Mine Ventilation

Q. What are the objective of Ventilation ?

A. The objective of ventilation is :

1. To restore the proper composition of mine atmosphere which should not contain less than 19% of oxygen or more than 0.5% of Carbon dioxide.
2. To dilute other noxious and inflammable gases like CO, CH_4 etc.. so that they are harmless. A Place is not considered to be free from firedamp if gas percentage is above 1.25.
3. To Provide good environmental conditions and to prevent excessive rise of temperature and humidity so that the workmen can work with maximum efficiency. The wet bulb temperature in development faces should not exceed 33.5°C.
4. To remove or dissipate the Coal or rock dust produced in the mine.

Q. What are the standard of Ventilation ?

A. The standard of Ventilation is

(a) Quantity of air in a Ventilating district should be
   (i) Minimum $6 m^3/min$. per person employed in the district on the largest shift.
   (ii) More than $2.5 m^3/min$ per daily tonne output.

(b) Underground air should not have less than 19% O_2.

(c) Underground air should not have more than 0.5% CO_2 or other noxious gases.

(d) Inflammable gas should be below 0.75% in the general body of return air of any ventilation district & below 1.25% at any place in the mine.

(e) Wet bulb temperature should not exceed 33.5°C, if it exceeds 30.5°C at any place, air Current should be faster than 1 m/s.

Q. what is the Composition of mine air?

A. The Composition of mine air is

Components	% of volume	% by mass
oxygen (O_2)	20.93	23.15
Carbon dioxide (CO_2)	0.03	0.04
Nitrogen (N_2) and hydrogen & other gases	79.04	76.81
	100.00	100.00

Quantity of air

In gassy coal mines of category 2 and 3 the major consideration to decide the quantity of air going underground is the rate of emission of methane gas which should be so diluted by the Ventilating air so its Percentage should be not more than 0.5 in the main return airway of the mine. With this object some Ventilation standards have been made by the D.G.M.S.

Under CMR the standard of Ventilation is:-

1. Quantity of air should be
   (i) minimum 6m^3 Per minute Per person in the largest
   (ii) More than 2.5 m^3/min Per daily tonne output.
2. Underground air should not have less than 19% O_2.
3. underground air should not have more than 0.5% of Carbon dioxide.
4. wet bulb temperature should not exceed 35°C, if it exceed 35° at any place air should be faster than 1 m/s.

In metal mines which are not deep upto 300m, the quantity of air that should go down 4 to 5 m^3 per minute.

The instrument which are used for Proper control of mine ventilation, adequacy and assess the environmental condition.

1. Thermometers
2. Barometer
3. Hygrometer
4. kata thermometer
5. Air Velocity meter
6. water gauge
7. gas detectors

Thermometers:

It is an instrument to measure the temperature. Temperatures are often stated in degrees farenheit or centigrade and the conversion ratio is

$$C/5 = \frac{f-32}{9}$$

where c denote temperature in degrees Centigrade.
f denote temperature in degrees farenhit.

absolute zero:

The absolute zero temperature is -273.15°c or -459.63°f. for calculation purposes these figures are taken as -273°c and -460°f.
It is a point at which all heat would be extracted from a substance if it can be cooled sufficiently.

Barometer:

It is an instrument to measure the atmospheric pressure.

* fortin barometer
* aneroid barometer

normal atmospheric pressure:

It is defined as that pressure which supports a column of mercury 760mm high at sea level when the temperature of mercury is 0°c.

Humidity:

The atmospheric air capacity to absorb moisture and air containing it is called humid air. The extent to which the air is humid is called relative humidity.

Relative humidity = $\frac{\text{mass of water vapour Per meter cube of air}}{\text{mass of water vapour required to Saturate } 1m^3 \text{ Cube of air.}}$

[meter cube = m^3]

Sources of humidity:

1. Original moisture Content of air.
2. wet roadways. working places and drains
3. respiration of men.
4. water vapour given off during burning of lamps.
5. water introduced in the mine for wet cutting, water infusion, spraying on coal dust etc...

Hygrometer:

An instrument to determines the relative humidity of air, that is the extent to which it saturated with moisture, is known as hygrometer.

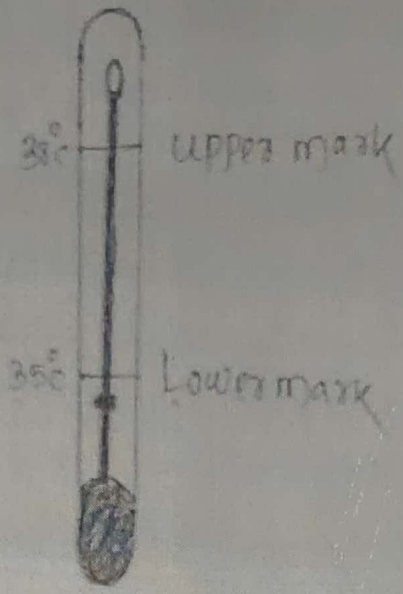
* It Consists of two thermometers mounted side by side on a suitable frame. one thermometer has a dry bulb and it indicates the actual temperature of the surrounding air.
* The other thermometer has its bulb covered with a moist cloth with dips into a small bottle filled with water. Constant evaporation of moisture takes place from the wet bulb, there by cooling it and bringing down its temperature. This principle is applied.

Calculation:

1) if dry bulb temp. is greater than 25°c then deduct from 100, 7% per degree centigrade temp. difference betn the dry bulb and wet bulb.
2) If dry bulb temp. is 20-25°c then deduct from 100, 8% per degree centigrade temp. difference betn the dry bulb and wet bulb.
3) If dry bulb temp. is 20°c then deduct from 100, 9% per degree Centigrade temp. difference betn the dry bulb and wet bulb.

Kata thermometer:

figure:



To ~~know~~ know wheater a working place is suitable for a worker to work efficiently and without discomfort, it is necessary to know the temperature of air at the working place to the relative humidity and air velocity. The joint effect of all ~~these~~ factor can be known by a instrument which is known as kata thermometer, which measure the cooling power by a combination all these three factor.

Construction and operation:

Kata thermometer Consists an alcohol thermometer with 2 marks graduated on the stem at 35°c & 38°c.

The bulb is ~~s~~mmersed in hot water carried in a thermoflasks untill the alcohol rises above the upper graduation.

The bulb is wiped dry and the time required for alcohol and drop from upper mark to the lower mark is noted. The procedure is repeated wet muslin cloth wrapped.

$$\text{Cooling power} = \frac{\text{kata factor}}{\text{time in second for alcohol to fall from } \overset{\text{upper}}{\cancel{\text{lower}}} \text{ mouth to } \overset{\text{lower}}{\cancel{\text{upper}}} \text{ mouth.}}$$

Kata factor:

kata factor of an instrument a number of mili Calories of heat which it looses ~~Kata factor~~ per square centimeter area of the bulb from cooling 38°c to 35°c.

Production of ventilation:

Ventilation is produced in u/g mine by 2 ways. These ways are: (i) purely natural mean (natural ventilation)

(ii) by a fan (Mechanical Ventilation)

Natural Ventilation:

If the air in both the shaft is at the same temp. & the pressure, there are two column of the air equal in weight which balanced eachother, there will be no flow of air in one shaft to other. If however, density of air is more than that of other shaft then their will be difference in pressure which is cause the flow of air from higher level to lower level.

Motive Column:

In the case of natural ventilating pressure 9t is the excess wet of air in down cast air column which give rise to natural ventilating pressure, the height of the excess weight of their down column, $1m^2$ in cross section which gives rise to nvp is called motive column.

$$\text{motive column (h)} = \frac{\text{nvp (natural ventilating pre.)}}{\text{density of air in Dc shaft}}$$

Q. Mean air temperature in a dc shaft 400m dip is 28° Centigrade and in up cast shaft 38°c. Calculate the motive column and nvp assuming avg. barometric pressure in down cast shaft to be 750 mm Hg.

Ans $$M.C(h) = \frac{Tu - Td}{273 + Tu} \times D$$

$$= \frac{38 - 28}{273 + 38} \times 400 = \frac{4000}{311}$$

$$= 12.86m$$

density $\omega = \frac{0.4645\,B}{273+Td}$

$= \frac{0.4645 \times 750}{273+28}$

$= 1.157 m$

NVP $= 12.86 \times 1.157$

$= 14.87 kg/m^2$

$= 146.02 N/m.$

NOTE

* M.C(h) $= \frac{NVP}{\text{density of air in Dc shaft}}$
* height of the m.c.(h) $= \frac{Tu - Td}{273 + Tu} \times D$
* B - Barometric temp.
* Tu - upcast
* Td - downcast
* D - depth
* $\omega = \frac{0.4645\,B}{273 + Td}$

Q. A dc shaft is 465 m dip and the avg. temp is downgoing air is 30°c. the upcast shaft has equal depth the avg. air temp. is 37°c, what assistant expressed in hp thus this difference in air temp. renders, when the air passing the dc shaft is 100m^3 per second. Assume the barometric pressure in 750 mm Hg.

Ans

$M.C(h) = \frac{Tu - Td}{273 + Tu} \times D$

$= \frac{37 - 30}{273 + 37} \times 465 \Rightarrow 10.5$

$$w = \frac{0.4645\,B}{273+T_1}$$

$$= \frac{0.4645 \times 750}{273+30}$$

$$= 1.149$$

$$NVP = 10.5 \times 1.149$$

$$= 12.06$$

$$H.P = \frac{12.06 \times 100}{75}$$

$$= 16.08$$

(Ans)

distribution of air in mines :-

Controll distribution of air to various Portion of mine is essential so as to ensure compliance with the ventilation standard. This may be affected by using Bratticed from the Center of the roof or Ventilating door, stopping, Air Crossing, Regulator etc.

Ventilation Appliances :

These appliances must be maintain in efficient working order and good repair. An overman shall once at least every 14 days in (coal mines) or 30 days in metal mines. and shall record the result.

Bratticed clothes :

This is simply a sheet of Canvas on from props and plans to Prevent the short circuit of air intake to return, so causing the Ventilation air to reach the face. It may be used as a Partition along a road way to divide in to 2 parts. These are (i) intake (ii) return

→ It is used to divert an air Current upward into a roof cavity to clear away accumulation of gas.

Stopping :-

These are used to block of any old roadways not required for haulage, man travelling or ventilation. To close any direct connection between the main intake and main return.

Stopping may be temporary or permanent. temporary stopping made by braticed clothes, plastic clothes or metal lath spread with urethene foam.

Permanent stopping are usually made up of brick or Concrete wall, the thickness of brickwall should be 38cm and should be plaster lime or Cement mortar to prevent Likage of air.

Aircrossing :-

Whenever the return air Current has to cross the intake air Current without mixing in it then air Crossing is required. An air crossing may be temporary or permanent in character.

Temporary aircrossing are which the Partition ~~of into~~ are made up of timber or c

may be used : 1. near the working face
2. in Connection with narrow hedding required independent Ventilation.
3. In restoring working after an explosion where permanent air crossing having Rearranged.

The pitot tube :

A pitot tube is a device which can be used to measure the static pressure, the velocity pressure or the total pressure.

Natural Ventilation :-

Flow of air through the mine working by purely natural means is called natural ventilation.

Density of air :-

$$\text{Density of air } \rho = \frac{B \times 10^3}{287.17}$$

B = Barometric pressure

Laws of mine air friction :

→ For air to flow bet^n 2 points along an airway or air circuit, there must be a difference of pressure bet^n 2 points. The difference of pressure is called the ventilating pressure.

→ It is the pressure producing ventilation and is expended in overcoming the frictional resistance bet^n the 2 points.

→ The frictional Resistance depends on the dimension of the airways, velocity of air and the nature of the airway.

→ The Rel^{n}ship bet^n these various factor was enunciated by Atkinson 1854 in the form of following 4 Laws which are called Laws of mine air friction.

Law-1

The pressure p required to overcome friction is directly proptional to area of the rubbing surface.

$$p \propto s$$

where s = rubbing surface.

Law-2

The pressure p required to overcome friction is directly proptional to the square of the velocity of air.

$p \propto v^2$ where v = air velocity.

Law-3

The pressure p required to overcome friction is inversely proportional to the area of cross section of the airway, this is $p \propto 1/A$

where A = Area of cross section

Law-4

The pressure p required to overcome friction varies with the degree of roughness of the rubbing surface or in other word on the cooficient of friction of the airw

$P \propto K$ where K = coefficient of frictio

Atkinson's equation:

The four law of mine air friction are combined in th following equation is known as atkinson's equation. ventilating pressure overcoming friction or pressure loss due to friction

$$P = \frac{ksv^2}{A} \quad OR \quad P = \frac{KSQ^2}{A^3}$$

where P is in Pascal

k = coefficient of friction of airway in kgm^3

S = area of rubbing surface in m^2

V = velocity of air current in ms^{-1} (IPxL)

A = Area of cross section of the airway in m

Q = Quantity of air flowing in m^3/sec.

Geothermic gradient:

Geothermic gradient is the rate of increasin temp. w.r.t increasing depth in the earth interior. Geothermic gradient.

Geo means earth, thermal means heat gradient means change in a particular quantity with respect to distance. so geothermal gradient as change of heat and temp of subsurface rocks increases with depth.

Geothermal gradient $\frac{\Delta T}{\Delta Z}$ c/m

ΔT = Change in temperature

ΔZ = change in depth.

Air lock :

An air lock is formed when 2 or more set of doors are installed between main intakes and return. The purpose of producing an air lock is for a better safety against short circuiting of intake and return air. when ever one door is opened for passing of person or transportation of machinery and equipment.

→ At a number of mines the types of air lock provided consists of only a simple covering at the top of a shaft which is lifted up by upcoming cage. In this design heavy leakage of air, as much as 30% of the quantity of air circulated by mechanical ventilator, takes place when the cage is resting at the pit top.

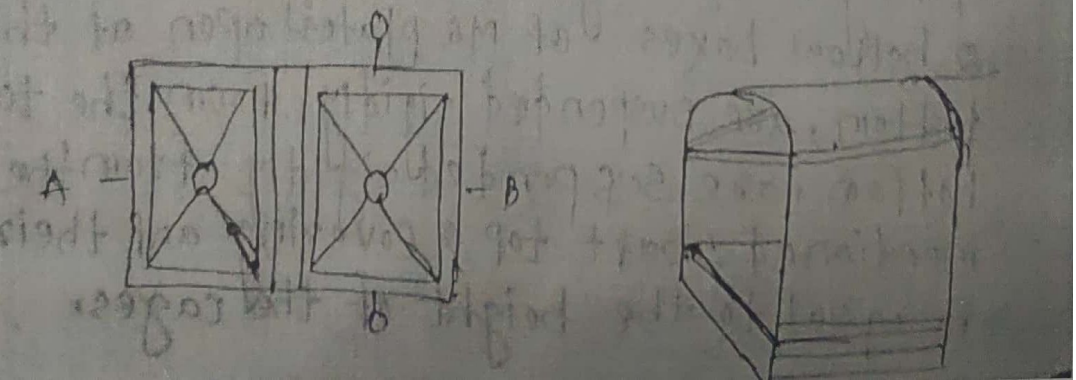
The suitable air lock designs are :

1. The standard type of air lock at the top of a shaft enclosing part of the pit top.
2. Guillotine type of doors which are provided in vertical steel box fitted with the head gear.
3. German type of a air lock which form an air lock inside the shaft.

→ Compared to the other air lock the german type air-lock is not constructed above the banking level but below it.

→ The pit top is completely covered with steel joints and thick wooden planks except for two rectangular opening for passage of the cages in these openings 2 hollow boxes of MS plates open at the top & bottom, are suspended rigidly from the top and bottom are suspended rigidly from the above mentioned shaft top & covering and their length is equal to the height of the cages.

→ The pit top banking level is flush with the pit top covering and the space betn the shaft walls and pit top wooden covering is closed by rubber linings.
→ The hollow steel boxes suspended from the pit top covering are also lined with rubber sheets throughout the length and also at the top & bottom opening. A trapezoid shaped covered of alluminium to cover the bridle chains is provided and it has a small opening for the passage of safety hook. this trapezoid shaped aluminium box rests on the pit top covering the corresponding cage at the pit bottom but can be lifted by it when ascending the small opening at the top of the trapezoidal aluminium body is covered by a separate wooden lid with a small hole for the winding rope.
→ When the ascending cage approaches the banking level the safety hook first lifts the wooden lid over the aluminium boxing which is itself lifted a second later, by the ascending cage. The space of guide ropes betn adjacent cage is also covered with in a wooden frame lined with rubber sheets and small opening are provided in the frame ~~lined with rubber~~ for the requirement of guide rope shoes as the cage moves upand down. the rubber linings at various opening prevent leakage of air.

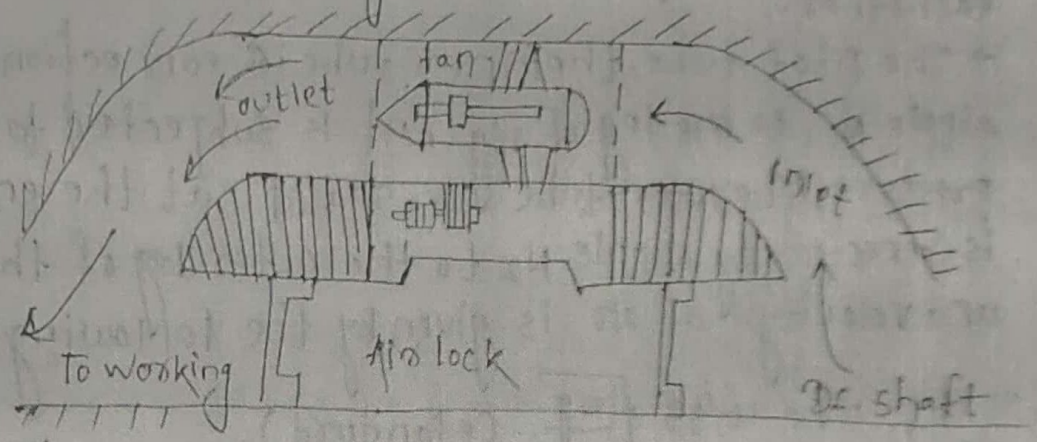


Booster fans :-

A common arrangement to improve the qty of air in one or more districts having high resistance without increase the total quantity of air circulated by the main surface fan, is the ~~circulation~~ installation of a booster fan.

→ A booster is a more or less permanent installation designed to pass the whole of the air circulating in the district or district concerned.

→ A booster fan may be placed in the return to act as an exhaust fan or it may be placed in the intake to act as a forcing fan. It is usually of axial flow type and the manner of its installation is shown in figure.



→ The axial flow fan placed in the byte pass of an intake airway is shown in figure. It is a forcing fan. A door provides access to the motor room & an air lock provides for passage of men and material.

→ The installation advantages :

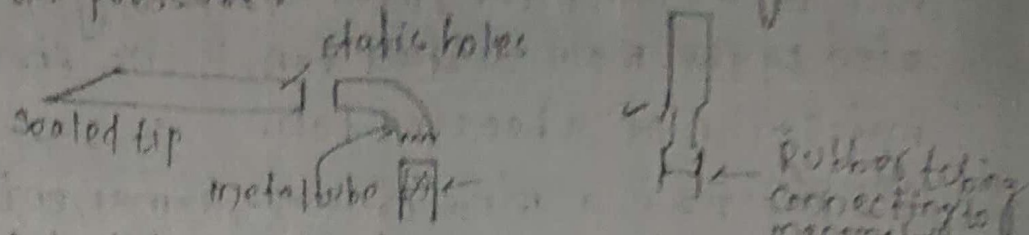
1 - compactness

2 - The fan can be mounted directly in the path of ventilating airas air float

3 - A small size axial flow fan up to 0.5m diameter fitted with a direct driving motor can be mounted in the canvas ventilation tube used for ventilating a long split.

The pitot static tube :

A pitot tube is a device which can be used to measure the static pressure, the velocity pressure and the total pressure.



→ The principle involved is shown above figure that one leg utilised to obtain the static pressure and other to obtain total pressure, the actual reading the velocity pressure which is equal to the difference bet^n the limbs of u tube.

→ If the velocity pressure of air at any point has to be measured by the two limbs should be nearer to eachothers.

→ The Pitot tube, the inner tube is connection via nipple N_1, to one leg of w/g and is subjected to total pressure. The outer tube is sealed at the end. It is connected by Nipple N_2 to the outer leg of the w/g and velocity of air is given by the following eq^n.

$$V = 4.43 \sqrt{\frac{wg}{w}} \quad \text{(standard)}$$

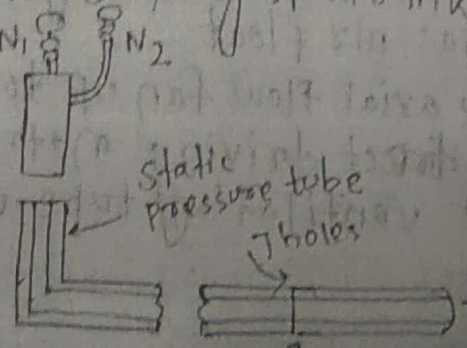
$$V = 4.015 \sqrt{w.g}$$

$$V = 4\sqrt{w.g}$$

Where V = velocity of air in m/sec.

wg = Pressure in mm of w.g or in kgf/m²

w = density of air in kgf/m³



W = Quantity of air in kgf/m³

A pitot tube should be used in conjuction with a sensitive inclined manometer.

Boundary or unidirectional ventilation system:

The boundary ventilation system where the air flow unidirectional from intake to return through the working is by far the most efficient system necessity the least use of ventilation control devices and thus resulting in a high volumetric efficiency of ventilation (70-80%). It is commonly used in metal mine. The intake and return shaft are located at the two strike boundries of the mine mostly preferable in mines with lower gas emission.

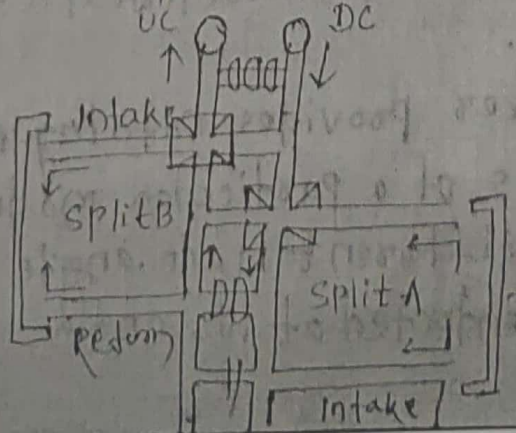
There is no splitting of airways and equivalent resistance Required which is given by the relation,

$$Req = R_1 + R_2 + R_3$$

Ascensional and descensional ventilation:

Ascensional ventilation implies taking the intake ventilating air to the lowest point of a district or face and allow it to travel to higher levels to ventilate the district or face before it goes to the return.

Descensional ventilation implies taking the air to the rise side of a district and allow it to travel to lower levels as its ventilates the working places.



* Ascensional ventilation is preferable because:
1. Fire damp being lighter than air, is readily to higher levels.
2. If the fan should stop the air will continue to flow in the same direction by natural ventilation.

* Descensional ventilation has some advantage in hot deep mines. The main advantages in the air has not to pass over water drains of the dip side and it reaches the working face in drier and cooler condition one deep mine in Raniganj field worked by advancing longwall and hydraulic sand stowing the dip side face of the double unit longwall face had a relative humidity at 93% with ascensional ventilation because the intake air was passing over drains of water coming out from slowed goaf.
→ when the particular face was ventilated by descensional ventilation, the relative humidity came down 85%.

Fan characteristics Curves :-

for every speed of a mine fan a performance curve can be drawn from fan test data pressure qty curve, power quantity curve and efficiency quantity curve. They are known as fan characteristics curve of that particular fan.

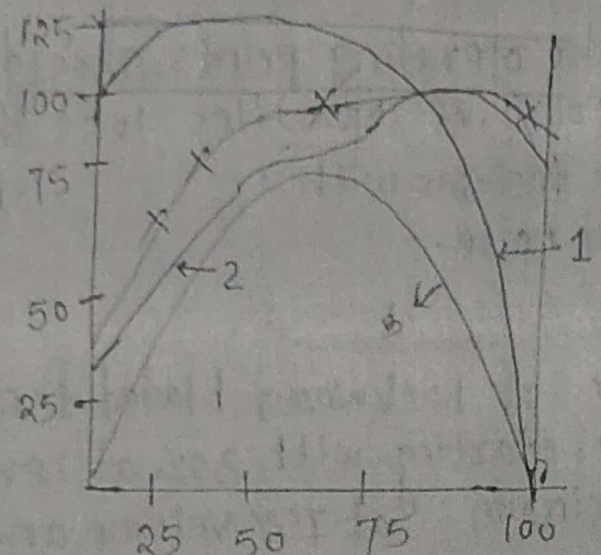
→ Pressure quantity curve being the most important sometimes the term fan characteristics is used for this single curve.

→ Fan manufacturer provides catalogue showing fan characteristics of a particular model for different speeds, different blade angle etc.... based on fan tests conducted at his end.

characteristics curves can be used :-

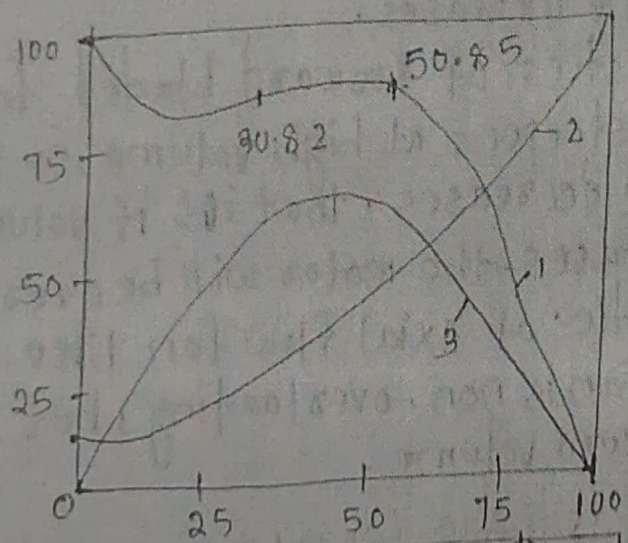
1. To assess efficiency of a fan.
2. To compare 2 or more fans.
3. To choose the most efficient fan for a given mine resistance.
4. To choose a prime mover of suitable power.
5. To acces the performance of 2 or more fans in series or in parallel, by compounding curves of the individual fans.

Characteristics curves of various types of fans :



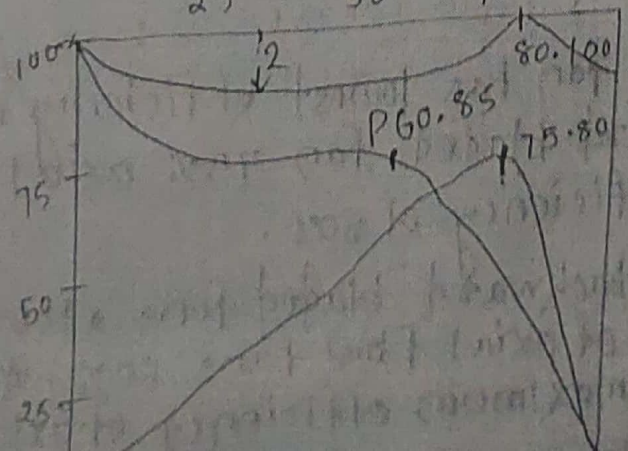
(Curve-1)

Q % of max
(Backward bladed)



(Curve-2)

Q % of max
forward bladed



(Curve-3)

Q % of max
axial of flow

(I) Pressure characteristics (P-V curve) (curve-1)

Backward bladed centrifugal fan pumped characteristics it rises to the maximum at the stall point and then falls fairly steadily to zero with increase of volume.

→ Pressure characteristics curve of forward bladed c fan falls at first rises somewhat up to stall point & then falls steeply as maximum volume is reached.

→ Pressure curve of axial flow fan shows max^m press at zero volume, it then falls rises to the stall point then falls to zero at max^m volume.

→ In all types of fan the operating points should be to the right of stall point, At capacities less than this, the fan becomes unstable with in an velocity, vibrations and noise.

(II) Power characteristics (curve-2):

→ Power characteristic of backward bladed fan is almost a straight line, starting with 30% at zero volume, rising to maximum at 75% volume and then falling as volume increases.

→ Power characteristics of forward bladed fan rises steadingly but steepens at high volume, so that if mine, resistance decreases that is if volume of air flowing increases the motor will be overloade

→ Power characteristic of axial flow fan like that of backward bladed fan is non-overloading, but it starts at 100% at zero volume.

(III) Efficiency characteristics (curve-3):

→ Forward bladed fan has lowest efficiency 65-70 Next comes backward bladed, fan 75% axial flow fan has highest efficiency of 80%.

→ However modern backward bladed fans also reach efficiency of axial flow fans 80%. A point to note is that maximum efficiency of axial

Measures : (Preventive measures)

1. Airlocks at pit top should be of proper design.
2. Doors of the airlocks and the fan drift should have rubber lining.
3. Precaution should be taken to seale that both the doors of an air lock are not be opened simultaneously and this point should be compressed the workers If possible the doors should be mechanically interlocked so that when one is open, the other can not be open.
4. Here the u/g intake and return as far aparts as possible and have very few connections betn than if possible the main intake of the mine shoul be kept in different seams.
5. All the u/g ventilation doors, ventilation stoppin and air crossing should be will constructed and main-tained.
6. In L/w method of coal mining road side pack wall should be well constructed to avoid leavage through them.

Anemometer :

⇒ It is an instrument to determine the distance travelled by air in a given time and which is used where the air velocity are betn 60m and 1000 m/min.

⇒ One type of annemometer consists of a small fan having its vanes at 40° to 50° to the direction of airflow.

⇒ The travelling air rotates the vanes and through gearing arrangement the pointer on the dial of the

anemometer record the distance travelled. (12)

→ There are usually one large and 3-4 small inner dials & a little pratice is required in taking readings of the instrument. The gears of the anemometer can be engaged or disengaged by a cluth.

→ When using the instrument in an underground road ways it should be held away from the body or observer and the plane of rotation of the vanes should be as near as normal to the direction of air flow.

→ To determine the velocity of air a stopwatch is essential in conjunction with an anemometer. The instrument can be held at the end of a stick to avoid obstruction by the body of Observer.

→ To determine the average velocity of air at any point of a roadway note the reading of the pointer of the instrument and with the instrument in declutched position hold in roadways away from the body. keep stopwatch ready at hand.

→ As the desired moment set the stopwatch in motion and simultaneously engage at the gear of the anemometer by the clutch arrangement.

→ The instrument now record the distance travelled by air. Move the instrument throughout the cross-section of the roadway as shown by the path a. After 3 to 4 minute declutch the instrument and simultaneously stop the stop watch. Take the reading.

The place where avg. velocity of air has to be measured should be selected on the following consideration.

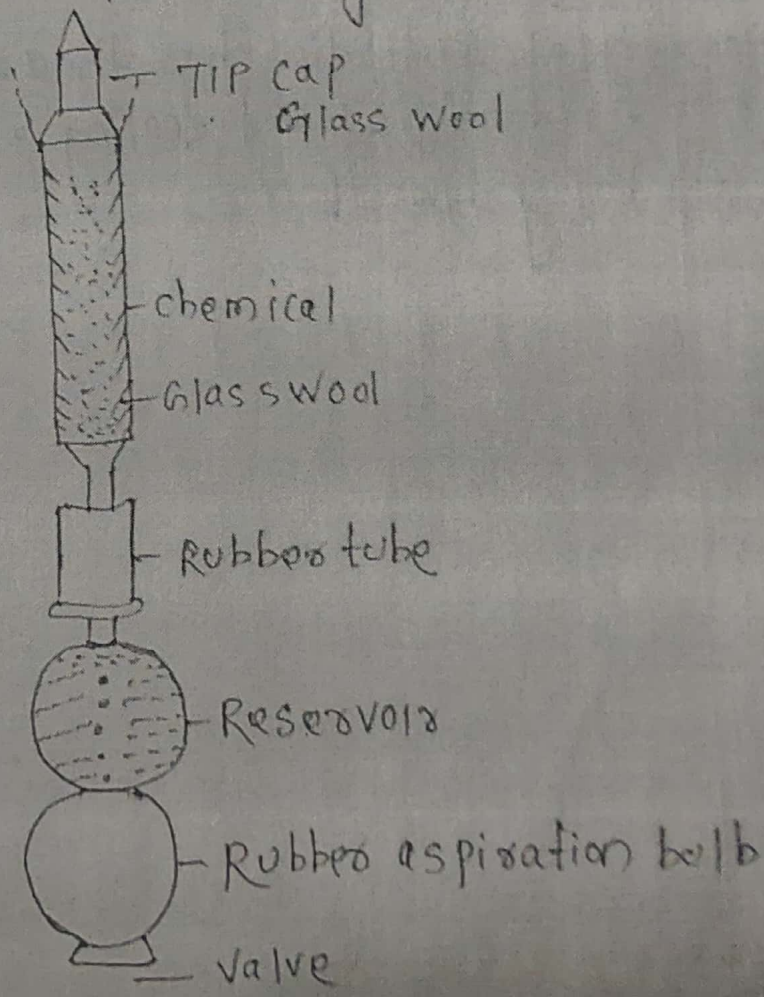
→ The roadway should have nearly have nearly uniform cross section for nearly 15m on either side and should be straight.

→ The cross section should be such that its area can be easily calculated.

→ Two men standing about 100m apart with stopwatches in hand measure the time taken for the smoke or other visible vapour to travel from posⁿ of one person to the position of another person. In a coal mine, the visible ~~vapour to travel~~ smoke cloud is produced by a simple arrangement. (13)

→ Smoke generator consists of glass tube containing granulated pumice stone saturated with anhydrous tin or titanium tetrachloride.

→ Glass tube is fitted with a rubber aspirator bulb by rubber tubes at one end and the other end is in the form of a tip covered by a rubber cap.



(Smoke generator)

Homotropal & Antitropal Ventilation :

→ When the air and mineral flow in the same direction the ventilation is known as homotropal ventilation.

→ When air and mineral flow in opposite direction the ventilation is said to be antitropal ventilation.

→ This would apply to split 'A', where coal flows on conveyours in the direction opposite to air current

→ With homotropal ventilation the velocity of air relative to coal is less compared to that in antitropal ventilation.

→ The amount of coal dust at the face is therefore less with homotropal than in case of antitropal ventilation.

→ Homotropal ventilation has other advantage in respect of humidity and dealing with fire in mines having L/w faces.

Auxiliary ventilation :

→ It is basically a mean of ventilation which is used in UG for ventilating the following.
→ Long development heading which are drive in advance of the working.
→ Roadway being draw off after collapse of the roof which has blocked the normal air current.
→ Ventilation of cross measore drifts.
→ Narrow place in mechanized board and pillar working.

Advantages :-

→ It delivers freshland dry air at the face.
→ The life of fan and motor is higher in case of ventilation system as it is placed in fresh air intake.
→ The maintainance cost of fan and lower is lesser.
→ In this ventilation air travel to the face at higher velocity. This is advantageous for hot & humid condition prevailing near the face.

Disadvantage :-

→ There is slow movement of blasting dust and fumes from heading.
→ Air travelling to the face picks up gas and moisture from the exposed strata.

Mechanical efficiency, static efficiency and total efficiency of fan:

→ efficiency of a fan is the ratio of its output to input. The o/p of the fan is the air power while input may be taken as (a) power given to the fan shaft or (b) power given to the driving motor or engine.

→ when fan shaft hp is considered as the input the efficiency is called the mechanical efficiency of the fan or simply fan efficiency.

→ $$\text{fan efficiency} = \frac{\text{Air HP}}{\text{fan shaft H.P.}}$$

→ If fan is direct driven, BHP of the motor or engine may be taken as fan shaft hp but if it is driven through gearing η of gearing should be taken into consideration.

→ when the power given to the motor or engine is considered input the efficiency is called as overall mechanical efficiency or static efficiency.

→ $$\text{overall mechanical efficiency} = \frac{\text{Air power}}{\text{power input to fan motor or engine.}}$$

$$\text{Air power} = PQ \times 10^{-3}\ \text{kW}$$

$$= (H \cdot f g) Q \times 10^{-3}\ \text{kW}$$

where H = head generated by fan

f = density of air

g = Acceleration due to gravity.

$$\text{overall mechanical efficiency} = \frac{(H \cdot f g) Q \times 10^{-3}}{\text{power input of a fan motor in kW}}$$

water gauge :-

A water gauge which is essentially an ordinary glass tube of U shape containing water and having one open end of U-tube connected to one point of low pressure and the other open end connected to another point having high pressure.

→ The difference bet^n the water levels of the two legs of the U-tube record the pressure difference bet^n the two points.

Centrifugal Fan :-

→ A Centrifugal fan consist of a wheel carrying blades or vanes at the periphery.

→ ~~Consider a particle of air at a~~ when the blade moves with the rotation of the fan it tends to drive the particle in a circular path towards b.

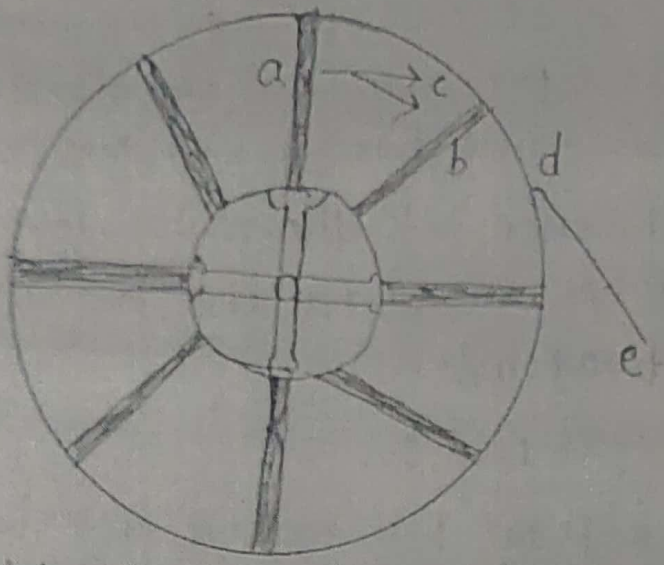
→ The particle however, has inertia and it therefore tries to move in a straight line in the direction AC.

→ The effect of these two motion is that it follows an intermediate path and is finally thrown clear beyond the tip of the blade in a direction approximately tangential to the circumference as shown by the arrow de.

→ As the blade act simultaneously on all the air in contact with them and are driving the air beyond the periphery during rotation, there is a suction effct at the centre of the fan wheel where air enters to takes place of the air driven out at the periphery.

→ The speed of the fan varies from 100 to 300 rpm. In actual practice the blades of the fan

are not exactly radial, but either curved backward or curved forward, through the backward curved blade types are common.



(Principle of working of centrifugal)

Air screw or axial flow fan:-

Axial flow fan are (1) Tube axial

(2) Vane axial

→ air screw fan or an axial flow fan pushes the air forward in the direction parallel to the axis that is axially without changing the direction of air current. unlike in the centrifugal fan.

→ consider a long bolt fitted in a nut at half its length. If the nut is confined to one place and made to rotate, the bolt travels along its axis and when the nut is rotated in reverse direction, the travel of bolt is in opposite direction.

→ In the case of an air screw fan its radial blades can be compared with the nut which has to rotate in one place are the air column on both the side of the plane of the blade as compare to a long bolt.

Ventilation Survey is done in three ways.

(17)

1. Quantity Surveying
2. pressure Surveying
3. ~~Qualitative~~ Surveying
   Qualitative

1. Quantity Surveying :-

This involves the measurement of air velocity and the quantity of air flowing in various parts of the mine.

2. pressure Surveying :-

This involves the determination of the pressure drop from point to point and location of stretches having unusually high pressure drop.

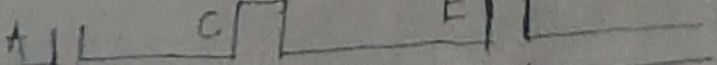
3. Qualitative Surveying :-

This involves the determination of the fire damp consient at different strategic point in the mine and chemical analysis of the air samples, if necessary.

Water gauge :-

The pressure is used in mine ventilation, there are:

1) static pressure
2) velocity pressure
3) Total pressure



Working principle of centrifugal fan :-

Consider a particle of air of a in figure when the blade moves with the rotation of the fan it tends to drive the particle in a circular path towards 'b'.

→ The particle however has inertia and it therefore tries to move in a straight line in the direction of ac.

→ The effect of these 2 motion is that it follows an intermediate path and is finally thrown cleard beyond the tip of the blade in a direction approximately tangential to the circumference as shown by the arrow de.

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→ The speed of the fan varies from 100 to 300 r.p.m.

→ In actual practice the blades of the fan are not exactly radial, but either Curved backward or Curved forward through the backward Curved blade types are common.

causes of leakage of air

1) doors of the fan drift ~~that~~ and air lock.
2) broken or crushed pillar of coal
3) use of brattice partition causes of leakage of air.
4) upcast shaft through the air lock's.
5) ventilation stopping, ventilation doors and air crossing

prevention:-

i) Air locks at the pit top should be of proper design.
ii) doors of the air locks and of the fan drift should have rubber lining for leakage-proof closing.
iii) precautions should be taken to see that both the doors of an air locks are not opened simultaneously
iv) All the ventilation doors, stopping and air crossing should be well constructed and maintained.
v) In L/w method of coal mining roadside pack walls shall be well constructed to avoid leakage through them.

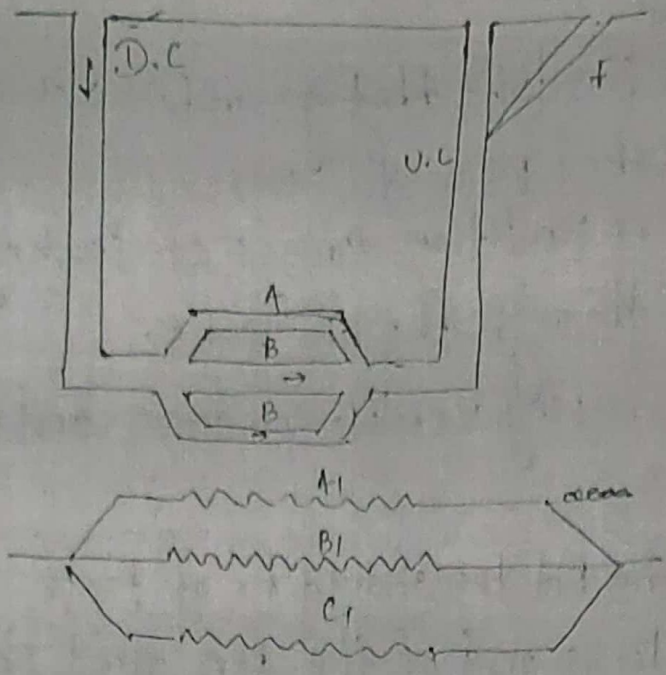
Regulator:-

It is a window of adjustable opening in a brick stopping.

The shutter of the regulator can be locked in pos^{n} to prevent tampering by workers.

Splitting of air current:-

With a view to have fresh air in a district unpolluted by human breathing or gas emission in other districts, a branch of air current called split is taken from the main air current which travels in bye from the DC shaft.



Barometer

It is an instrument used to measure the atmospheric pressure.

The standard atmospheric pressure is also called the mean or normal atmospheric pressure is defined as that pressure which supports a column of mercury 760 mm Hg high at sea level when the temp. of mercury is 0°.

There are 2 types

1) Fortin
2) Aneroid

Fortin

→ This is the standard from of barometer and accurate measurement of atmospheric pressure.

→ It consist of a straight glass tube about 900mm long and about 8mm inside diameter.

→ the upper end being sealed and the lower (open) end dipping into a small box/bard

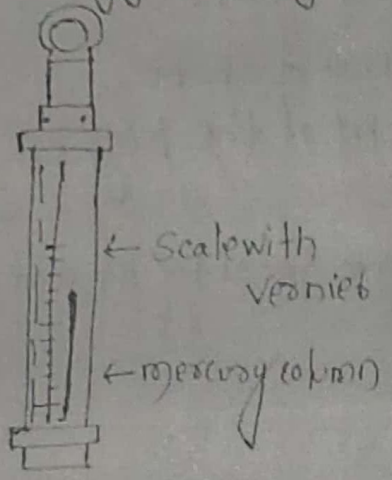
cistern of mercury having a soft chamois leather base.

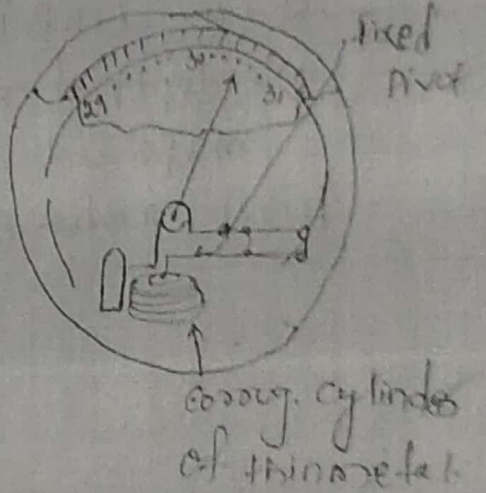
Aneroid :- Aneroid means

This instrument that doesn't contain liquid is much more used in ventilation survey.

-> this instrument. Its construction is based on different principle of measuring atmospheric pressure.

-> It consist a hollow, air tight, gas filled box made of thin springy corrugated metal.





Fan laws :-

let Q = Quantity of air in m^3/sec
N = RPM of fan
V = peripheral speed of blade tips in m/sec.

Law-1 :- Q varies directly as fan speed i.e $Q \propto N$ or V.

Law-2 :- water gauge developed varies directly as square of the fan speed or of the velocity that is water gauge $\propto N^2$ or Q^2 or V^2.

Law-3 :- Horse power required to drive the fan varies as the cube of the fan speed or

of the qty that is H.P of N^3 or v^3 or Q^3

$$P = \frac{KSv^2}{A}$$

NVP from air density, formula of NVP :-

The height of the motive column is given by the formula, $h = \frac{Tv - Td}{273 + Tv} \times D$

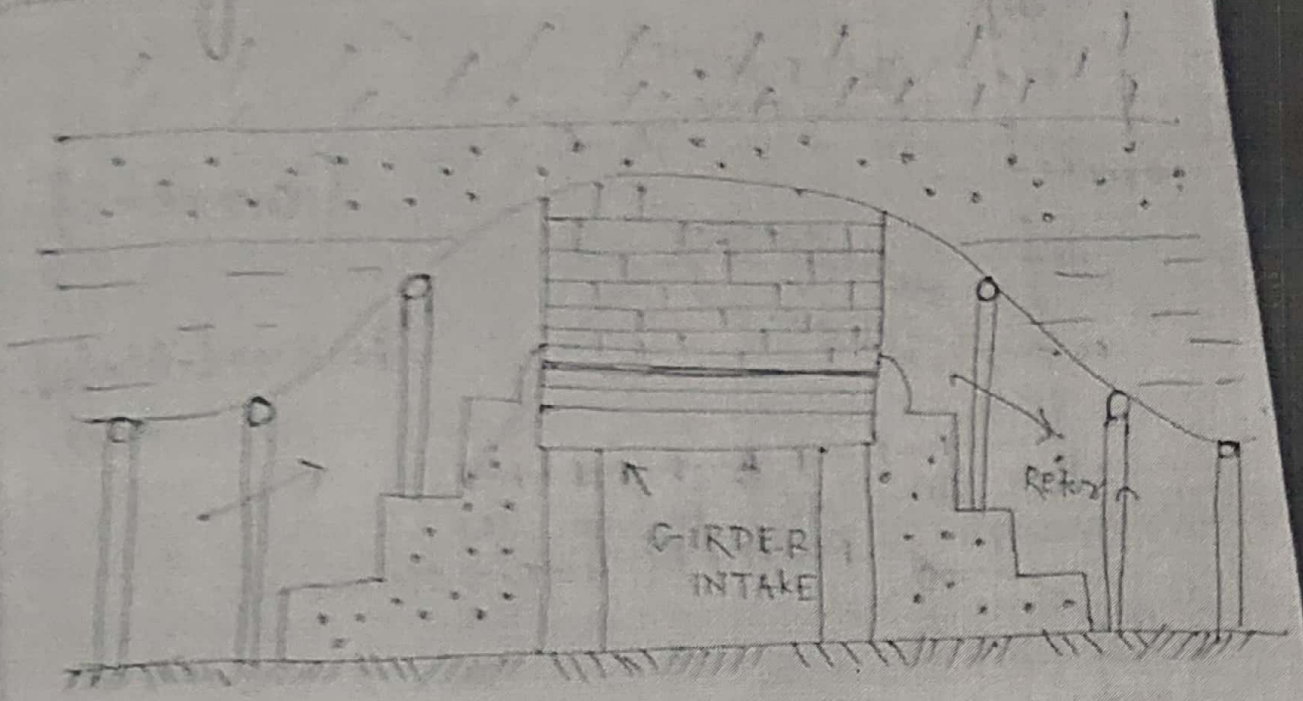
h = height of motive column

Tv = avg. temp. in upcast shaft

Td = avg. temp. in downcast shaft

D = depth of column top of the highest level shaft.

N.V.P = motive column x density of air in D.C shaft



fan drive :-

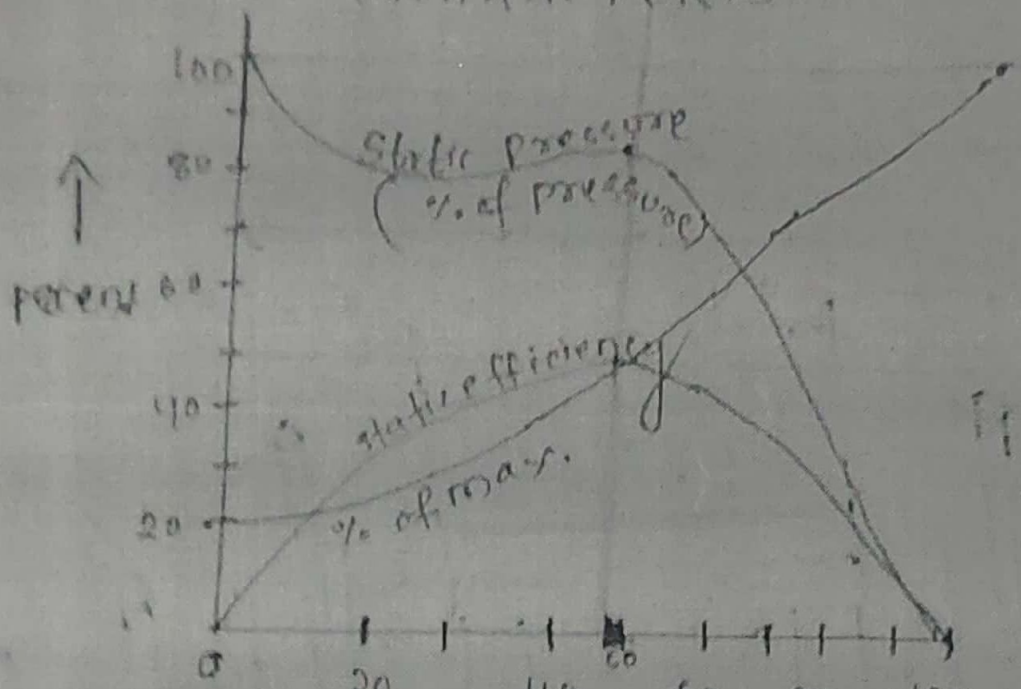
→ An electric motor is practically the standard driving arrangement for fans which have to run continuously.

→ The motor is usually of constant speed with V belt arrangement

→ The speed of the fan is varied by changing the gearing ratio of the driving and driven pulley.

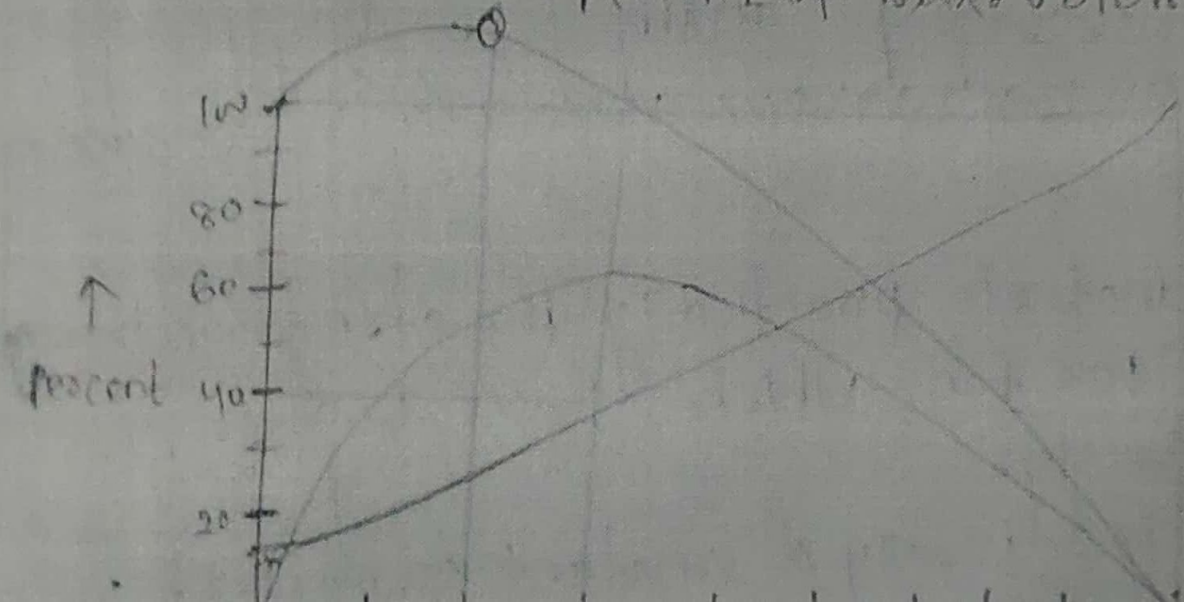
→ The main fan has to run for all 365 days of the year, 24 hours a day.

FAN CHARACTERISTICS CURVE



(Curve-2)

Forward-bladed fan



(Curve-3)

Radial bladed fan.

	Forward bladed fan	Radial bladed fan	Backward bladed fan
No. of blade	24-64	4-24	8-16
Commercial size	76-3350	1520-2540	3050-335000

(Comparison of different types of centrifugal fan)

Diffusers:-

It refers to a gradually expanding duct meant for converting a part of the kinetic energy in the air leaving the fan to useful pressure energy.
* It fitted to forcing fan.

evasees:-

It refers to gradually expanding duct meant for converting a part of the kinetic energy in the air leaving the fan to useful pressure energy.
* It attached to exhaust fan.

boundary ventilation:-

This types of ventilation system is generally adopted in metal mines.

It is possible where the D.C. & U.C. shaft are located in opposite end.
In boundary ventilation system where the air flows from intake to return