സഹായി

SFI GEC PALAKKAD

Module 2

Refrigeration

Process of maintaining a low temperature environment so as to preserve food pdts, comfort ~~com~~ air condition. Preserving chemical pdts.

Refrigerant

Working fluid used in a refrigeration system. It changes liquid to vapour during the process of absorbing heat and condenses to liquid while liberating heat.

Eg: Flurinated hydrocarbon (Freon), Ammonia, CO_2

Applications

Application

- Industrial purpose
  - a) chemical pdts
  - b) medical purpose.
- Preservation of perishable goods
  - a) Fish, fruit Vegetable, meat
- Providing comfortable environment.
  - a) Air condition in theatres, malls

Types of Refrigerator.

Refrigerator

- Air refrigerator
- Vapour refrigerator

like CO_2, SO_2,

~~working fluid~~

Refrigeration capacity

The rate of heat absorbed from a body or space to be cooled is termed as refrigeration effect. The std unit of refrigeration is TON

Imp The rate of heat absorbed by the system from the body to be cooled, Equivalent to the latent heat of fusion of one TON of ice from an at 0°c in 24 hours is called 1 TON refrigeration.

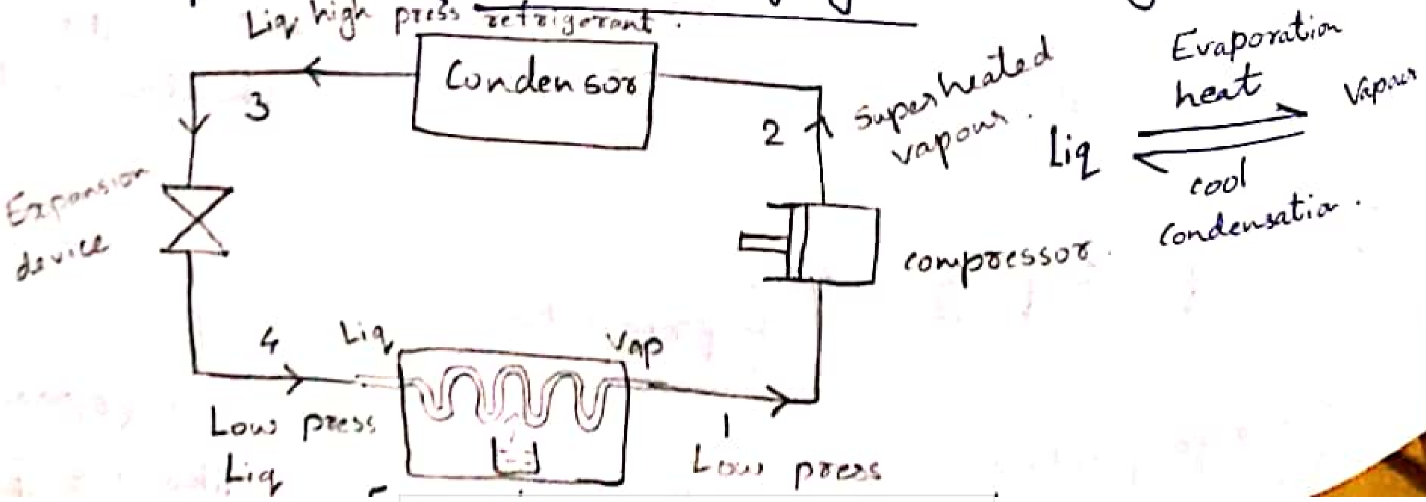
1 TON = 211 KJ/min.

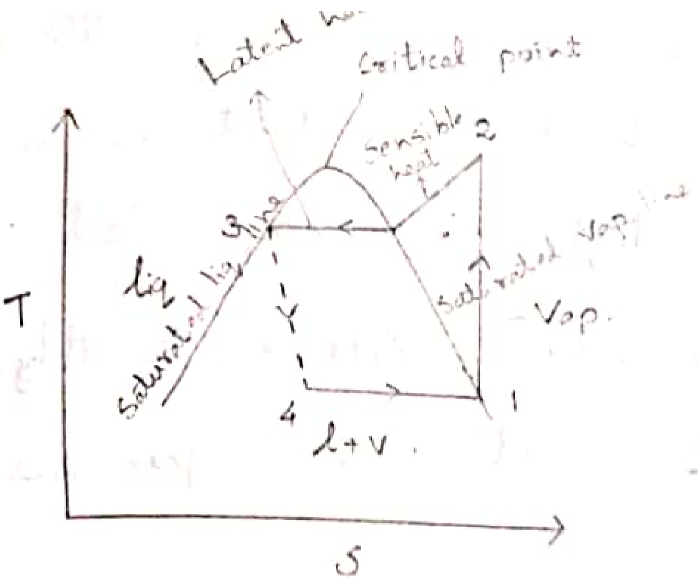
= 3.5 KJ/sec.

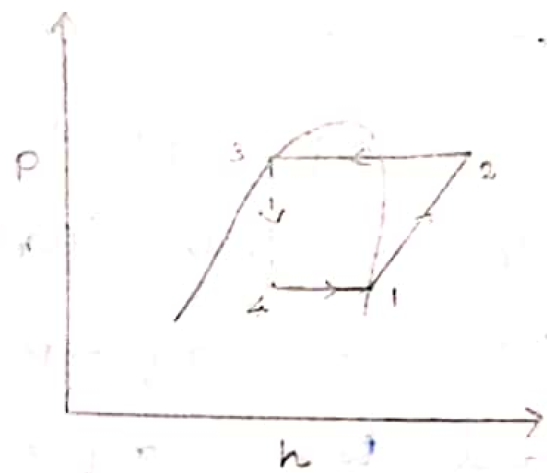
Desirable properties of refrigerator

pdf 5.1

Vapour - compression refrigeration system.







In a VCRS system working fluid is a vapour refrigerant which readily evaporates and condenses. During evaporation process it absorbs heat and gets converted from liq. to vapour. During the condensation process it rejects heat and get converted from vap. to liq.

Following are its basic components.

1) Evaporator.
2) Compressor.
3) Condensor.
4) Expansion device.

Let the vapour leaving the evaporator be dry & saturated. This is then drawn into a compressor. At the end of compression vapour is in super heated state.

Vapour at this condition is passing through condensor in which heat content is removed. The high pressure liq. is expanded in a expansion valve (Throttle valve). After throttling we get refrigerant at low pressure and tem. required.

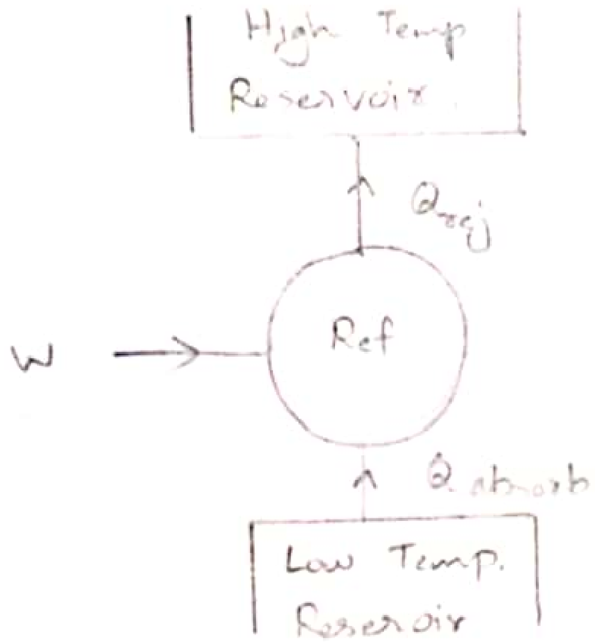
Coefficient of perfomormance = $\frac{\text{Heat extracted by refrigerant}}{\text{Work done by compressor}}$

$$COP = \frac{H_1 - H_4}{H_2 - H_1}$$

Coefficient of performance

The effectiveness of a refrigerator is expressed by a term known as ~~ie~~ COP. It is the ratio of desired refrigeration effect to the work spent to produce the refrigeranting effect

COP of a refrigerator will be greater than the unity.

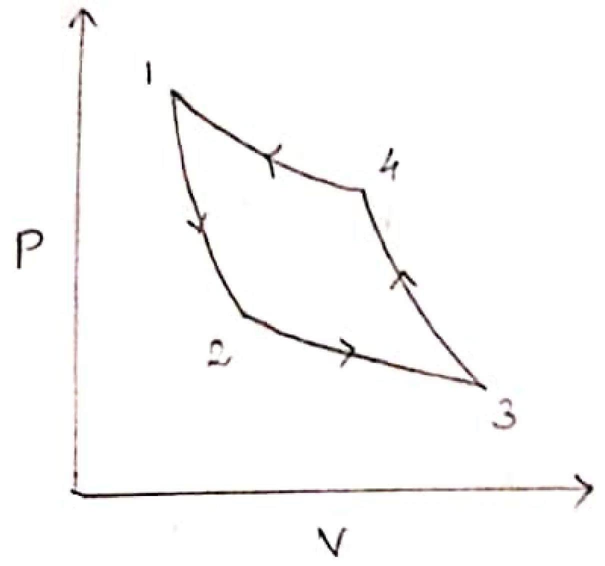


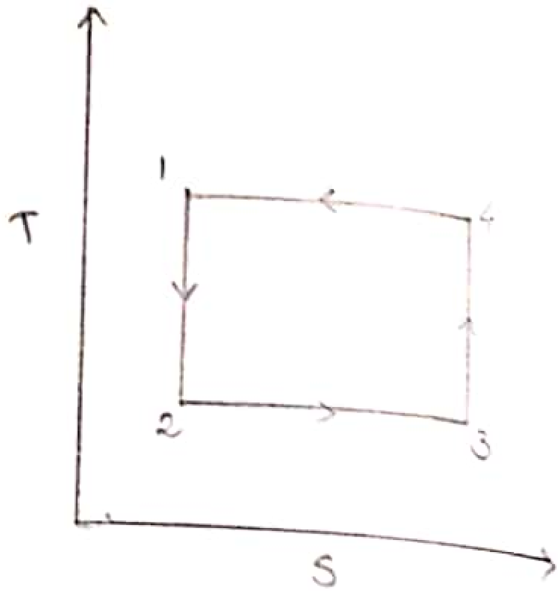
$$COP = \frac{Q_{absorbed}}{W_{in}}$$

Reversed carnot cycle.

If a machine working on reversed carnot cycle is ~~given~~ driven from ~~ab~~ an external source, it will work or function as a refrigerator. The production of such a machine as not be possible practically because the adiabatic portion of the stroke would ~~good~~ need a high speed while during the isothermal portion of the stroke a very low speed will be necessary, which is not practicable.

PV and TS diagram are as shown below.





Proces 1-2 adiabatic expansion

" 2-3 ~~a~~ isothermal "

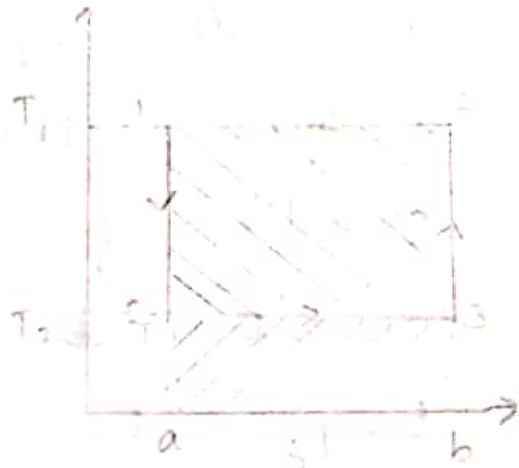
" 3-4 adiabatic compression

" 4-1 ~~a~~ isothermal "

Starting from point 1 ~~air~~ air is expanded adiabatically to point 2. during which temp. falls from T_1 to T_2. The air is then expanded isothermally to point 3. as ~~As~~ a result of which heat is extracted from the cold body. At temp T_2. Now the cold body is removed, from 3-4. temp rises to T_1. Then a hot body at temp T_1 is put in contact with the cylinder. Finally the air is compressed isothermally during which process heat is rejected to the hot body.

$$COP = \frac{\text{Heat extracted from cold body}}{W_{net}}$$

$$= \frac{\text{Area of } \square \, 23ab}{\text{Area of } \square \, 1234}$$



$$= \frac{T_2 \times (2-3)}{(T_1 - T_2)(2-3)} = \frac{T_2}{T_1 - T_2}$$

$$= \frac{T_L}{T_h - T_L}$$

Psychrometry

Subject which deals with the behaviour of moist air.

The properties of moist air is known as psychrometric properties.

1) Dry air

Dry air is a mixture of O_2, N_2, CO_2, He, Ar, etc. with N_2 and O_2 as its major constituents. ($N_2 = 78\%$, $O_2 = 21\%$)

2) Moist air

It is ordinary atmospheric air which is a mix of dry air and water vapour

3) Saturated air

It is the air which contains max. amount of water vapour which the air can hold at a given temperature and pressure. The max quantity of water vapour that can be present in the air depends upon temp. and pressure of air.

4) Specific or absolute humidity / humidity ratio

It is defined as the ratio of mass of water vapour (m_v) to the mass of dry air (m_a) in a given volume of moist air $\frac{m_v}{m_a}$

5) Relative humidity

It is the ratio of mass of water vapour in a given volume of moist air at a given temp to mass of water vapour contained in the same volume of moist air at the same temp when the air is saturated. $\frac{m_v}{m_{vs}}$

6) Dry bulb temperature

It is the temp of air measured by a ordinary thermometer

7) Wet bulb temperature

It is the temp. recorded by a thermometer when its bulb is covered by a wet cloth and is exposed to a current of moving air.

If relative humidity is high, the rate of evaporation from the wet cloth is low. and helps. wet bulb dippression will be low.

wet bulb dippression = Difference b/w dry bulb temp and wet bulb temp.

8) Dew point temperature

It is the temp at which the condensation of moisture begins when the air is cooled at const pressure.

The difference b/w dry bulb temp and dew point temp is known as dew point dippression.

9) Sensible heat of air

It is the enthalpy of dry air which can be calculated by measuring its dry bulb temp.

10) Total heat

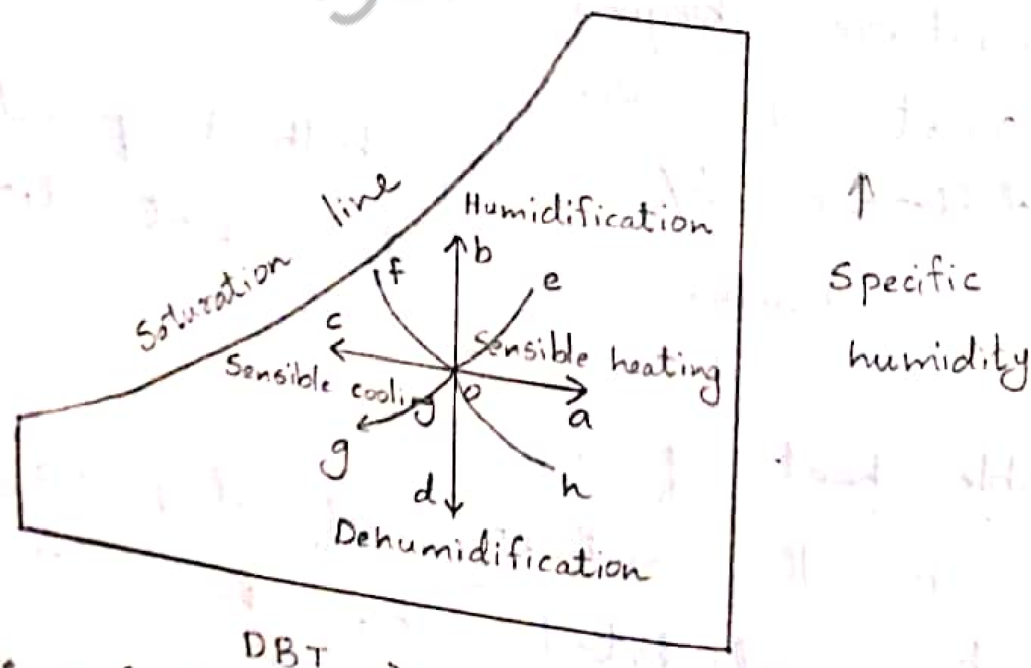
The total heat of the moist air is

the sum of sensible heat of dry air. (sensible + latent heat) of water ~~w~~ vapour present in it.

Psychrometer

It is an instrument containing dry bulb thermometer and wet bulb thermometer. The difference in reading of these two thermometers gives the measure of relative humidity of air surrounding the psychrometer.

Psychometric chart



Oe - Sensible heating and humidification

Of - Sensible cooling and "

Og - Sensible cooling and "

Oh - Se...

Physical processes involved in air conditioning

1) Air purification

In order to safe guard the health of occupance, it is necessary to remove all possible harmful ingredients from the air before admitting into the air condition system.

Air purification is carried by methods like air filtration, ~~ord~~ oudor seperation, air stabilisation etc. most of the dust particle are removed by air filters.

2) Temperature control

Major process in air conditioning system. This is attained by heating or cooling. Heating of air can be achieved by passing the air over heated surface. Cooling can be attained by passing the air over evaporated coils of a refrigerating system.

3) Humidity control

The 3rd important process in air conditioning. Achieved by process of humidification (↑ing humidity) or dehumidification (↓ing humidity). ~~the~~

Humidification is accomplished by

addition of steam or hot water to air.

Eg: Steam humidification

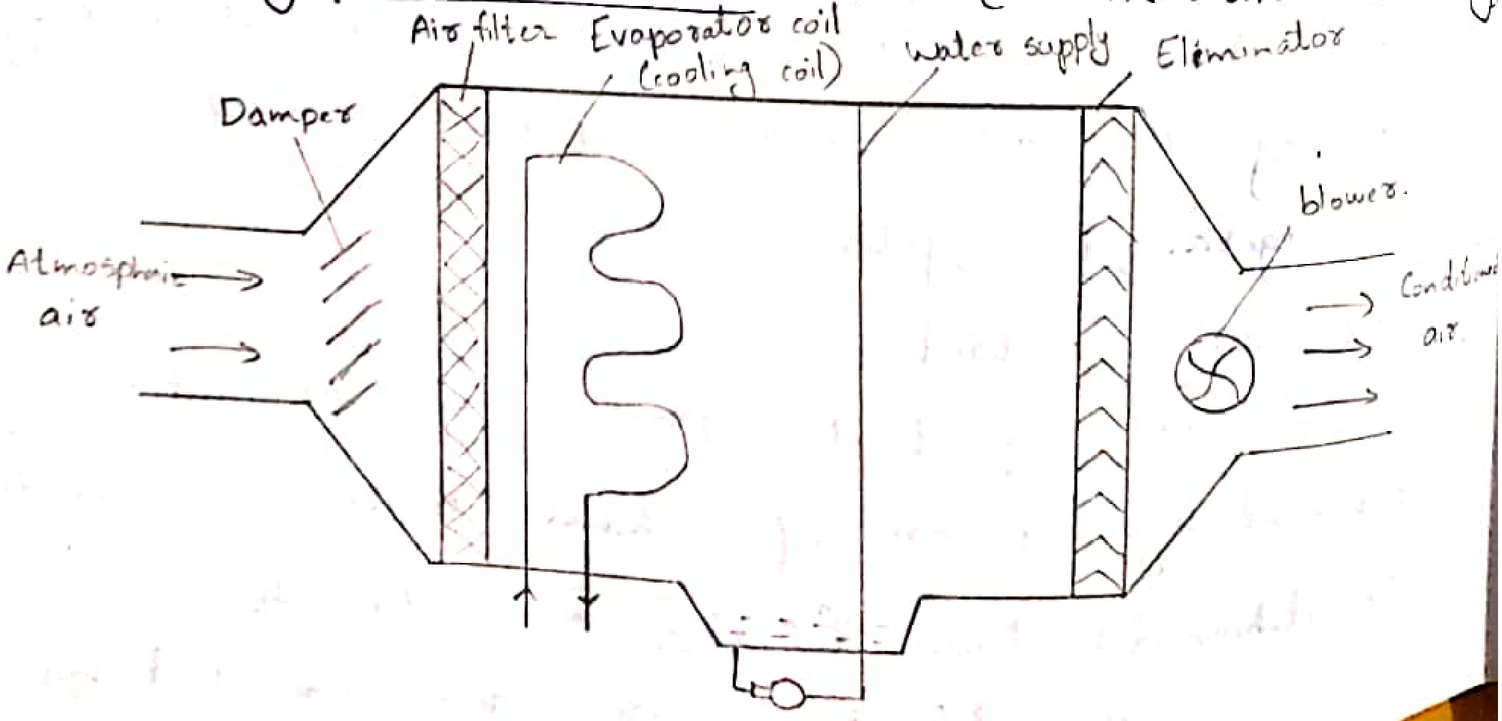
Dehumidification can achieve through absorbent (materials having capasity to absorb moisture)

Eg: Silica gel, calcium chloride.

4) Air distribution

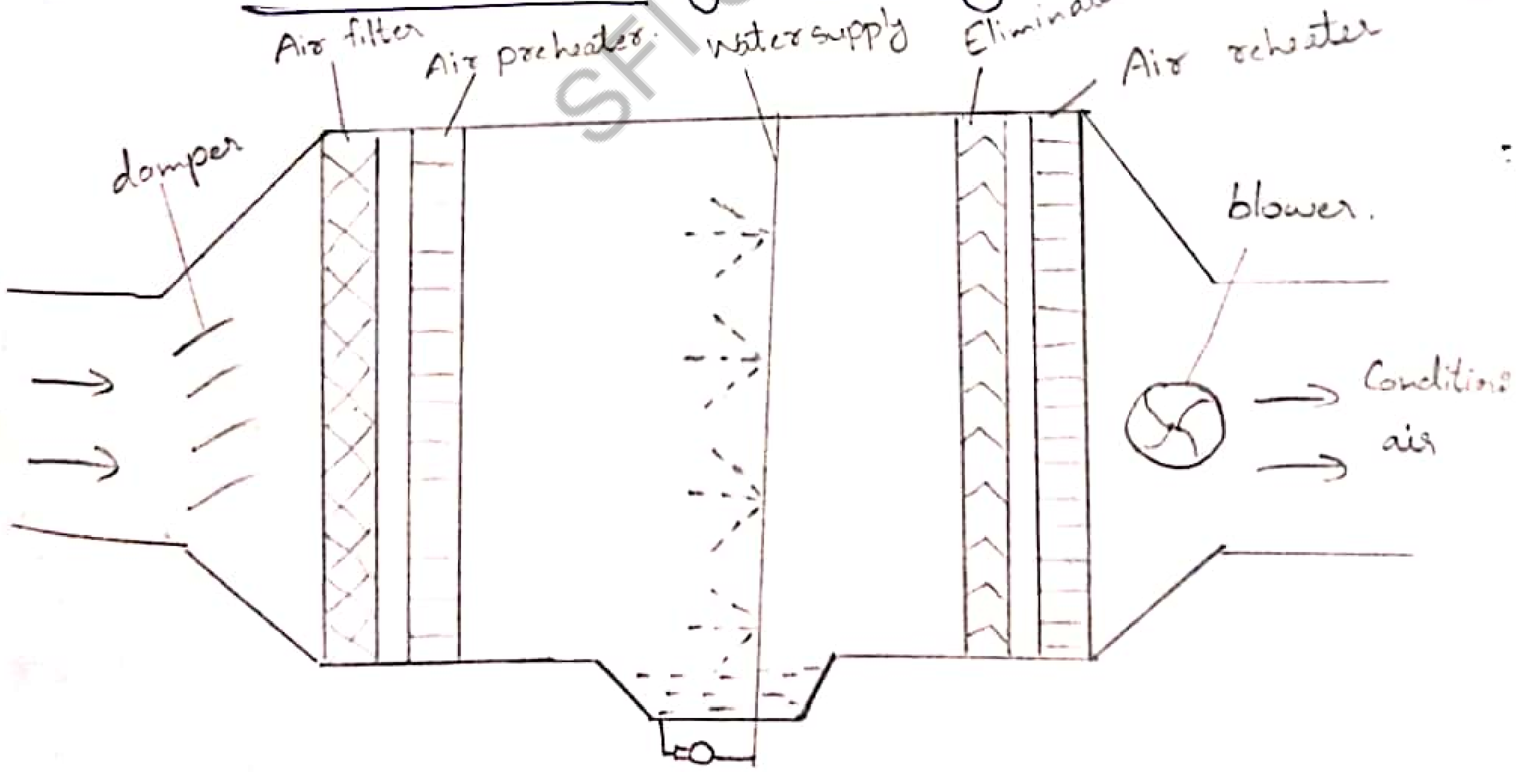
Desired air movement is 7.5 m per min. limited to a maximum of 15 m/min. Flow direction of air is towards the phase of occupance. Also downward flow of air is prefered upward flow.

5) Cooling and dehumidification (Summer air conditioning)



Here air is cooled and generally dehumidified. Atmospheric air after passing through ~~d~~ a damper get filtered ~~and~~ in air filter. Air now passes through a cooling coil. Water is then sprayed to air. The temp. of water is below the dew point temperature of air due to the vaporisation of water, the temp. of the air further decreases. ~~The~~ An ~~E~~ eliminator is placed in the path to remove water carried with air. Finally the conditioned air is supplied to the required space using a blower.

Winter air conditioning. (heating and humidification)

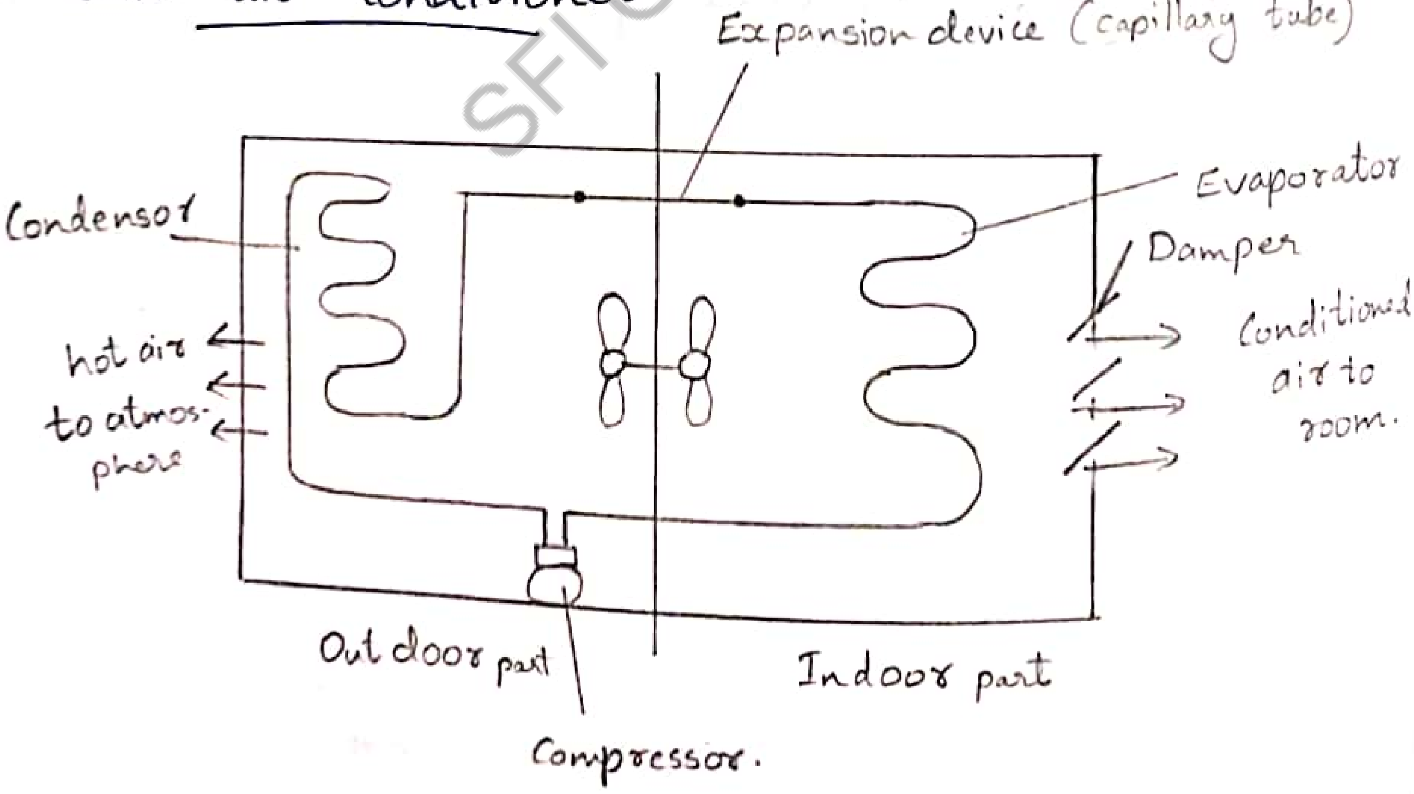


This type of ~~a~~ air conditioning is used when temp. of atm. air is considerably low (5-10°C)

After passing through air filter air is preheated in ~~xx~~ preheater in order to prevent the ~~free~~ possible freezing of water. Required Relative humidity is accomplished by spray humidifier.

Eliminator is placed in the path to remove water droplet carried with air. Now the air is ~~t~~ heated in reheater to the required ~~condition.~~ comfort condition. The conditioned air is supplied to the required ~~t~~ space using a blower.

<u>Unit air conditioner</u>



A unit air conditioner consist of a case divided into 2 parts., Outdoor and indoor parts by a partition.

Indoor part - Evaporator and a fan.

Outdoor part - Compressor, condensor and a fan.

Capillary tube (Expansion device) is provided in between the condensor and evaporator.

Low pressure vapour refrigerant drawn from the evaporator is compressed to a high pressure and is delivered to the condensor. In the condensor the refrigerant vapour is condensed by releasing heat to the surroundings, the hot air is driven out using a fan. High Pressure liq. refrigerant enters the capillary tube where the pressure is reduced. This low pressure liquid vapour enters the evaporator, Liquid refrigerant evaporate by absorbing latent heat of vaporisation from surroundings.

Central air conditioner.

This is the most important type of air conditioner. In this system all the components are installed in a seperate central room. The conditioned air is distributed through ~~ducks~~ ducts. from the central room to various rooms to be air conditioned. It is adopted when.

1) Cooling capacity required is 25 ~~tons~~ TONS or more.
2) when the air flow is more than $5m^3/hour$
3) when different zones in a building are to be air conditioned.

For figure refer assignment no-2.

Pumps

Pump is used for lifting liquids from lower level to higher level. This is achieved by creating a low pressure at the inlet and a high pressure at outlet of the pump.

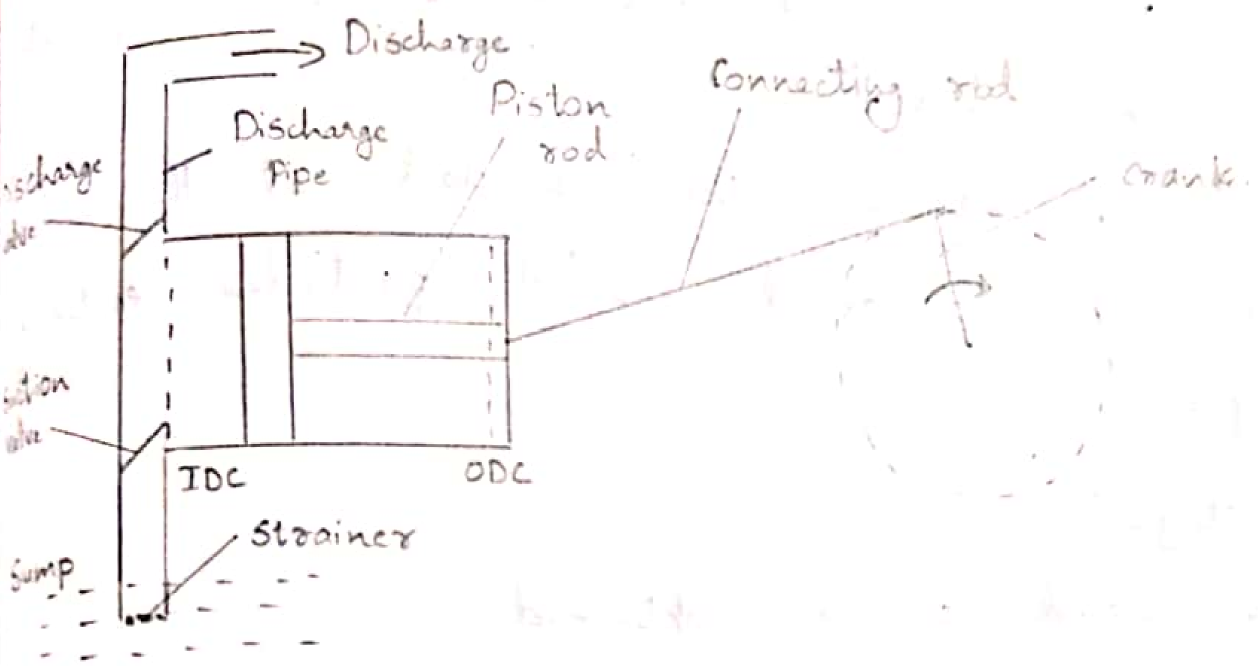
Based on the working principle pumps are

~~Positive~~

Pump

- Positive displace pump.
  - → Reciprocating pump
  - → Gear pump.
- Rotodynamic pump.
  - → Centrifugal pump.
  - → Propeller pump.

Reciprocating pumps



Main components

Piston, piston rod, connecting rod, crank, suction pipe, suction valve, delivery valve, delivary pipe.

Working

As the piston moves from IDC to ODC Vaccum is created inside the scylinder and thus liq enters into the cylinder through suction pipe. During the movement of piston from ODC to IDC. (ie from Right → Left) liq. is pushed into the delivary pipe.

Suction and delivary pipes are provided with non-return valve which ensures unidirectional flow of liquid. Movement of piston inside the cylinder is obtained by ~~conne~~ slider-crank mechanism. Crank is rotated using an electric motor. When crank rotates piston reciprocates inside the cylinder.

A strainer is provided at the end of suction pipe to avoid solid particles entering the pipe.

Advantage

1) High head can be obtained
2) No priming is required.

Disadvantage

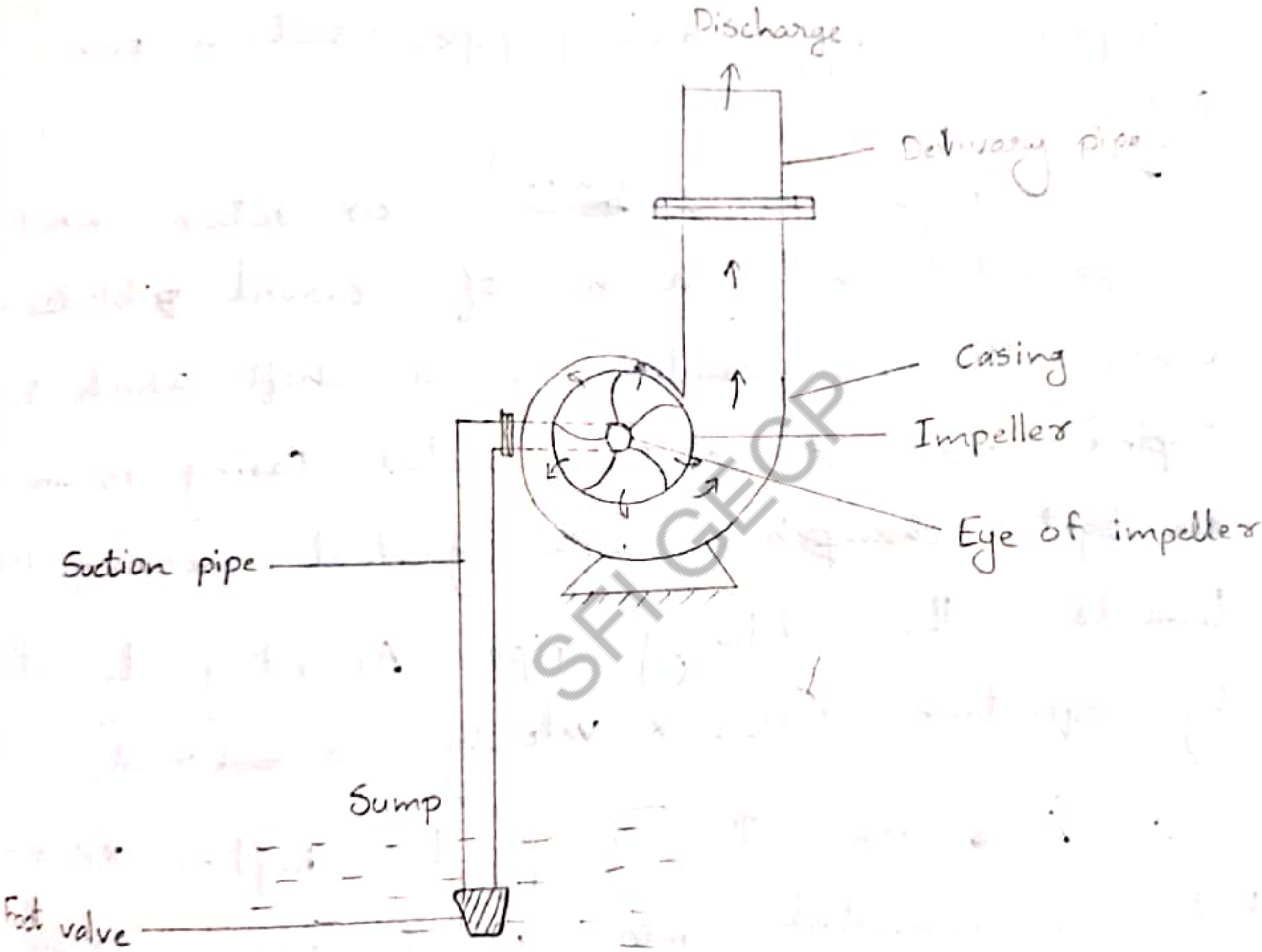
1) Pulsating flow
2) High initial cost.
3) Higher ~~das~~ floor space.

Application

Suitable for high head and low discharge

~~Centrifugal pump~~.

Centrifugal pump



A roto dynamic pump in which low pressure at the ~~the~~ inlet of pump and high pressure at the outlet of pump is obtained through ~~the~~ centrifugal ~~as~~ action. When a certain mass of liq. ~~is~~ is made to rotate by an external force, it is thrown away from the axis of rotation and a centrifugal head is impressed which enables the liquid to rise to a higher level.

Main components

Impeller, casing, delivary pipe, suction pipe, foot valve

The impeller is a ~~beam~~ wheel or rotor which is provided with a no. of curved blades or vanes. It is mounted on a shaft which is coupled to a electric motor. Casing is an air tight chamber with gradual increasing area towards the delivary pipe. According to continuity equation (area × velocity = a ~~cost~~ const)

∴ As area ↑s velocity ↓s implies KE reduces but is converted into useful pressure energy. Suction pipe connects center of impeller to sump. From which liq. is to be pumped. Lower part of the suction pipe is fitted with a foot valve and strainer. Foot valve is a non-return valve

After priming the impeller is rotated by means of electric motor. The rotation of impeller in the casing produces a forced vortex which imparts a centrifugal head to the liquid. The vaccum created at the eye of impeller causes the liq: from the sump to rush through the suction pipe, & replacing the liq: which is being discharged from the impeller. The KE thus is converted into Pressure energy while flowing through the volute casing. Thus the liq. is discharged from the pump to delivery pipe with very high pressure.

Advantages

1) Smooth flow
2) Large discharge
3) Less initial cost.
4) Compact, so less floorspace
5) High viscus liq can be handled
6) Easy installation and less maintenance cost.
7) No reciprocating parts.
8) Less weight for given discharge.

Disadvantages

1) Leads priming.
2) Low head.

Application

- Suitable for low head and high discharge

Numerical problem on centrifugal pump

Overall efficiency

$$\eta_o = \frac{\text{Output power}}{\text{Input power}}$$

Let ρ be the density of liquid.

$\rho_{water} = 1000\ kg/m^3$

$g \rightarrow$ acceleration due to gravity $= 9.81\ m/s^2$

H be ~~the~~ total head ~~in~~ in meter

Q be discharge m^3/sec

1 litre/sec $= 1 \times 10^{-3}\ m^3/s$

1000 litre/sec $= 1000 \times 10^{-3}\ m^3/s$

$$\eta_o = \frac{\rho g Q H}{P} \text{ watt}$$

Output power $= \rho g Q H$ watt

$= \frac{\rho g Q H}{1000}$ KW

$$\eta_o = \frac{\rho g Q H}{1000 P} \text{ KW}.$$

?. A centrifugal pump discharges water at a rate of 2000 litres per second against a head of 16 m when running at 300 rpm. Calculate the power required to run the pump if overall efficiency of

Given,

$\eta_o = 50\% = \frac{50}{100}$

$H = 16\ m$

$\rho_{water} = 1000$

$N = 300\ rpm$

$Q = 2000\ litres/s = 2000 \times 10^{-3}\ m^3/s$

$$\eta = \frac{\rho g Q H}{1000 P}$$

$$P = \frac{\rho g Q H}{1000 \eta} = \frac{1000 \times 9.8 \times 2000 \times 10^{-3} \times 16}{\frac{50}{100} \times 1000} = 500$$

$$= \frac{313600}{500} = \underline{627.2}\ kW$$

? A centrifugal ~~m~~ pump discharges water at 120 ~~m~~ litr per sec against a head of 25 m. If the power required is 40 kW, calculate the overall efficiency of pump

Given, $Q = 120\ Litre/s$, $g = 9.81\ m/s^2$

$H = 25\ m$

$P = 40\ kW$

$\rho_{water} = 1000$

$$\eta_o = \frac{\rho g Q H}{1000 P} = \frac{1000 \times 9.81 \times 120 \times 10^{-3} \times 25}{1000 \times 40}$$

$$= \cancel{73575}\ 0.7357 = \underline{73.57\ \%}$$

Hydraulic turbine

Hydraulic energy → mechanical energy → Electrical energy.

A hydraulic turbine consist of a wheel called runner provided with a no. of curved or straight vanes (blades) on its perifery.

Based on the action water

Impulse turbine

Potential energy of water converted to ~~b~~ KE by a set of nossils This produces powerfull jets impinging buckets provided on the perifery of a wheel.

The wheel is fixed to a ~~shaap~~ shaft. which is coupled with generator.

Eg Pelton wheel

Turgo wheel.

Reaction turbine

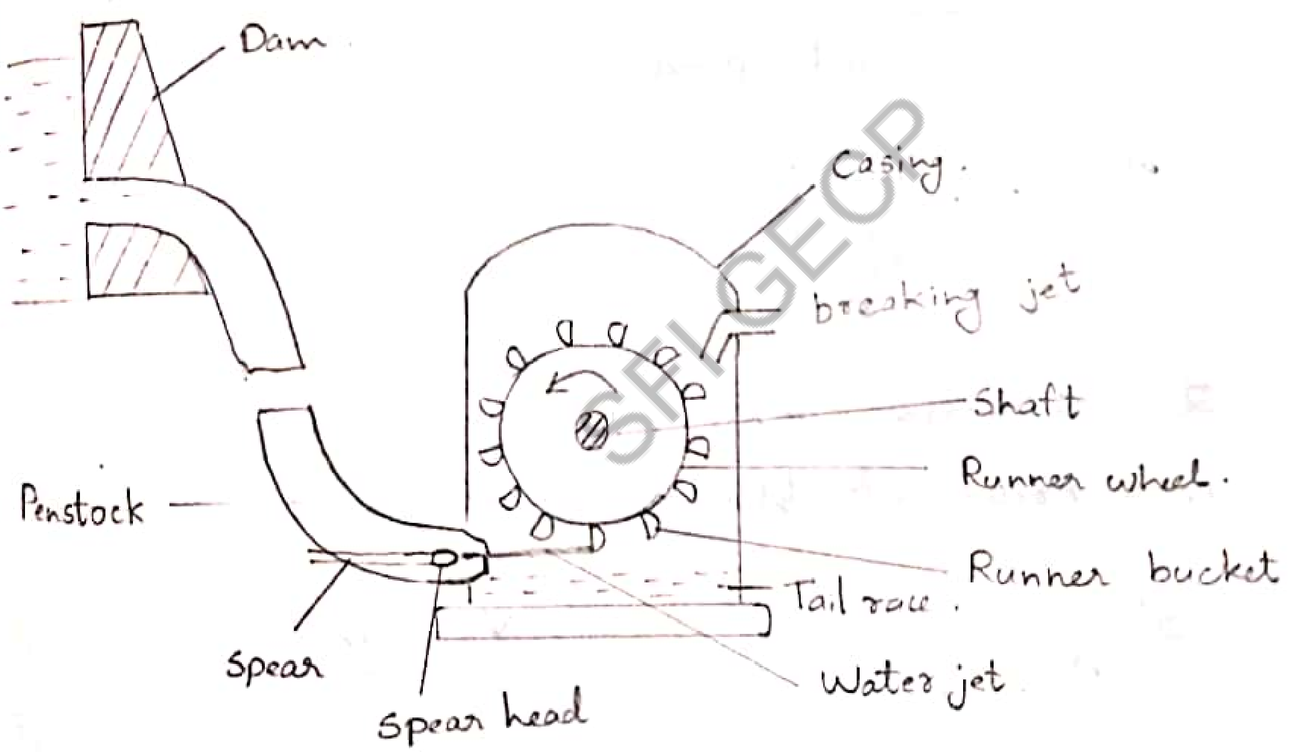
The water entering the runner posess Pressure energy and ~~then~~ this water in turn ~~thus~~ doesn't work on the vanes by the principle of reaction.

Eg: Francis turbine

Kaplan turbine.

Parameter	Pelton	Francis	Kaplan
working	impulse	Reaction	Reaction
Head	high head	Medium head	Low head
Specific speed	Low	Medium	High

Pelton wheel



Most commonly used impulse turbine. The nossil producing the jets will invinge on runner bucket which makes the wheel to rotate. Runner buckets are double hemi spherical in shape.

A spear head provision in the nossil

control the opening of nossil. The water after imparting its energy to the turbine is discharged into the tail race. A breaking jet provision helps in stopping the runner when not in use.

Application

Used where high head of water in present.

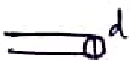
Overall efficiency

$$\eta_o = \frac{\text{Output power}}{\text{Input power}}$$

$$\boxed{\eta_o = \frac{1000P}{\rho g Q H}}$$

Q = discharge m^3/s.

Q = Area x velocity. = $m^2 \times m/s = m^3/s$.



$A = \frac{\pi}{4} d^2$. $V = \sqrt{2gh}$.

$A = lb$.

? A pelton wheel working under a head of 500 m. produces 15 mWatt at 500 rpm. If the overall efficiency of the turbine is 85%. Calculate the discharge of turbine.

$H = 500\ m$.

$\eta_o = 85\% = 0.85$. $\rho = 1000\ kg/m^3$

$P = 15\ mW = 15 \times 10^3\ kW = 15 \times 10^6\ W$.

$N = 500\ rpm$.

$$\eta_o = \frac{1000\ P}{\rho g Q H}$$

$$0.85 = \frac{1000 \times 15 \times 10^3}{1000 \times 9.81 \times Q \times 500}$$

$0.85 \times 4905\ Q = 15000$

$$Q = \frac{15000}{4169.25} = 3.59$$

$= \underline{3.6\ m^3/s}$.

? 2 jets strike the buckets of pelton wheel which develops 15 mW. The diameter of each jet is 15 cm and the net head is 500 m. Calculate the overall efficiency of turbine.

$P = 15\ mW = 15 \times 10^3\ kW$.

$d = 15\ cm = 15 \times 10^{-2}\ m$.

$H = 500\ m$

$$A = \frac{\pi}{4} d^2 = \frac{\pi}{4} \times (15 \times 10^{-2})^2 = 0.0176\ m^2$$

$$V = \sqrt{2gH} = \sqrt{2 \times 9.81 \times 500} = \underline{99.04}$$

$Q = 2(A \times V) = 2 \times 0.0176 \times 99.04 = \underline{1.743} \times 2$

$= \underline{3.486\ m^3/s}$.

$$\eta_o = \frac{1000P}{\rho g Q H} = \frac{1000 \times 15 \times 10^3}{1000 \times 9.81 \times 3.486 \times 500}$$

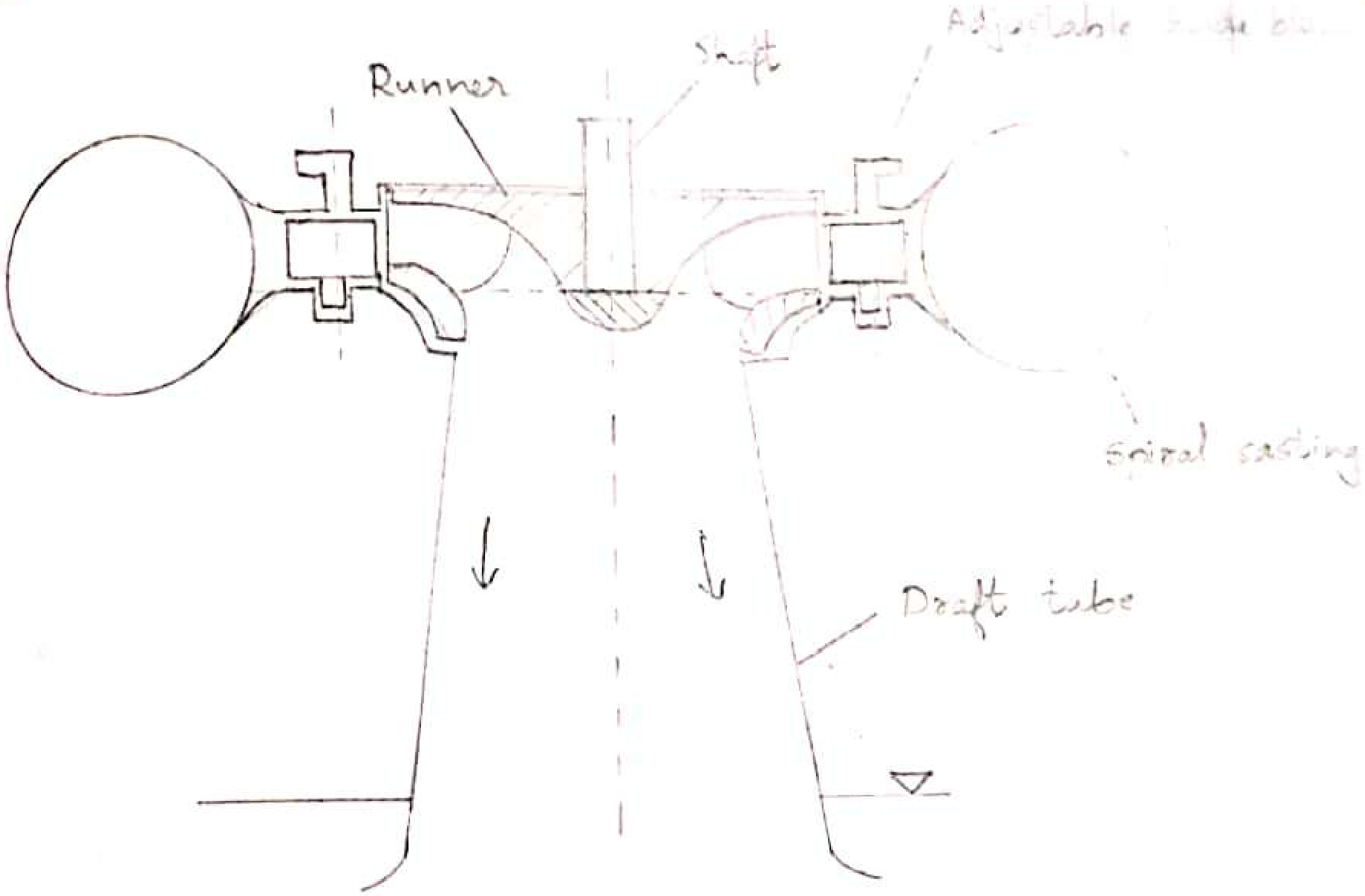
$$= 0.877 = 87.7\%$$

Since 2 jets $Q = 2AV$.

Francis turbine

It is one of the mostly used reaction turbine. In reaction turbine the water entering the runner possess pressure energy and this water in turn does work on the vanes by the principle of reaction.

Francis turbine consist of a runner with vanes, surrounded by an outer ring of guiding mechanism. Water from the penstock flows into a ~~t~~ scroll casing. surrounding the turbine runner. From the scroll casing water flows through the guiding mechanism and enters the runner. Finally water flows through draft tube. [Penstock → Scroll casing → Guiding mechanism → Runner → Draft tube]



? Calculate the discharge from a francis turbine with overall efficiency 75%, working under a head of 7.5 m and producing a power of 0.15 MW.

$$\eta_o = \frac{1000P}{\rho g H Q}$$

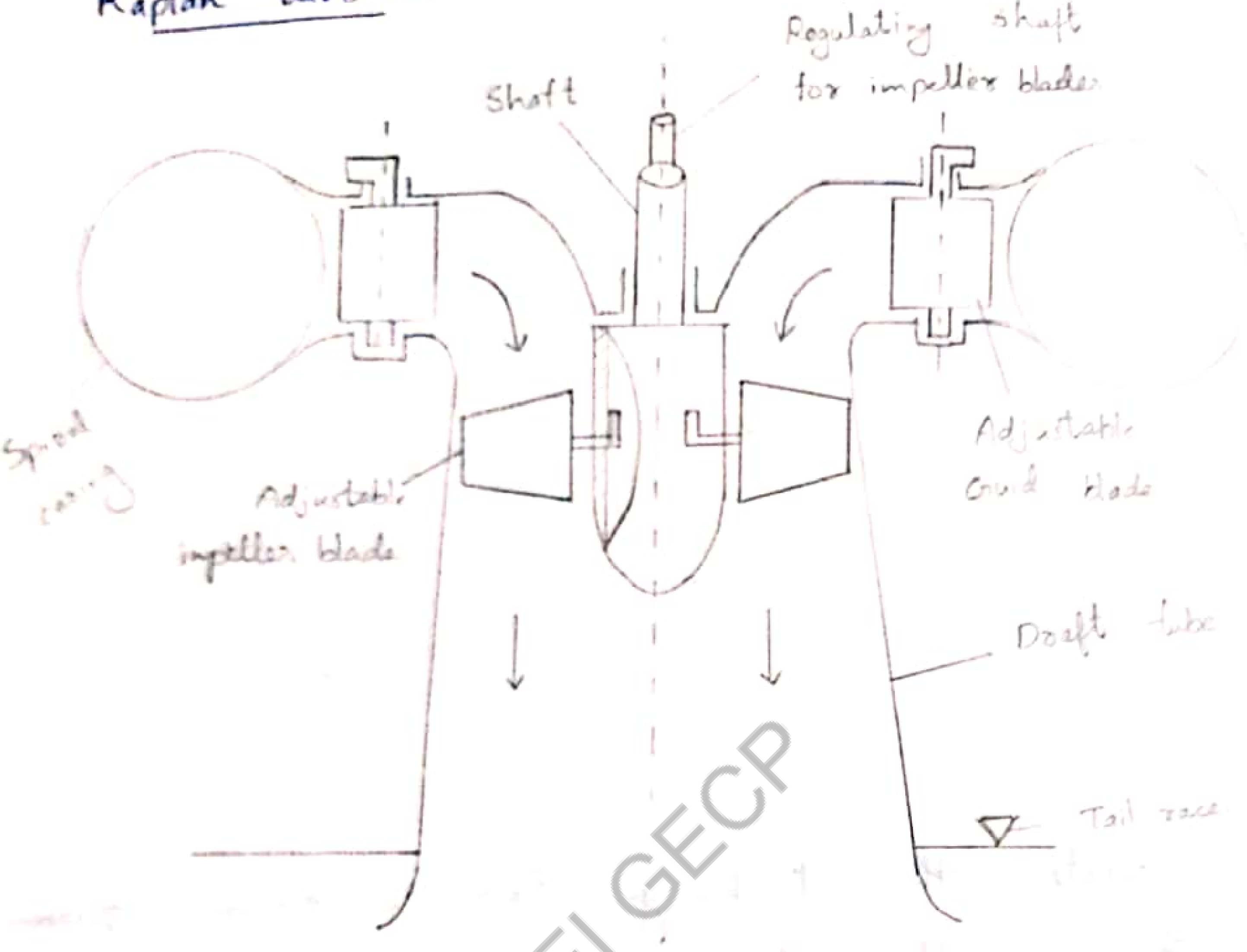
$\eta = 0.75$, $H = 7.5m$.

$P = 0.15\ Mw = 0.15 \times 10^3\ kw$.

$$Q = \frac{1000P}{\eta_o \rho g H} = \frac{0.15 \times 10^3}{0.75 \times 1000 \times 9.81 \times 7.5}$$

$$= 2.72 \times 10^{-3}\ m^3/s.$$

Kaplan turbine



It is an axial flow reaction turbine where water enters and leaves the ~~r~~ runner vanes parallel to the axis of shaft. It is particularly suited for low head and high discharge of water. Main components include scroll casing, Guide weighing mechanism, boss with adjastable vanes, draft tube

Water from the penstrock flows into the scroll casing ~~sun~~ surrounding the turbine runner. From the scroll casing water flows through the guide mechanism and enters the runner vanes. The force exerted by water on the ~~water~~ vanes causes the runner shaft to rotate. After imparting energy to the runner water is discharged through draft tube [Penstock $\rightarrow$ Scroll casing $\rightarrow$ Guide vane $\rightarrow$ Runner $\rightarrow$ Draft tube].

? A Kaplan turbine develops 12000 kw power. Calculate the overall efficiency of the turbine when the discharge from the turbine is 70 m³/s. Given velocity of flow is 19.8 m/s.

$Q = 70 \ m^3/s$ $\qquad g = 9.81$

$P = 12000 \ kw$ $\qquad V = 19.8 \ m/s$

$$\eta = \frac{1000P}{\rho g Q H}$$

$$V = \sqrt{2gH}$$

$$19.8 = \sqrt{2 \times 9.81 \times H} = \sqrt{19.62H}$$

$$19.8^2 = 19.62H$$

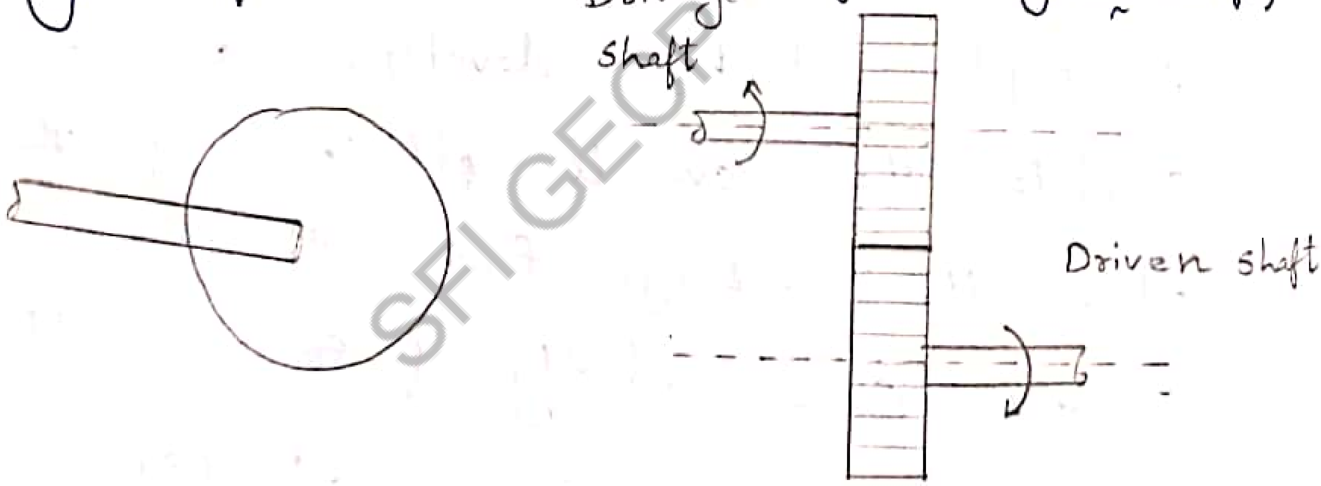
$$H = \frac{392.04}{19.62} = 19.98 \ m$$

$$\eta_0 = \frac{\cancel{1000} \times 12000}{\cancel{1000} \times 9.81 \times 70 \times 19.98}$$

$$= 0.874 = \underline{87.4}\ \%.$$

Gear

The term gear is generally used to denote the toothed wheel. ~~where~~ For the transimission of power one gear is mounted on the driving shaft. and another one of the ~~given~~ driven shaft,

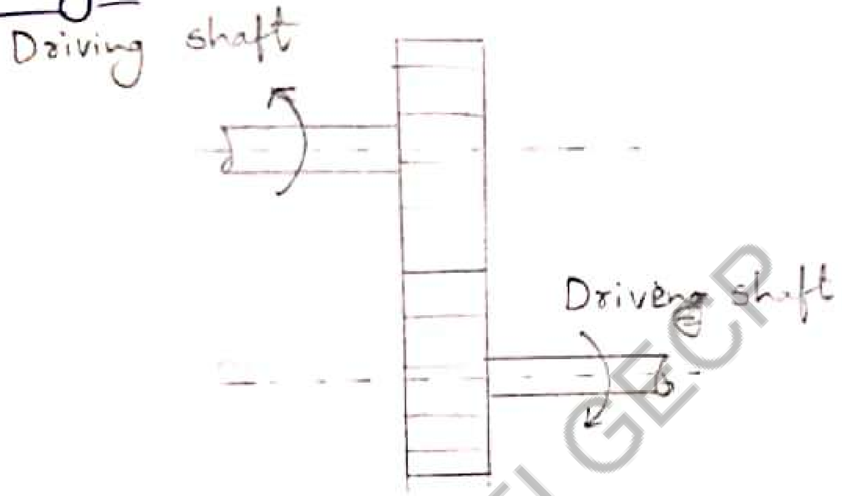


their teeth ~~need~~ meshing with each other. The distance b/w the 2 shaft should be just sufficient to enable machine of the gear teeth. If the driving and ~~given~~ driven shaft are at a ~~to~~ long distance, so that the direct meshing of 2 gears is not possible, then required no of gears may have to be incorporated in b/w those 2 gears so as to make the drive possible.

Materials used: Gray cast iron, cast steel, Alloy steel.

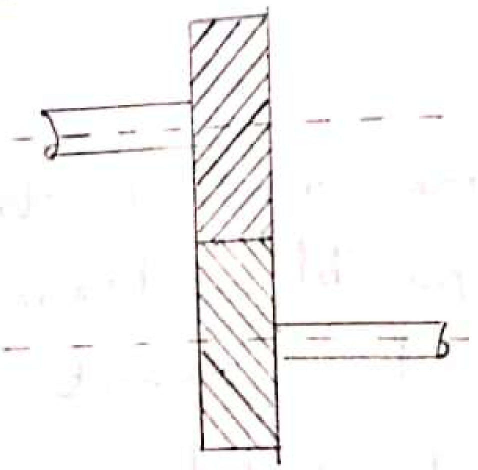
Types of Gears

1) Spur gear



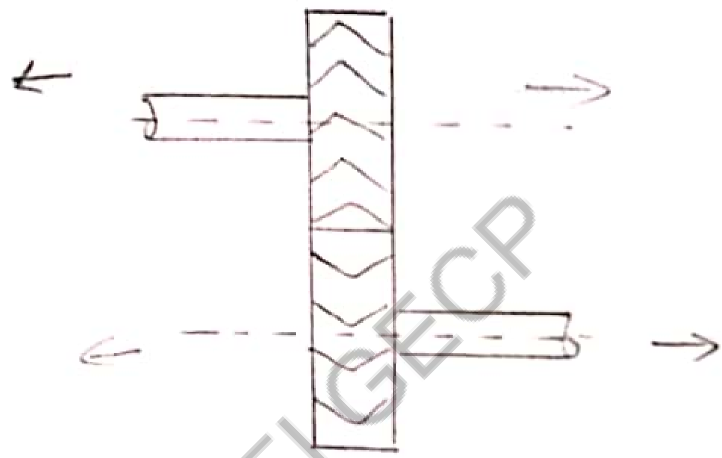
Spur gears are those which have teeth cut parallel to the axis of shaft. Spur gears are used to transmit power b/w parallel shaft.

2) Hellical gear

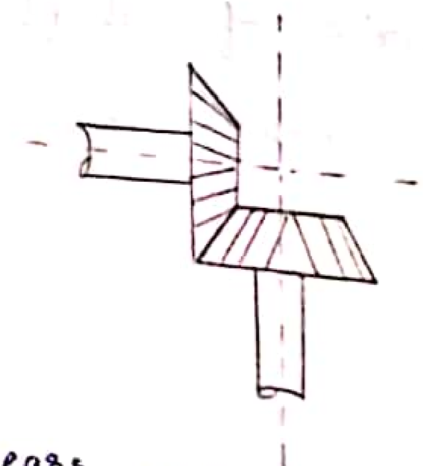


Hellical gears are used to transmit power b/w parallel shaft. Here the teeth are cut in an angle to the axis of shaft. and ~~the~~ angle is called helix angle (usually denoted by α).

a) Double hellical.

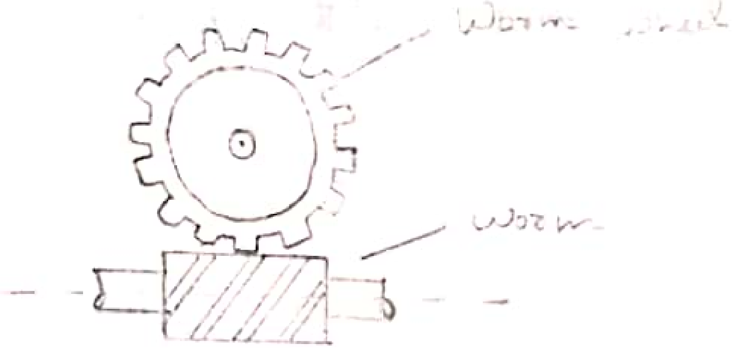


3) Vevel gear



Vevel gears are used to transmit power b/w two non parallel intersecting shafts. It is used to connect shaft which are having some angle.

4) Worm gear



Worm gears are used for higher speed reduction. The threaded ~~to~~ one is called worm and the bigger one worm wheel. Worm gears are used for power transmission b/w non intersecting shafts that are generally at right angle to each other.

Advantages of gear driving

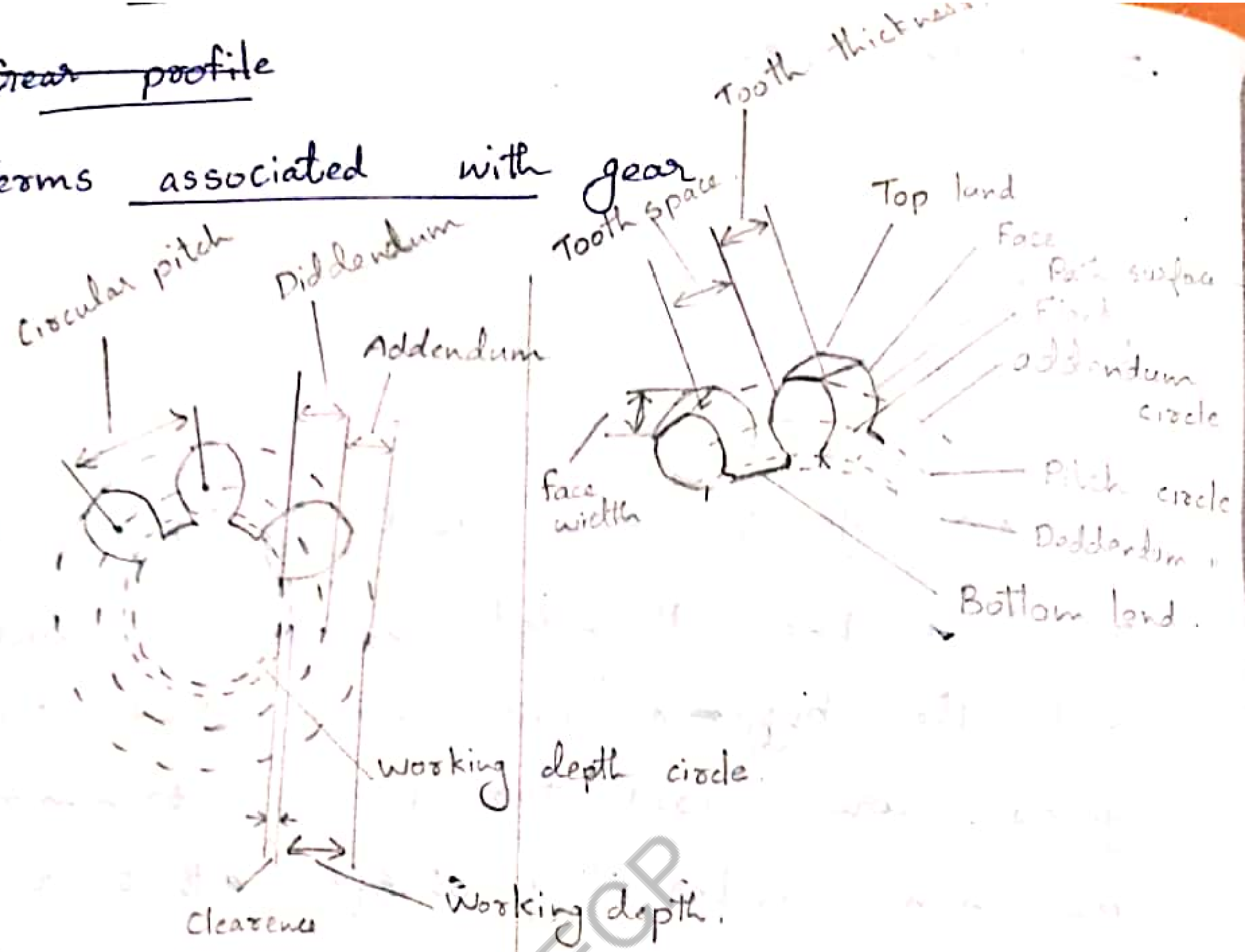
- Higher power transmission.
- Higher efficiency.
- Higher durability.
- Less maintanence.
- Reduced slip.

Disadvantages

- Costly
- Rigid construction.

~~Gear profile~~

Terms associated with gear



1) Pitch circle

It is the circle with radius equal to pitch cylinder.

2) Pitch cylinder - Imaginery cylinders which by rolling together transmit the same motion as the pair of gears.

3) Pitch circle diameter - It is the diameter of pitch circle.

4) Pitch point - It is the point of contact of 2 pitch circles

5) Circular pitch - It is the distance measured along the circumference of pitch circle from a point from one tooth to the corresponding point on adjascent tooth. It is denoted by P_c.

$$\boxed{P_c = \frac{\pi D}{T}}$$

d → diameter of gear.
t → No of tooth.

6) Pitch angle - It is the angle subtended by circular which at the center of pitch circle,

7) Diametrical pitch - It is the no of teeth per unit length of pitch circle diameter. It is denoted by P.

$$\boxed{P = \frac{T}{D}}$$

8) Module - It is the ratio of pitch circle diameter to the no of teeth. It is denoted by m.

$$\boxed{m = \frac{D}{T}}$$

9) ~~Addendum~~ Addendum circle - It is the circle passing through the tips of teeth.

10) Addendum - It is the radial distance b/w pitch circle and addendum circle.

11) Deddendum circle - It is the circle passing through the ~~th~~ roots of teeth.

12) Deddendum - It is the radial distance b/w pitch circle and deddendum circle.

13) Full depth of teeth = Addendum + Deddendum

Working depth = Full depth - clearence.

14) Top land - It is the surface ~~the~~ at the top of tooth.

15) Bottom land - It is the surface at the root of the tooth, in b/w 2 adjacent teeth.

16) Tooth thickness - It is the width of the tooth measured along the pitch circle

17) Tooth space - It is the width of space b/w the 2 adjacent teeths measured along the pitch circle.

18) Backlash - It is the difference b/w the toothed space and tooth thickness measured along the pitch circle.

19) ~~Bt~~ Face - It is the tooth surface b/w the

pitch circle and top land.

10) <u>Flank</u> - It is the tooth surface b/w the pitch circle and the bottom land.

11) <u>Face width</u> - It is the length of tooth measured parallel to the axis of gear.

12) <u>Profile</u> - It is the curve formed by the face and flank of tooth.

<u>Peripheral velocity</u>

$$v = r\omega$$

$$r_1\omega_1 = r_2\omega_2$$

$$\frac{d_1}{\cancel{2}}\frac{2\pi N_1}{6\cancel{0}} = \frac{d_2}{\cancel{2}}\frac{2\pi N_2}{60}$$

$$\frac{d_1}{d_2} = \frac{N_2}{N_1}$$

$$\boxed{\frac{d_1}{d_2} = \frac{N_2}{N_1}}$$

Power

P_{linear} = Force × Velocity

P_{rot} = Torque × ω

$$= T \times \frac{2\pi N}{60}$$

$$= \frac{2\pi NT}{60}$$

$$P_{c_1} = P_{c_2}$$

$$\frac{\pi D_1}{T_1} = \frac{\pi D_2}{T_2}$$

$$\boxed{\frac{D_1}{D_2} = \frac{T_1}{T_2}}$$

$$\boxed{\frac{N_2}{N_1} = \frac{D_1}{D_2} = \frac{T_1}{T_2}}$$

? Two spur wheels, A and B on parallel shafts are in mesh. A has 40 teeth and rotates at 250 rpm B is to rotated 100 rpm. Find the no of teeth on B

$N_1 = 250$ rpm

$N_2 = 100$ rpm

$T_1 = 40$

$\frac{N_2}{N_1} = \frac{T_1}{T_2}$

$\frac{100}{250} = \frac{40}{T_2}$

$T_2 = \frac{40 \times 250}{100} = \frac{1000}{10} = \underline{100}$ Teeth

? Two making spur gears has 60 and 40 teeth. Their common module is 5 mm. Determine the center distance b/w the gear axis

$M = 5$ mm

$T_1 = 60$

$T_2 = 40$

$M = \frac{D}{T}$

$D_1 = MT_1 = 5 \times 60 = 300$

$D_2 = MT_2 = 5 \times 40 = 200$

~~D = D_1 - D_2 = 300 - 200 = 100~~

$$D = \frac{D_1}{2} + \frac{D_2}{2} = \frac{300}{2} + \frac{200}{2}$$

$$= 150 + 100 = \underline{\underline{250}}$$

Single plate clutch

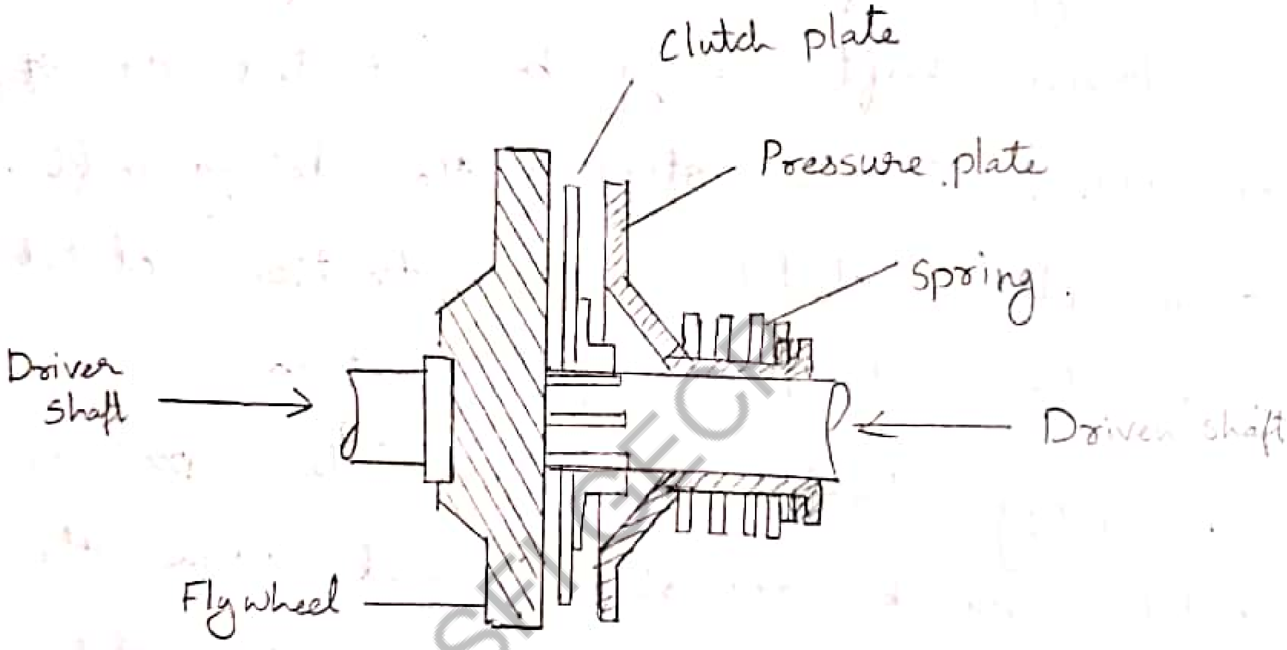
A clutch is a device ~~com~~ used to connect a driving shaft to a driven shaft. So that the driven shaft may be started or stopped at will, without stopping the driving shaft.

Single plate clutch is a friction clutch which transmit power by friction.

A spring loaded pressure plate presses the clutch break against flywheel, when the clutch is engaged. On one side of clutch plate friction b/w the lining of clutch plate and fly ~~who~~ wheel and on other side friction b/w the lining of the clutch plate and pressure plate causes the clutch plate and the driven shaft to rotate.

When the pressure plate is pulled back by further compression of the spring, contact b/w the flywheel and clutch plate breaks and then the flywheel rotates without driving the clutch plate and the driven shaft. Thus the rotation of driven shaft can be stopped without stopping the engine.

Applications - Automobiles.



Gear train

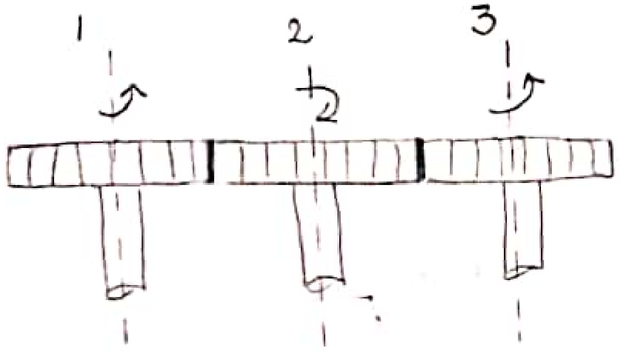
A gear train consists of 2 or more gears transmitting power from the driving shaft to the driven shaft. The gear train are classified into following.

1) Simple gear train.
2) Compound "

3) Reverted gear train.

4) Epicyclic "

Simple gear train



In simple gear train each shaft ~~has~~ carries only one. Here velocity ~~of~~ ratio is equal to no. of teeth of the last driven gear to the no of teeth on the first gears are Idler gear.

Driving and driven gears rotate in same direction when the no of Idler's is ~~odd~~. odd

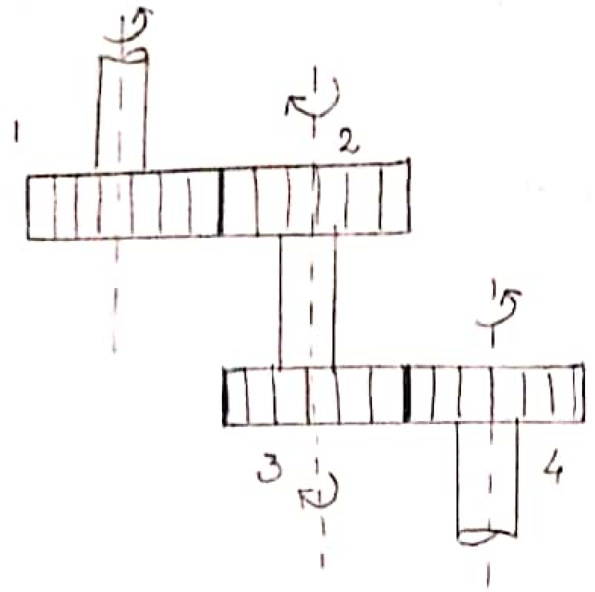
Driving and driven gears rotate in opposite direction when the no of Idlers ~~is~~ is even.

Velocity ratio $= \frac{N_1}{N_3} = \frac{T_3}{T_1}$

Major draw back

Large overall dimension and weight

Compound gear train

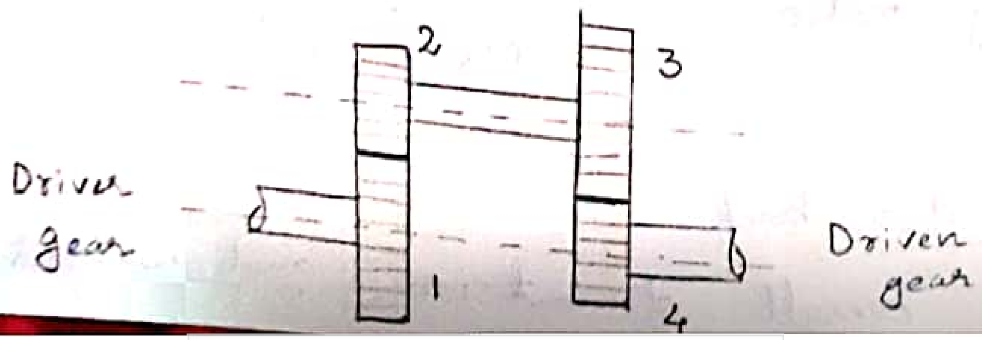


Compound gear train is compact in construction compared with simple gear train. Here atleast one shaft carries two gears. ~~Ved~~ Velocity reduction is done in 2 stages.

Velocity ratio, $V_r = \frac{N_1}{N_4} = \frac{\text{Pdt of No of teeth on driven gears}}{\text{Pdt of No of teeth on drivers gears}}$

$$\frac{N_1}{N_4} = \frac{T_2 \times T_4}{T_1 \times T_3}$$

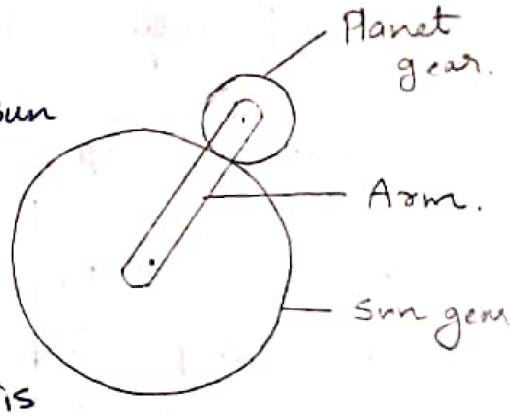
Reverted gear train



In a reverted gear train the driving and driven shafts are located on the same central line. It is the most compact gear box. Finds application in clock and similar instruments.

$$V_r = \frac{N_1}{N_4} = \frac{T_4 \times T_2}{T_1 \times T_3}$$

Epicyclic gear train.



The center gear is called sun gear and the revolving gear is called planet gear. It has compact construction. Sun geare is the driving gear. Here in operation one gear is fixed and the meshing gear has a motion composed of 2 parts. namely a rotation about its own axis and a rotation about axis on the fixed gear.