PRACTICALS

Determination of vapour pressure and calculation of relative humidity

The important measures of humidity are vapour pressure, relative humidity and dew point temperature. The pressure of air is the total weight of all the gases including water vapour in small proportions. Since water vapour also contributes to this air pressure, the partial pressure due to water vapour alone is called **vapour pressure**. It is expressed in millibars or millimeters of Hg. The ratio between the amount of water vapour present in a given volume of air and the amount of water vapour required for saturation under fixed temperature and pressure or The ratio of actual water vapour pressure and saturation vapour pressure under fixed condition of temperature is called **relative humidity**.

The instruments used for measuring water vapour or relative humidity content of the atmosphere are called hygrometers. The two main types of the instruments used for measuring the relative humidity of the air near the earth's surface are:

(a) Combination of dry and wet bulb thermometers (also called psychrometer) and

(b) Hair hygrograph

Combination of dry and wet bulb thermometers (also called psychrometer)

- Temperature readings are obtained from dry and wet bulb thermometers.
- Then, hygrometric tables are used to determine the dew point temperature and relative humidity.

Hair hygrograph

It records the continuous changes in relative humidity on graph paper during the hours of the day. When a hygrometer is transformed into a self recording device it is called as a hygrograph. This is used to record the relative humidity of the air continuously.

……

Measurement of dew point temperature

Dew point temperature is the temperature at which air would become saturated if cooled at constant pressure without addition or removal of water vapour. Thus, the actual vapour pressure is equal to the saturated vapour pressure at the dew point temperature.

Dew point can be calculated by the formula:

$$T = T1 - G\,(T1 - T2)$$

Where, T = dew point temperature, T1 = Dry bulb temperature, T2 = wet bulb temperature and G = Glashier factor (Its value depends upon room temperature)

Example: If the dry and wet bulb thermometers show the reading of 20°C and 15°C respectively, find out the dew point temperature and relative humidity. (Value for G at 20°C is 1.79)

Solution: T =T1 – G (T1 – T2)

T1 = 20, T2 = 15, G for 20°C =1.79

T = 20 – 1.79(20 -15)

= 20 – 8.95 = **11.05°C**

……

Measurement of atmospheric pressure

The weight exerted by a column of air on unit surface of the earth is known as atmospheric pressure. This can be measured by an instrument called barometer. There are two types of barometers, viz.,

1. Mercury barometers 2. Aneroid barometers

Of these two, the most accurate instrument is the mercurial barometer. This is used as standard for calibrating the others. The following instruments are used to measure the atmospheric pressure.

Mercurial barometers:

There are two types of mercurial barometers. A) Fortin's barometer B) Kew pattern barometer

Principle: Balancing of column of air against a column of mercury in a sealed glass tube. The height of the mercury column is proportional to the pressure.

Units of measurements:

I. Height of mercury column is measured in inches, centimetres or millimetres.

2. The S.I. unit for pressure is Pascal.

One atmospheric pressure = 76 cm or 760 mm of Hg

= 1013.250 millibar

= 101.325 kilopascal (kPa)

……

Measurement of wind direction and speed

Wind is the air in horizontal motion caused due to differences in atmospheric pressure. Wind has to be specified by its direction and speed.

Wind vane : This is used in observatories to find the wind direction.

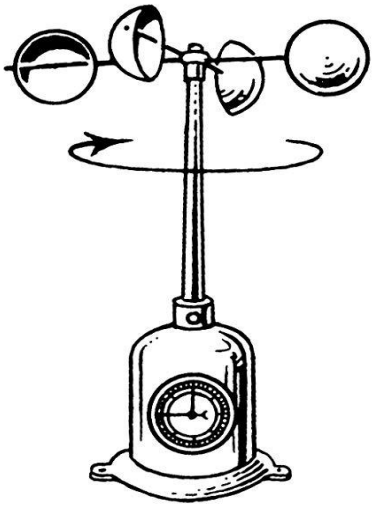
Anemometer: It measures speed of the wind.

Aerovane : This measures the velocity and direction of the wind simultaneously.

WIND VANE: Wind direction is measured with an arrow head installed on a metal frame free to rotate in the horizontal plane with the direction of the arrow pointing towards the wind direction of the wind. Below the indicator, a frame indicating 4 (north, east, south and west) or 8 or 16 points of the compass is fixed to the frame to facilitate the estimation of the direction. The direction is read by noting the direction to which the arrow head points. Wind vane is read by standing exactly in the line of the arrow of the instrument.

ANEMOMETER: Wind speed is measured by Robinson Cup anemometer which has a mechanical arrangement for converting the rotational motion into linear motion in kmph. To determine wind speed at the time of observation, the two successive readings of the anemometer should be taken at an interval of 3 minutes. The difference between the two readings when multiplied by 20 will give the wind speed in kilometer per hour, if the anemometer is calibrated in kilometers.

For example: If the first anemometer is 4005.6 and the second reading is 4006.8, the wind speed will be 20 x (4006.8-4005.6) = 20 x 1.2 = 24 kmph.

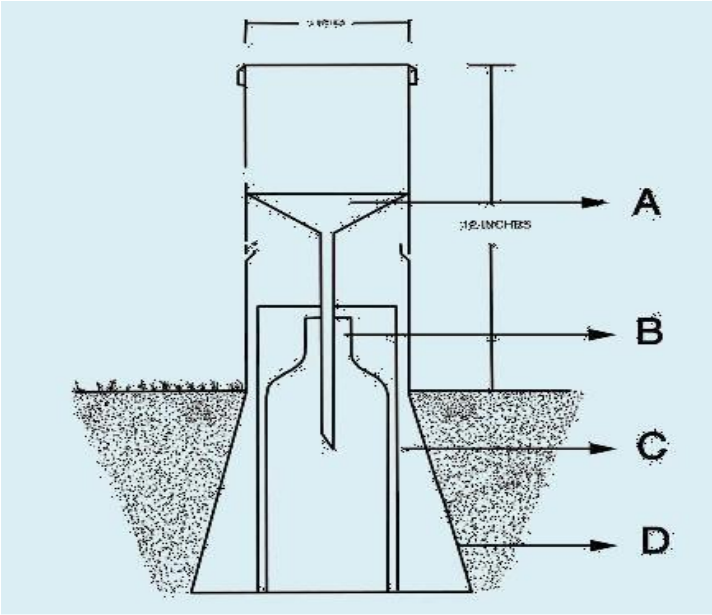


……

Measurement of rainfall

The simplest and most common method of measuring rainfall is to use a raingauge. It's essential parts are:

1. Collector (funnel) of circular shape with brass rim of 200 cm^2 area. The collector has a deep funnel.
2. Cylindrical body on which funnel is supported.
3. Receiver bottle with narrow neck made of polythene and rain falling into funnel gets collected in the bottle.
4. Base which is partially sunk and fixed in the ground and supports the cylindrical body.
5. Measuring cylinder whose graduation is consistent with the diameter of funnel. The collected rain water in the bottle is measured with the appropriate specific measuring glass. The measure glass is graduated in tenths of millimeter.



A= Collector (funnel)

B= Receiver bottle

C= Cylindrical body

D= Base

The rain gauge should be fixed on a concrete foundation, not upon a slope and never on a wall or roof. It should not be installed on a ground that has slope on the side of the prevailing wind since

in that case quite a few rain drops will be carried away by the winds. A foundation of 60 x 60cm x 60 cm should be provided to rain gauge.

Calculation of rainfall amount from crop field

As we know, rainfall is measured in depth units. So if the area of the crop field (A) in sq cm and the rainfall amount (R) in cm are known, the volume of water (V) can be calculated in cubic m or cubic cm from following formula:

$V = A \times R$

Note: 1000 cubic cm is 1 litre and 1000 litres is 1 kilo litre or 1 cubic m.

……

Measurement and determination of evaporation

Evaporation is a physical process in which the amount of water is converted into water vapor under environmental conditions. Water is lost from the earth‘s surface from water bodies, moist surface and through plants. Evaporation is measured in depth units (mm/day) just like rainfall.

Measurement of Evaporation

Evaporimeters can be categorized into 3 main classes. They are: Float pan, Below ground sunken pan and above ground pan

1. Floating pans: These pans are used to measure water loss from water bodies.
2. Pitche evaporimeter or Atmometer: Atmometer is hung at stevensson screen. It consists of a glass tube. The open end of the tube is covered by drier paper which is placed in position by metallic clip.
3. Sunken pan evaporimeter : It is a below ground evaporimeter which gives good values of evaporation very close to potential evapotranspiration.
4. USWB Class A open pan evaporimeter: This evaporimeter is most commonly used in observatories for measuring evaporation by IMD.

For evaporation measurement, generally a pan evaporimeter adopted by United States Weather Bureau pan evaporimeter (Class A pan evaporimeter) is used.

Observations are made by measuring the amount of water evaporated from an open pan. Measurements are carried out by adjusting the water level in the pan to fixed point. This is done by adding or removing a fixed amount of water.

Procedure

Initially the water is filled upto the fixed point tip. Due to evaporation water level will normally be below the tip at the time of observation, then add water to the evaporimeter using the measuring cylinder till the water level once again coincides with the tip of the reference point. Hence, the amount of water added, which is equal to the evaporation can be directly measured. For example, if on a particular day, 64 cm has been added to bring the water level to the reference point, the evaporation can be determined by dividing the amount of water added by 100, since the area of pan is 100 times than that of the base of the measuring cylinder. Thus, evaporation during the day is 640mm/100 =6.4 mm.

EVAPOTRANSPIRATION:

The process by which water is transferred from the land to the atmosphere by evaporation from the soil and other surfaces and by transpiration from plants. Evapotranspiration is the sum of evaporation and plant transpiration from the Earth's land and ocean surface to the atmosphere.

- **Potential evapotranspiration** is the amount of evapotranspiration that is expected over a surface with no limitaion of water.
- **Actual Evapotranspiration** is amount of evapotranspiration that actually occurs when water is limited.
- For lake :- Potential evapotranspiration=Actual Evapotranspiration.

……