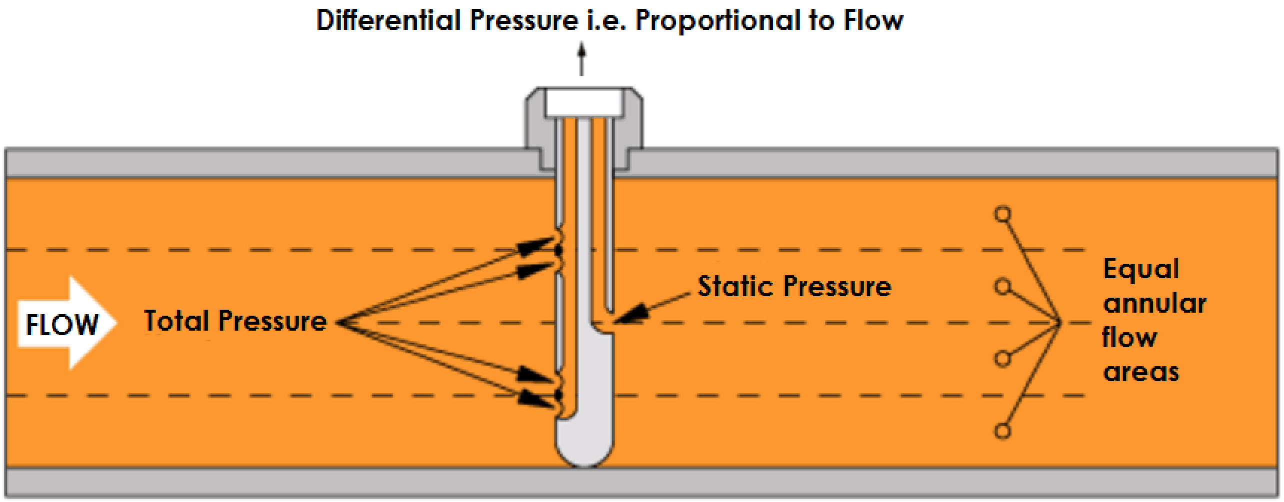
Hot wire

Kata thermometer



Velocity Measurement

Pitot Tube



The averaging pitot tube

Velocity Measurement

- When specific weight difference exceed 5%, correction should be applied using the equation below:

$$R'_a = R_a + C_a \sqrt{\frac{w_c}{w_m}} \qquad (6.3)$$

- R'_a : Corrected Reading
- R_a : Anemometer reading
- c_a : correction from anemometer curve
- w_c : specific weight at time calibration
- w_m : specific weight at time measurement

Techniques of Measuring Velocity

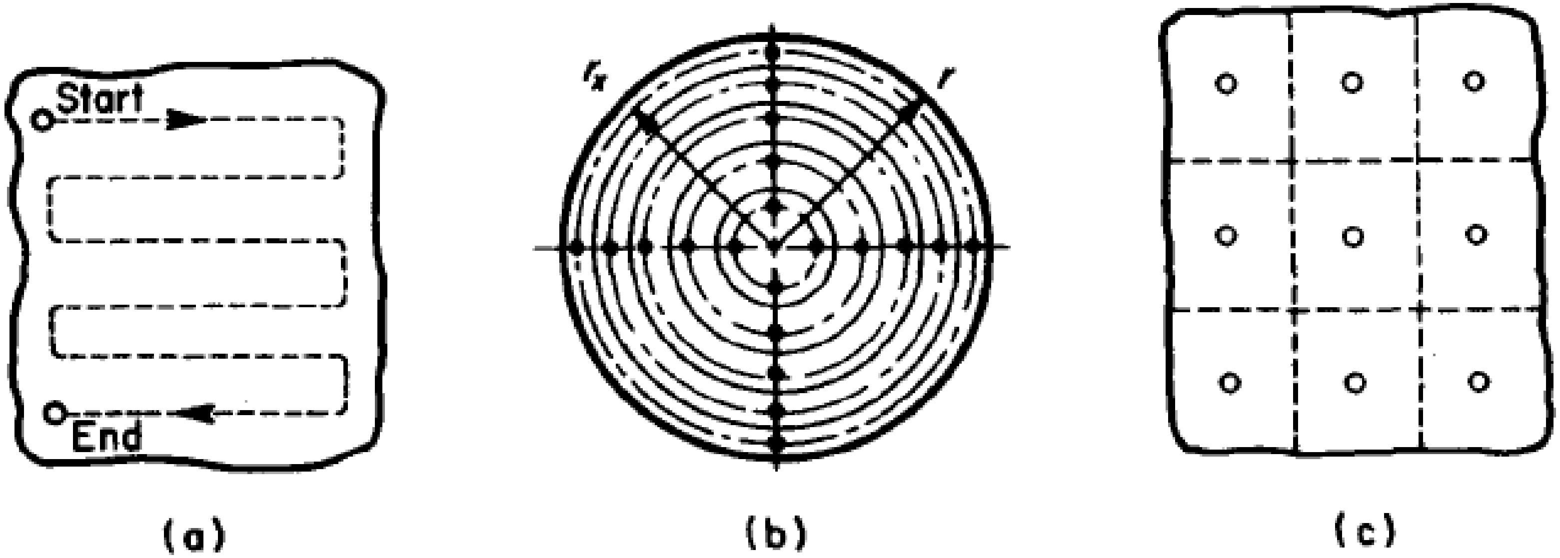
- There are Two techniques to measure the velocity :

a. Single : it is simplest, fastest but least accurate. It is made by holding the instrument at the center of the air way.
b. Multiple : it is made by taking a series of readings by either the fixed point traversing or contiguous traversing methods.

- Fixed point measurements
- Traversing continuous method.

Techniques of Measuring Velocity

- a) contiguous traversing
- b) fixed point circular
- c) fixed point rectangular



Techniques of Measuring Velocity

- This is equivalent to saying that the radius *rx* for any concentric group of readings is :

$$r_x = r\sqrt{\frac{2x-1}{2N}} \qquad (6.4)$$

- r : airway radius
- x: : no. of concentric group of reading
- N : no. of alternate circles

Techniques of Measuring Velocity

- **Example** : If 20 readings are required, N=20/4=5, then,

$$r_1 = r\sqrt{\frac{1}{10}} = 0.316r$$

- the radius of the circle for the second group of readings is

$$r_2 = r\sqrt{\frac{3}{10}} = 0.548r$$

- And so on,

$$r_3 = 0.707r$$
$$r_4 = 0.837r$$
$$r_5 = 0.949r$$

Air Quantity Measurements

- Tracer gas technique is a direct method to measure the quantity (Q)
- It is advantages, in mine of irregular shape cross section and in unsteady flow in mine opening.

- Two method of using tracer-gas technique which are:
- 1. Thimson
- 2. Kissell

Air Quantity Measurements

- The rate of airflow is calculated by using eq. :

$$Q = \frac{Q_g}{C} \qquad (6.5)$$

- Q_g :feed rate of tracer gas (ft^3/s)
- C :Concentration of tracer gas (ft^3/ft^3)

$$Q_g = \int_{\tau_0}^{\tau_f} QC_\tau d\tau \qquad (6.6)$$

$$Q = \frac{Q_g}{C_{av}\tau_T} \qquad (6.7)$$

- C_{av} : concentration average of tracer-gas

Air Quantity Measurements

- **Example 6.1**
- Thimons and Kissell (1974) report that, when they released 0.37 ft^3 of sulfur hexafluoride in a mine and monitored its concentration in the return, of the 45 samples taken at 2-min intervals, only 31samples contained measurable quantities of the gas (Fig. 6.7). Average concentration in the 31 samples of the gas is calculated as 3.77×10^{-7} ft^3/ft^3 of the air. The total sampling time was 62 min. Find the quantity of airflow?

Air Quantity Measurements

- **Example 6.1**
- **Solution**
- By using eq. 6.6, the quantity of air can be calculated as :

$$Q = \frac{0.371}{(3.77 \times 10^{-7})(62)} = 16{,}000 \text{ cfm}$$

1. First method, the tracer gas is continuously metered into an airway.
2. Second Method, A known mass of the gas (volume) is injected into the airstream. It's concentration at the downstream point is measured.

END OF PART-I