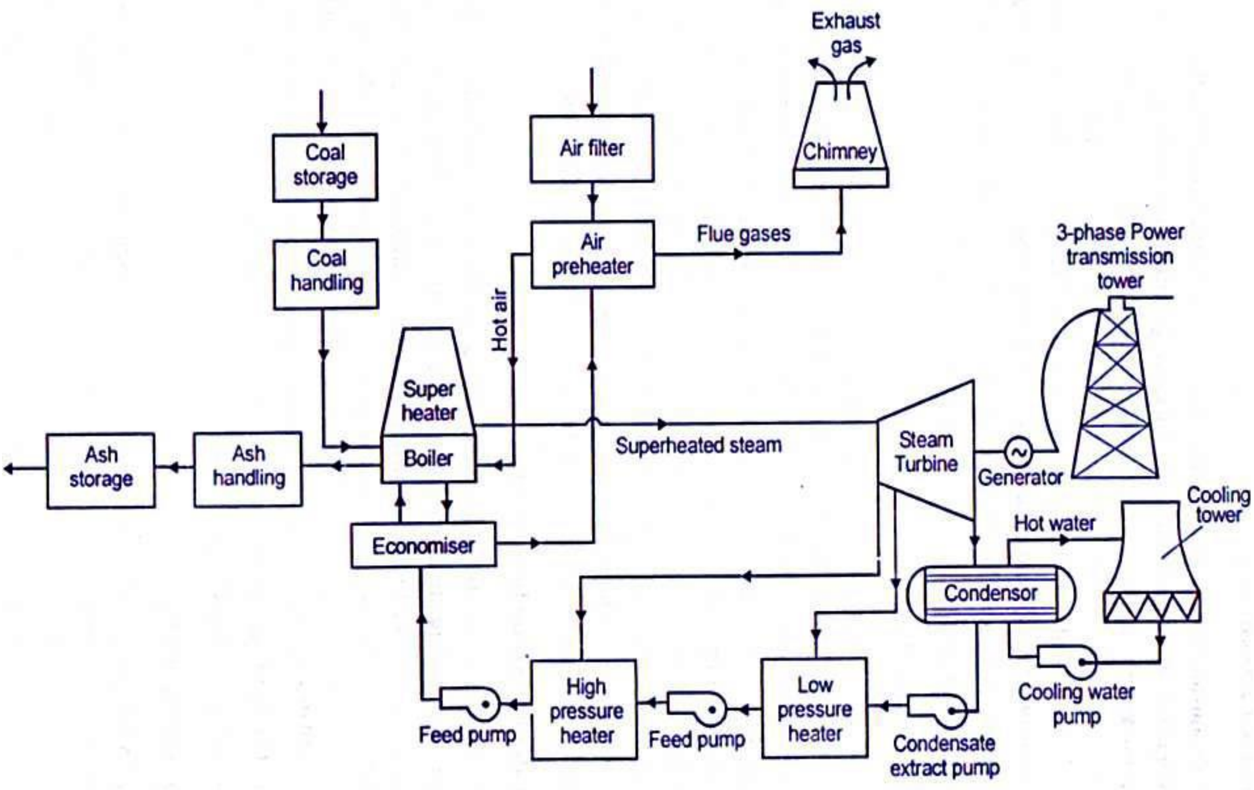
STEAM POWER PLANTS:

A thermal power station is a power plant in which the prime mover is steam driven. Water is heated, turns into steam and spins a steam turbine which drives an electrical generator. After it passes through the turbine, the steam is condensed in a condenser and recycled to where it was heated; this is known as a **Rankine cycle**. The greatest variation in the design of thermal power stations is due to the different fuel sources. Some prefer to use the term energy center because such facilities convert forms of heat energy into electricity. Some thermal power plants also deliver heat energy for industrial purposes, for district heating, or for desalination of water as well as delivering electrical power. A large proportion of CO2 is produced by the worlds fossil fired thermal power plants; efforts to reduce these outputs are various and wide spread.

LAYOUT OF STEAM POWER PLANT:



The four main circuits one would come across in any thermal power plant layout are

- Coal and Ash Circuit

- Air and Gas Circuit

- Feed Water and Steam Circuit

- Cooling Water Circuit

Coal and Ash Circuit

Coal and Ash circuit in a thermal power plant layout mainly takes care of feeding the boiler with coal from the storage for combustion. The ash that is generated during combustion is collected at the back of the boiler and removed to the ash storage by scrap conveyors. The combustion in the Coal and Ash circuit is controlled by regulating the speed and the quality of coal entering the grate and the damper openings.

Air and Gas Circuit

Air from the atmosphere is directed into the furnace through the air preheated by the action of a forced draught fan or induced draught fan. The dust from the air is removed before it enters the combustion chamber of the thermal power plant layout. The exhaust gases from the combustion heat the air, which goes through a heat exchanger and is finally let off into the environment.

Feed Water and Steam Circuit

The steam produced in the boiler is supplied to the turbines to generate power. The steam that is expelled by the prime mover in the thermal power plant layout is then condensed in a condenser for re-use in the boiler. The condensed water is forced through a pump into the feed water heaters where it is heated using the steam from different points in the turbine. To make up for the lost steam and water while passing through the various components of the thermal power plant layout, feed water is supplied through external sources. Feed water is purified in a purifying plant to reduce the dissolve salts that could scale the boiler tubes.

Cooling Water Circuit

The quantity of cooling water required to cool the steam in a thermal power plant layout is significantly high and hence it is supplied from a natural water source like a lake or a river. After passing through screens that remove particles that can plug the condenser tubes in a thermal power plant layout, it is passed through the condenser where the steam is condensed. The water is finally discharged back into the water source after cooling. Cooling water circuit can also be a closed system where the cooled water is sent through cooling towers for re-use in the power plant. The cooling water circulation in the condenser of a thermal power plant layout helps in maintaining a low pressure in the condenser all throughout.

All these circuits are integrated to form a thermal power plant layout that generates electricity to meet our needs.

Advantages

- Generation of power is continuous.
- Initial cost low compared to hydel plant.
- Less space required.
- This can be located near the load centre so that the transmission losses are reduced.
- It can respond to rapidly changing loads.

Disadvantages

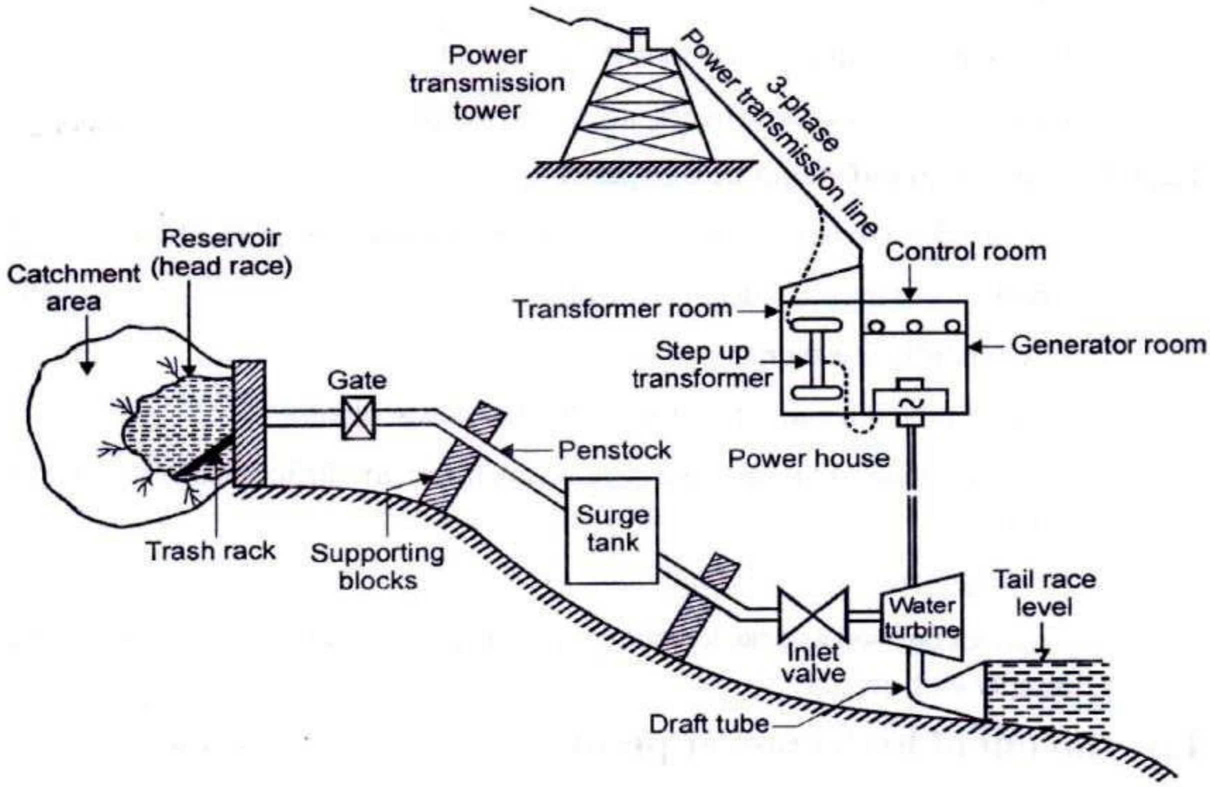
- Long time required for installation.
- Transportation and handling of fuels major difficulty.
- Efficiency of plant is less.

- Power generation cost is high compared to hydel power plant.
- Maintenance cost is high.

HYDEL POWER PLANTS

Hydroelectric power plants convert the hydraulic potential energy from water into electrical energy. Such plants are suitable were water with suitable head are available. The layout covered in this article is just a simple one and only cover the important parts of hydroelectric plant.

LAYOUT OF HYDEL POWER PLANT:



(1) Dam

Dams are structures built over rivers to stop the water flow and form a reservoir. The reservoir stores the water flowing down the river. This water is diverted to turbines in power stations. The dams collect water during the rainy season and stores it, thus allowing for a steady flow through the turbines throughout the year. Dams are also used for controlling floods and irrigation. The dams should be water-tight and should be able to withstand the pressure exerted by the water on it. There are different types of dams such as arch dams, gravity dams and buttress dams. The height of water in the dam is called head race.

(2) Spillway

A spillway as the name suggests could be called as a way for spilling of water from dams. It is used to provide for the release of flood water from a dam. It is used to prevent over toping of the dams which could result in damage or failure of dams. Spillways could be controlled type or uncontrolled type. The uncontrolled types start releasing water upon water rising above a particular level. But in case of the controlled type, regulation of flow is possible.

(3) Penstock and Tunnels

Penstocks are pipes which carry water from the reservoir to the turbines inside power station. They are usually made of steel and are equipped with gate systems. Water under high pressure flows through the penstock. A tunnel serves the same purpose as a penstock. It is used when an obstruction is present between the dam and power station such as a mountain.

(4) Surge Tank

Surge tanks are tanks connected to the water conductor system. It serves the purpose of reducing water hammering in pipes which can cause damage to pipes. The sudden surges of water in penstock is taken by the surge tank, and when the water requirements increase, it supplies the collected water thereby regulating water flow and pressure inside the penstock.

(5) Power Station

Power station contains a turbine coupled to a generator. The water brought to the power station rotates the vanes of the turbine producing torque and rotation of turbine shaft. This rotational torque is transferred to the generator and is converted into electricity.

The used water is released through the tail race. The difference between head race and tail race is called gross head and by subtracting the frictional losses we get the net head available to the turbine for generation of electricity.

Advantages

- Water the working fluid is natural and available plenty.
- Life of the plant is very long.
- Running cost and maintenance are very low.
- Highly reliable.
- Running cost is low.
- Maintenance and operation costs are very less.
- No fuel transport problem.
- No ash disposal problem.

Disadvantages

- Initial cost of plant is very high.
- Power generation depends on quantity of water available which depends on rainfall.
- Transmission losses are very high.
- More time is required for erection

DIESEL POWER PLANTS

Diesel power plants produce power from a diesel engine. Diesel electric plants in the range of 2 to 50 MW capacities are used as central stations for small electric supply networks and used as a standby to hydroelectric or thermal plants where continuous power supply is needed. Diesel power plant is not economical compared to other power plants.

The diesel power plants are cheaply used in the fields mentioned below.

1. Mobile electric plants

2. Standby units

3. Emergency power plants

4. Starting stations of existing plants

5. Central power station etc.

LAYOUT OF DIESEL POWER PLANT:

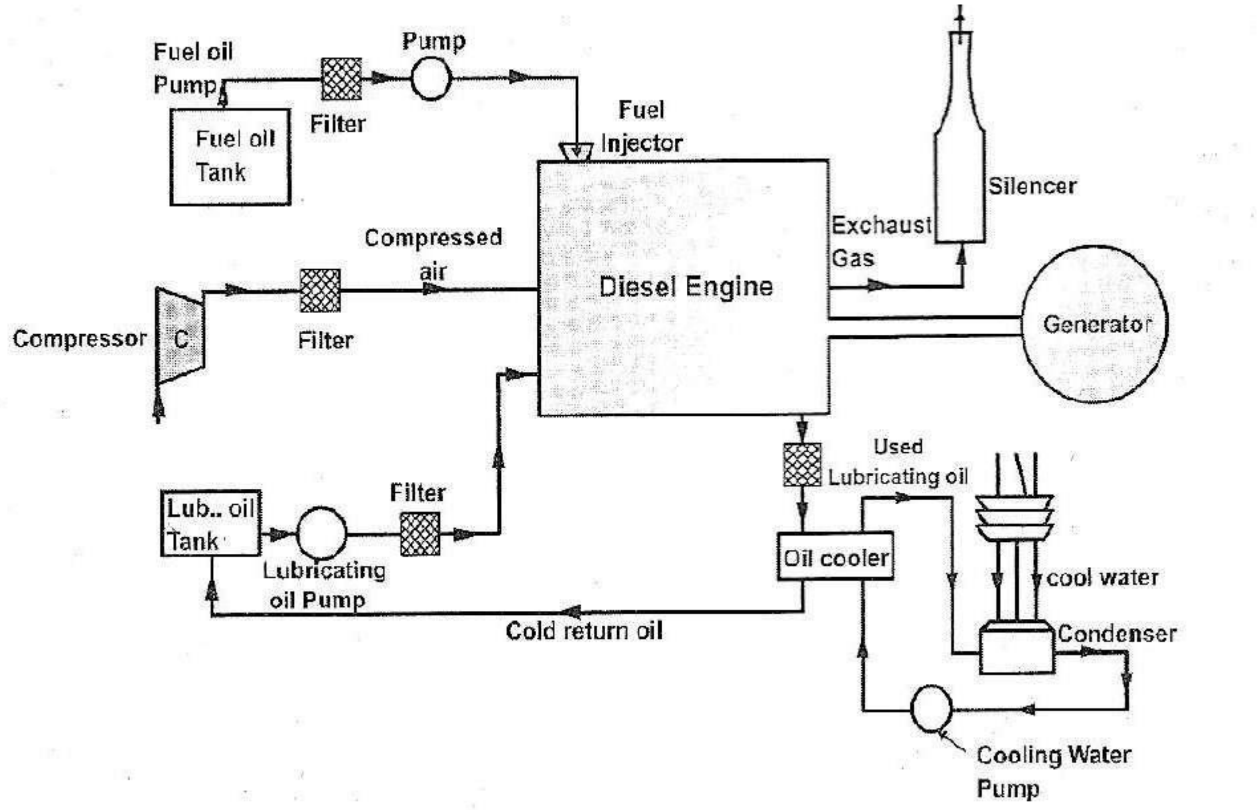


Figure shows the arrangements of the engine and its auxiliaries in a diesel power plant.

The major components of the diesel power plant are:

1) Engine

Engine is the heart of a diesel power plant. Engine is directly connected through a gear box to the generator. Generally two-stroke engines are used for power generation. Now a days, advanced super & turbo charged high speed engines are available for power production.

2) Air supply system

Air inlet is arranged outside the engine room. Air from the atmosphere is filtered by air filter and conveyed to the inlet manifold of engine. In large plants supercharger/turbocharger is used for increasing the pressure of input air which increases the power output.

3) Exhaust System

This includes the silencers and connecting ducts. The heat content of the exhaust gas is utilized in a turbine in a turbocharger to compress the air input to the engine.

4) Fuel System

Fuel is stored in a tank from where it flows to the fuel pump through a filter. Fuel is injected to the engine as per the load requirement.

5) Cooling system

This system includes water circulating pumps, cooling towers, water filter etc. Cooling water is circulated through the engine block to keep the temperature of the engine in the safe range.

6) Lubricating system

Lubrication system includes the air pumps, oil tanks, filters, coolers and pipe lines. Lubricant is given to reduce friction of moving parts and reduce the wear and tear of the engine parts.

7) Starting System

There are three commonly used starting systems, they are;

1) A petrol driven auxiliary engine

2) Use of electric motors.

3) Use of compressed air from an air compressor at a pressure of 20 Kg/cm.

8) Governing system

The function of a governing system is to maintain the speed of the engine constant irrespective of load on the plant. This is done by varying fuel supply to the engine according to load.

Advantages

- Diesel power plants can be quickly installed and commissioned.
- Quick starting.
- Requires minimum labour.
- Plant is smaller, operate at high efficiency and simple compared to steam power plant.
- It can be located near to load centres.

Disadvantages

- Capacity of plant is low.
- Fuel, repair and maintenance cost are high.
- Life of plant is low compared to steam power plant.
- Lubrication costs are very high.
- Not guaranteed for operation under continuous overloads.
- Noise is a serious problem in diesel power plant.
- Diesel power plant cannot be constructed for large scale.

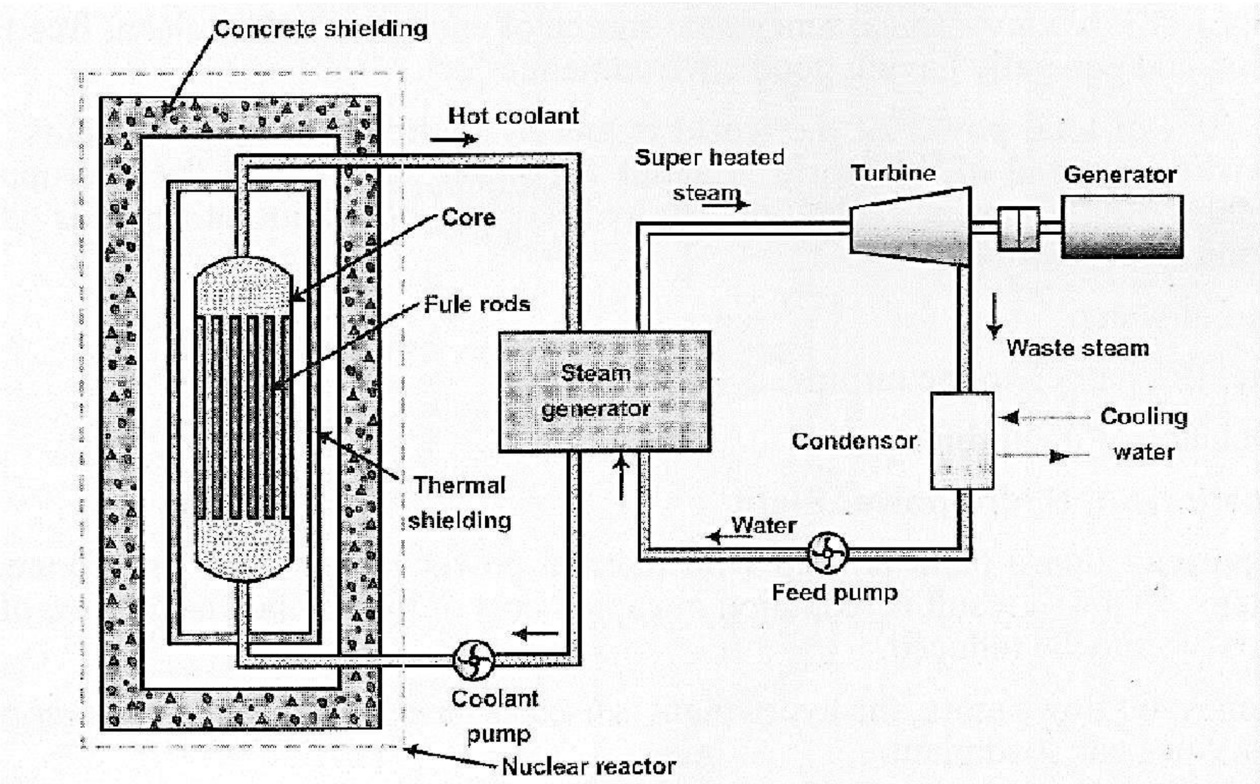
NUCLEAR POWER PLANTS

Nuclear power is the use of sustained or controlled nuclear fission to generate heat and do useful work. Nuclear Electric Plants, Nuclear Ships and Submarines use controlled nuclear energy to heat water and produce steam, while in space, nuclear energy decays naturally in a radioisotope thermoelectric generator. Scientists are experimenting with fusion energy for future generation, but these experiments do not currently generate useful energy.

Nuclear power provides about 6% of the world's energy and 13–14% of the world's electricity, with the U.S., France, and Japan together accounting for about 50% of nuclear generated electricity.

Also, more than 150 naval vessels using nuclear propulsion have been built. Just as many conventional thermal power stations generate electricity by harnessing the thermal energy released from burning fossil fuels, nuclear power plants convert the energy released from the nucleus of an atom, typically via nuclear fission.

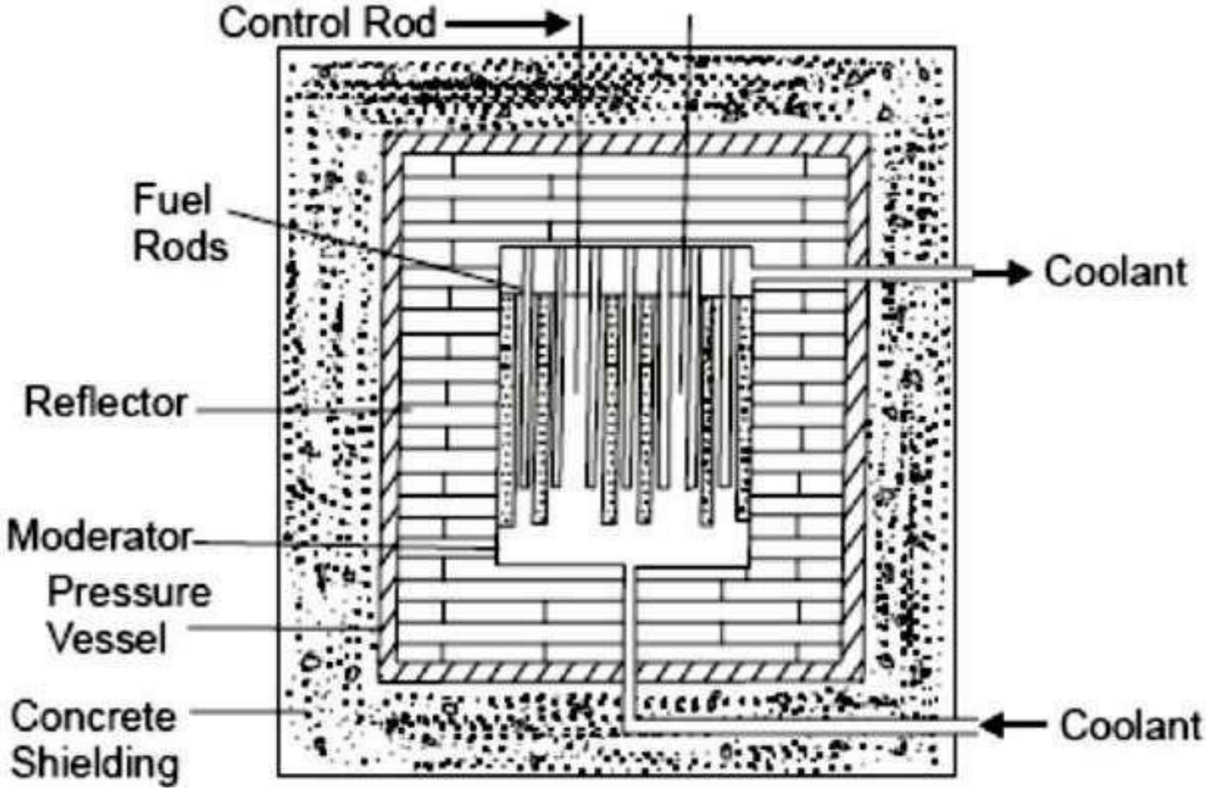
LAYOUT OF NUCLEAR POWER PLANT:



NUCLEAR REACTOR

A nuclear reactor is an apparatus in which heat is produced due to nuclear fission chain reaction. Fig. shows the various parts of reactor, which are as follows:

1. Nuclear Fuel
2. Moderator
3. Control Rods
4. Reflector
5. Reactors Vessel
6. Biological Shielding
7. Coolant.



Nuclear Reactor

1. Nuclear Fuel

Fuel of a nuclear reactor should be fissionable material which can be defined as an element or isotope whose nuclei can be caused to undergo nuclear fission by nuclear bombardment and to produce a fission chain reaction. It can be one or all of the following U^{233}, U^{235} .

Natural uranium found in earth crust contains three isotopes namelyU^{234}, U^{235} and U^{238} and their average percentage is as follows:

U^{238} - 99.3%

U^{235} - 0.7%

U^{234} – Trace

2. Moderator

In the chain reaction the neutrons produced are fast moving neutrons. These fast moving neutrons are far less effective in causing the fission of U^{235} and try to escape from the reactor. To improve the utilization of these neutrons their speed is reduced. It is done by colliding them with the nuclei of other material which is lighter, does not capture the neutrons but scatters them. Each such collision causes loss of energy, and the speed of the fast moving neutrons is reduced. Such material is called Moderator.

The slow neutrons (Thermal Neutrons) so produced are easily captured by the nuclear fuel and the chain reaction proceeds smoothly. Graphite, heavy water and beryllium are generally used as moderator

3. Control Rods

The Control and operation of a nuclear reactor is quite different from a fossil fuelled (coal or oil fired) furnace. The energy produced in the reactor due to fission of nuclear fuel during chain reaction is so much that if it is not controlled properly the entire core and surrounding structure may melt and radioactive fission products may come out of the reactor thus making it uninhabitable. This implies that we should have some means to control the power of reactor. This is done by means of control rods.

Control rods in the cylindrical or sheet form are made of boron or cadmium. These rods can be moved in and out of the holes in the reactor core assembly. Their insertion absorbs more neutrons and damps down the reaction and their withdrawal absorbs less neutrons. Thus power of reaction is controlled by shifting control rods which may be done manually or automatically.

4. Reflector

The neutrons produced during the fission process will be partly absorbed by the fuel rods, moderator, coolant or structural material etc. Neutrons left unabsorbed will try to leave the reactor core never to return to it and will be lost. Such losses should be minimized. It is done by surrounding the reactor core by a material called reflector which will send the neutrons back into the core. The returned neutrons can then cause more fission and improve the neutrons economy of' the reactor.

Generally the reflector is made up of graphite and beryllium.

5. Reactor Vessel

It is a. strong walled container housing the cure of the power reactor. It contains moderator, reflector, thermal shielding and control rods.

6. Biological Shielding

Shielding the radioactive zones in the reactor roan possible radiation hazard is essential to protect, the operating men from the harmful effects. During fission of nuclear fuel, alpha particles, beta particles, deadly gamma rays and neutrons are produced. Out of these gamma rays are of main significance. A protection must be provided against them. Thick layers of lead or concrete are provided round the reactor for stopping the gamma rays. Thick layers of metals or plastics are sufficient to stop the alpha and beta particles.

7. Coolant

Coolant flows through and around the reactor core. It is used to transfer the large amount of heat produced in the reactor due to fission of the nuclear fuel during chain reaction. The coolant either transfers its heat to another medium or if the coolant used is water it takes up the heat and gets converted into steam in the reactor which is directly sent to the turbine

Advantages

- Need less space.
- Fuel consumption is small, hence transportation and storage charges are low.
- Well suited for large power demands.
- Less work men required.

Disadvantages

- Capital cost very high.
- Radioactive wastes, if not disposed properly have adverse effect on environment.
- Maintenance cost high.

What Is Mechanical Power Transmission?

Mechanical power transmission refers to the transfer of mechanical energy (physical motion) from one component to another in machines. Most machines need some form of mechanical power transmission. Common examples include electric shavers, water pumps, turbines and automobiles.

In most cases, the rotational movement of the prime mover is converted into the rotational movement of the driven machinery. However, the speed, torque and direction may change.

Occasionally, they may convert rotational motion into translational motion (back and forth movement) depending on the application's functional requirements. Such change may be carried out using linkages or other machine elements.

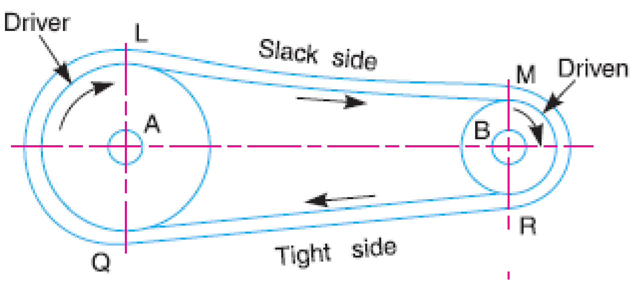
Types of Mechanical Power Transmission

Different machine elements can transmit power between shafts in machinery. The most common mechanical power transmission methods in use in the engineering industry today are:

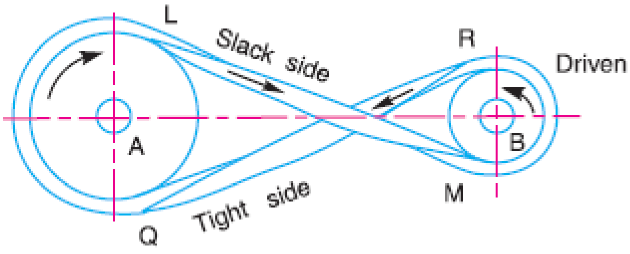
- Belt drives
- Chain drives
- Gear drives
- Rope drives

Types of belts used in belt drives:

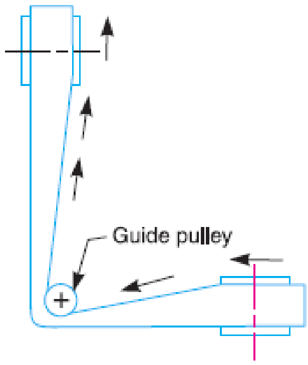
1. **Open Belt Drive:** It is used with shafts arranged parallel and rotating in the same direction. In this case the tension in the lower side belt (tight side) will be more than that in the upper side belt (slack side).



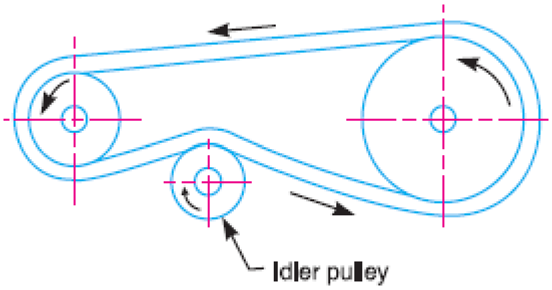
2. **Crossed / Twist Belt Drive:** It is used with the shafts arranged parallel and rotating in the opposite direction.



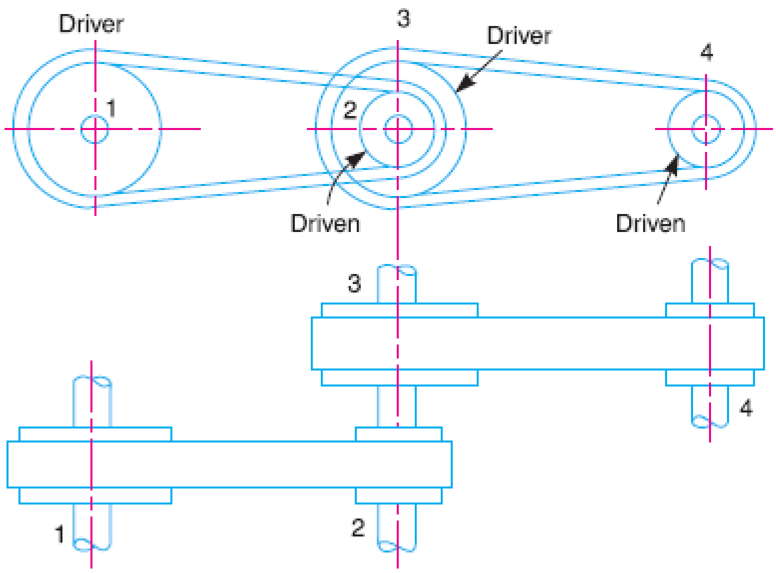
3. **Quarter Turn Belt Drive with guide Pulley / Right Angle Belt Drive:** It is used with shafts arranged at right angles and rotating in one definite direction.



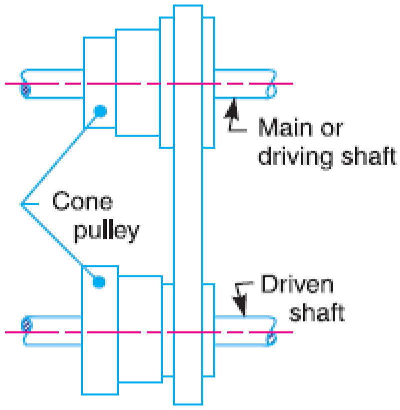
4. **Belt Drive with Idler Pulleys:** This type of drive provides high velocity ratio and required belt tensions.



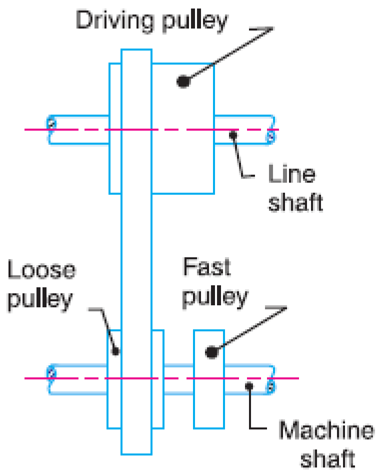
5. **Compound Belt Drive:** It is used when the power is transmitted from one shaft to another through a number of pulleys.



6. **Stepped / Cone Pulley Drive:** It is used for changing the speed of the driven shaft while the driving shaft runs at constant speed.



7. **Fast & Loose Pulley Drive:** It is used when the driven shaft is to be started / stopped whenever desired without interfering with the driving shaft.



Advantages

- Belt drives are more affordable than other drives due to low component cost and high efficiency
- They can transmit power over long distances
- Smoother and quieter operation compared to chain drives
- They can absorb shock and vibrations
- Belt drive provides some degree of overload protection through the slipping of the belt
- Lightweight and relatively durable
- Low maintenance costs

Disadvantages

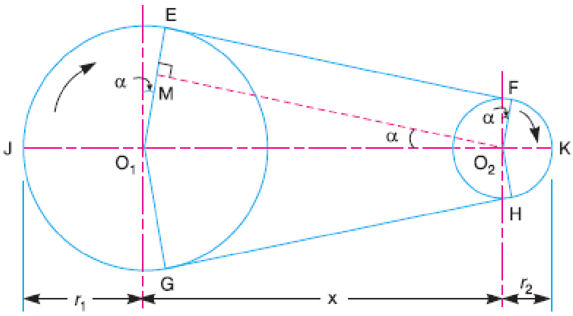
- Belt slippage can vary the velocity ratio
- Short service life if not maintained well
- Finite speed range
- They apply a heavy load on the bearings and shafts
- To compensate for wear and stretching, they need an idler pulley or some adjustment of center distance

Applications of Belt-drive

- The belt drive is used in the Mill industry.
- The belt drive is used in Conveyor.
- Power transmission in industrial machinery and equipment.
- Automotive applications, in different types of engines and transmissions.
- Agricultural machinery, such as tractors and harvesters.

1. **Obtain an expression for the length of a belt in**
   (a) Open Belt Drive, (b) Cross Belt Drive

ANS: (a) Length of Open Belt Drive: (Both the pulleys rotate in the same direction)



Let r_1 and r_2 = Radii of the larger and smaller pulleys,

x = Distance between the centres of two pulleys (*i.e.* $O_1\,O_2$), and

L = Total length of the belt.

Let the angle $MO_2\,O_1$ = α radians.

$\therefore \quad L$ = Arc GJE + EF + Arc FKH + HG = 2 (Arc JE + EF + Arc FK) ...(*i*)

From the geometry of the figure, we find that

$$\sin\alpha = \alpha = \frac{O_1 M}{O_1 O_2} = \frac{O_1 E - EM}{O_1 O_2} = \frac{r_1 - r_2}{x} \qquad \text{...}(ii)$$

$$\therefore \qquad \text{Arc } JE = r_1\left(\frac{\pi}{2} + \alpha\right) \qquad \text{...}(iii)$$

Similarly

$$\text{Arc } FK = r_2\left(\frac{\pi}{2} - \alpha\right) \qquad \text{...}(iv)$$

and

$$EF = MO_2 = \sqrt{(O_1 O_2)^2 - (O_1 M)^2} = \sqrt{x^2 - (r_1 - r_2)^2} = x\sqrt{1 - \left(\frac{r_1 - r_2}{x}\right)^2}$$

$$\therefore \quad EF = x - \frac{(r_1 - r_2)^2}{2x} \qquad \text{...}(v)$$

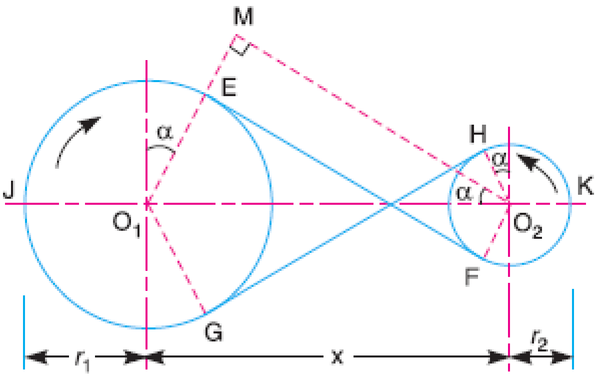
Substituting the value of $\alpha = \dfrac{r_1 - r_2}{x}$ from equation (*ii*), arc JE from equation (*iii*), arc FK from equation (*iv*) and EF from equation (*v*) in equation (*i*), we get

$$L = 2\left[r_1\left(\frac{\pi}{2} + \alpha\right) + x - \frac{(r_1 - r_2)^2}{2x} + r_2\left(\frac{\pi}{2} - \alpha\right)\right]$$

$$= \pi(r_1 + r_2) + 2x + \frac{(r_1 - r_2)^2}{x} \qquad \text{...(In terms of pulley radii)}$$

$$= \frac{\pi}{2}(d_1 + d_2) + 2x + \frac{(d_1 - d_2)^2}{4x} \qquad \text{...(In terms of pulley diameters)}$$

(b) Length of Cross Belt Drive: (Both the pulleys rotate in opposite direction)



Let $\quad r_1$ and r_2 = Radii of the larger and smaller pulleys,

x = Distance between the centres of two pulleys (*i.e.* $O_1\,O_2$), and

L = Total length of the belt.

Let the angle $MO_2\,O_1 = \alpha$ radians.

$\therefore \quad L$ = Arc $GJE + EF +$ Arc $FKH + HG$ = 2 (Arc $JE + EF +$ Arc FK) ...(*i*)

From the geometry of the figure, we find that

$$\sin\alpha = \alpha = \frac{O_1 M}{O_1 O_2} = \frac{O_1 E + EM}{O_1 O_2} = \frac{r_1 + r_2}{x} \quad \text{...}(ii)$$

$$\therefore \quad \text{Arc } JE = r_1\left(\frac{\pi}{2} + \alpha\right) \quad \text{...}(iii)$$

Similarly $\quad$ Arc $FK = r_2\left(\dfrac{\pi}{2} + \alpha\right)$ ...(*iv*)

and $\quad EF = MO_2 = \sqrt{(O_1 O_2)^2 - (O_1 M)^2} = \sqrt{x^2 - (r_1 + r_2)^2} = x\sqrt{1 - \left(\dfrac{r_1 + r_2}{x}\right)^2}$

$$\therefore \quad EF = x - \frac{(r_1 + r_2)^2}{2x} \quad \text{...}(v)$$

Substituting the value of $\alpha = \dfrac{r_1 + r_2}{x}$ from equation (*ii*), arc JE from equation (*iii*), arc FK from equation (*iv*) and EF from equation (*v*) in equation (*i*), we get

$$L = 2\left[r_1\left(\frac{\pi}{2} + \alpha\right) + x - \frac{(r_1 + r_2)^2}{2x} + r_2\left(\frac{\pi}{2} + \alpha\right)\right]$$

$$= \pi(r_1 + r_2) + 2x + \frac{(r_1 + r_2)^2}{x} \quad \text{...(In terms of pulley radii)}$$

$$= \frac{\pi}{2}(d_1 + d_2) + 2x + \frac{(d_1 + d_2)^2}{4x} \quad \text{...(In terms of pulley diameters)}$$

Chain drives

Chain drives are used to transmit power between two components that are at a greater distance. These drives consist of a roller chain and two or more sprockets. The driver sprocket's teeth mesh with the roller chain and transfer torque to the driven sprocket. Chains can be commonly seen in power transmission in bicycles and motorcycles, but they are also quite common in industrial machines.

They can fit into tight spaces by using idler sprockets. Chain drives are also used in applications where timing is critical and any delay caused by slippage would result in problems. This is why they are used in marine diesel engines, as timing chains to transfer power from the crankshaft to the camshaft. The camshaft operates the exhaust valve and the fuel injection timing. If the timing is off, the engine will suffer.

Advantages

- A chain drive is more compact than a belt drive and can fit into relatively tight spaces
- It can transfer torque over long distances

- Contrary to belt drives, chain drives do not slip
- One chain drive can power multiple shafts at a time
- It has high mechanical efficiency thanks to little friction
- A chain drive can work in all kinds of service environments (dry, wet, abrasive, corrosive etc.) and at high temperatures

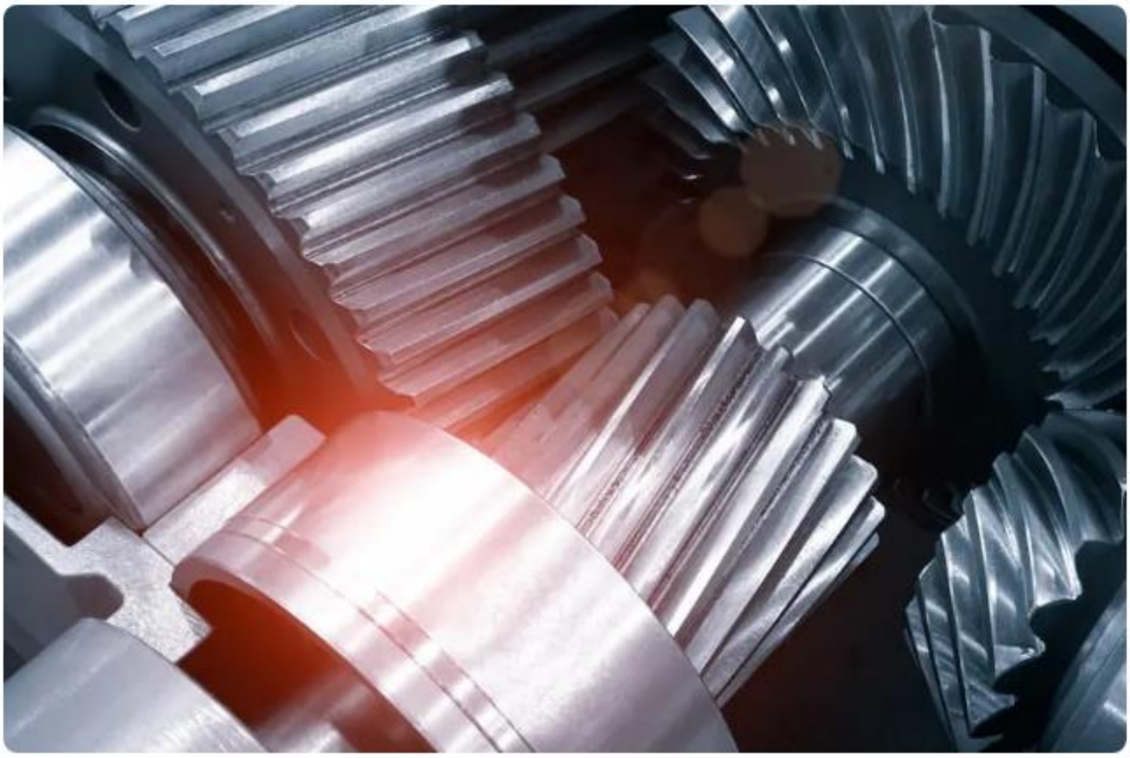
Disadvantages

- They are noisy and can also cause vibrations
- A chain drive cannot work with non-parallel shafts
- Some designs require constant lubrication
- Misalignment may cause the chain to slip off
- A chain drive usually needs an enclosure
- It requires an arrangement for chain tensioning in the form of a tightening idler sprocket

Chain Drives serve the following applications:

- Automotive timing systems.
- Bicycles for pedal-to-wheel power transfer.
- Conveyor systems for material handling.
- Industrial machinery in manufacturing.
- Agricultural equipment like tractors.
- Lifting and hoisting in cranes and hoists.
- Mining equipment for conveyors and rigs

Gear drives



Gear drives use gears for motion and power transmission from one shaft to another. They consist of a driving gear (on the input shaft) and a driven gear (on the output shaft). Power transmission from the power source to the load takes place through the meshing of the gear teeth. Due to the many available designs, they can work in a number of orientations and applications.

A gear drive can handle higher loads compared to a chain drive but is only suitable for short distances, as the gears need to be in direct contact with each other. Using multiple gears in a gear train makes it possible to change the gear ratio, rotational speed, torque and direction as needed. Too many gears in a single system will, however, reduce mechanical efficiency.

Gear drives do not slip but they may develop some backlash over time. Backlash is the gap between two meshing gear teeth at the pitch circle. At lower outputs, it may only result in some minor calculation errors. But at higher power outputs, the backlash will send a shock through the entire gear train. On occasion, it can even cause damage to the gear teeth.

Advantages

- Suitable for high mechanical power transmission applications

- Gears are sturdy and have long service lives
- Compact setup
- Gears have high efficiency and do not slip

Disadvantages

- Not suitable when distances between shafts are high, a direct connection is needed
- Prone to vibration and noise
- Metal gears are heavy and increase the weight of the machine
- They do not offer any flexibility
- They require lubrication
- Shock loads can damage gears
- Costlier than other drives (chain, belt, etc.)
- Meshing gears require precise alignment

Gear drives are used in many different applications, including: Automotive transmission systems, Wheel differentials, Marine equipment, Turbines, Gear motors.

Rope drives:

The rope drives are widely used where a large amount of power is to be transmitted, from one pulley to another, over a considerable distance. It may be noted that the use of flat belts is limited for the transmission of moderate power from one pulley to another when the two pulleys are not more than 8 metres apart. If large amounts of power are to be transmitted by the flat belt, then it would result in excessive belt cross-section. It may be noted that frictional grip in case of rope drives is more than that in V-drive. One of the main advantage of rope drives is that a number of separate drives may be taken from the one driving pulley. For example, in many spinning mills, the line shaft on each floor is driven by ropes passing directly from the main engine pulley on the ground floor.

The rope drives use the following two types of ropes:

1. Fibre ropes, and 2. Wire ropes.

The fibre ropes operate successfully when the pulleys are about 60 metres apart, while the wire ropes are used when the pulleys are upto 150 metres apart.

Advantages of the rope drive

- Significant power transmission.
- It can be used for long distance.
- Ropes are strong and flexible.
- Provides smooth and quiet operation.
- It can run any direction.

- Low-cost and economic.
- Precise alignment of the shaft not required.

Disadvantages of the rope drive

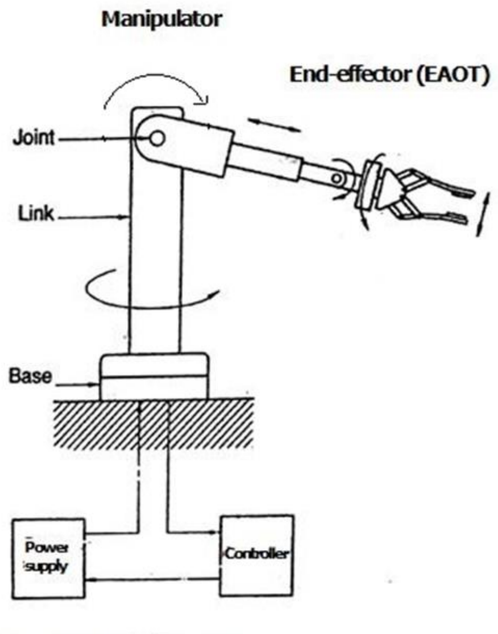
- Internal failure of the rope has no sign on external, so it if often get unnoticed.
- Corrosion of wire rope.

Wire ropes are used dynamically for lifting and hoisting in cranes and elevators, and for transmission of mechanical power. Wire rope is also used to transmit force in mechanisms, such as a Bowden cable or the control surfaces of an airplane connected to levers and pedals in the cockpit

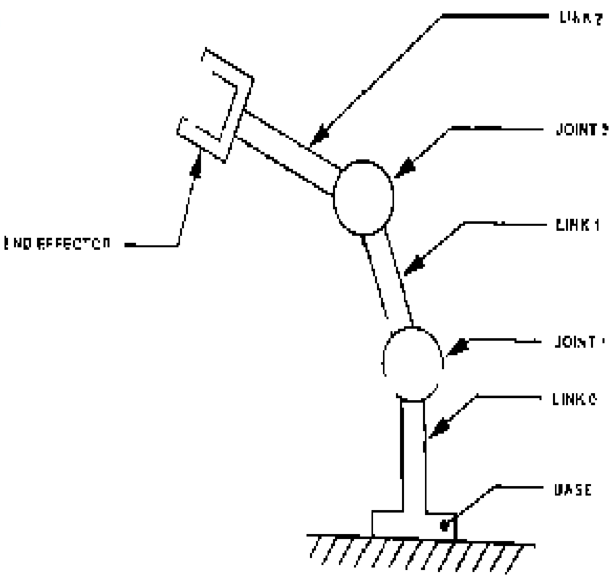
Robot definition: Robot is a reprogrammable, multifunctional manipulator designed to move materials, parts, tools, or special devices through variable programmed motions for the performance of a variety of tasks.

"Robotics" is defined as the science of designing and building Robots which are suitable for real life application in automated manufacturing and other non-manufacturing environments.

ROBOT COMPONENTS:
1. MANIPULATOR OR ROVER
2. END-EFFECTOR
3. ACTUATORS:
4. SENSORS:
5. CONTROLLER:
6. PROCESSOR:
7. SOFTWARE



Components or a robot system



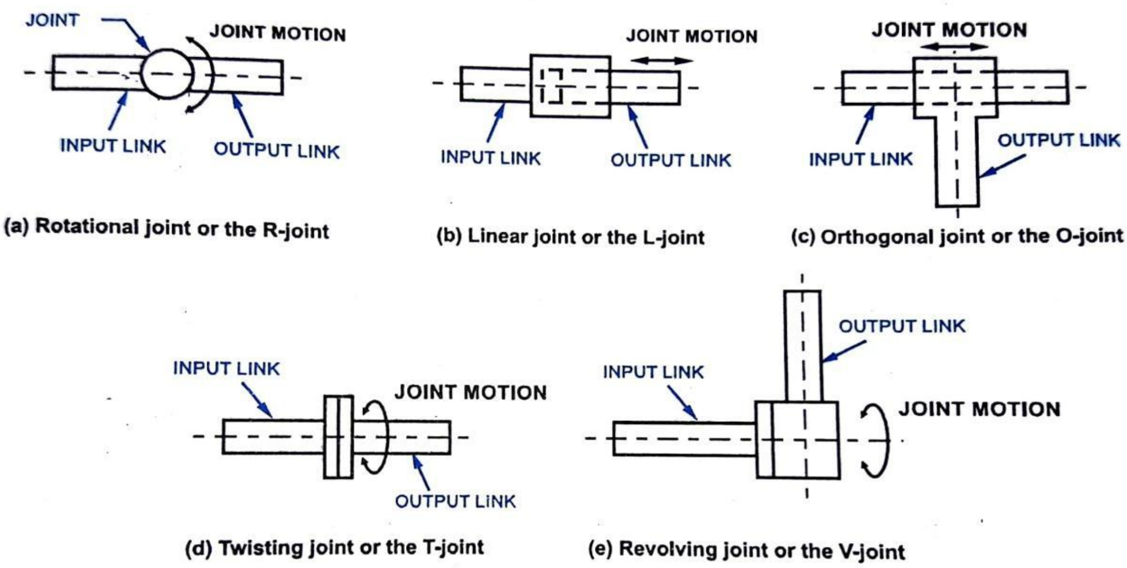
1. MANIPULATOR OR ROVER: The skeleton of robot is called Manipulator. Manipulator consists of links and joints. Joints provides relative motion. Links are rigid members between joints.
2. END-EFFECTOR: The lost link of the Robot is called End effector. This part is connected to the last joint (hand) of a manipulator that generally handles objects, makes connections to other machines, or performs the required tasks. Robot manufacturers generally do not design or sell end effectors. In most cases, all they supply is a simple gripper. There are two types of end effectors, Grippers and Tools. Grippers are used to grasp and hold the objects whereas tools are perform the operations, like drilling, milling, turning etc.
3. ACTUATORS: Actuators are the "muscles" of the manipulators. The controller sends signals to the actuators, which, in turn, move the robot joint and links. Common types are servomotors, stepper motors, pneumatic actuators, and hydraulic actuators. Other novel actuators are used in specific situations. Actuators arc under the control of the controller.

4. SENSORS: Sensors are used to collect information about the internal state of the robot or to communicate with the outside environment. As in humans the robot controller needs to know the location of each link of the robot in order to know the robot's configuration. When you wake up in the morning, even without opening your eyes, or when it is completely dark, you still know where your arms and legs ate. This is because feedback sensors in your central nervous system embedded in muscle tendons send information to the brain. The brain uses this information to determine the length of your muscles and, consequently, the state of your arms, legs. and so on. The same is true for robots, where sensors integrated into the robot send information about each joint or link to the controller that determines the configuration of the robot. Still similar to your major senses of sigh, touch, hearing, taste, and speech, robots arc equipped with external sensory devices such as a vision system, touch and tactile sensors, speech synthesizer, and the like that enable the robot to communicate with the outside world.
5. CONTROLLER: The controller is rather similar to your cerebellum; although it does not have the power of the brain, it still controls your motions. The controller receives its data from the computer (the brain of the system) controls the motions of the actuators, and coordinates the motions with the sensory feedback information. Suppose that in order for the robot to pick up a part from a bin, it is necessary that its first joint be at 35degree. If the joint is not already at this magnitude the controller will send a signal to the actuator (a current to an electric motor, air to a pneumatic cylinder, or a signal to a hydraulic servo valve), causing it to move. It will then measure the change in the joint angle through the feedback sensor attached to the joint (a potentiometer, an encoder, etc). When the joint reaches the desire valve the signal is stopped. In more sophisticated robot, the velocity and the force exerted by the robot are also controlled by the controller.
6. PROCESSOR: The processor is the brain of the robot. It calculates the motions of the robot's joints. It determines how much and how fast each joint must move to achieve the desired location and speeds, and oversees the coordinated actions of the controller and the sensors. The processor is generally a computer, which works like all other computers but is dedicated to a single purpose. It requires an operating system, programs, peripheral equipment such as monitors, and has many of the same limitations and capabilities of a PC processor.
7. SOFTWARE: There are perhaps three groups of software that are used in a robot. One is the operating system, which operates the computer. The second is the robotic software, which calculates the necessary motions of each joint based on the kinematic equations of the robot. This information is sent to the controller. This softy-are may be at many different levels, from machine language to sophisticated languages used by modern robots. The third group is the collection of routines and application programs that are developed in order to use the peripheral devices of the robots, such as vision routines, or to perform specific tasks.
It is important to note that in many systems. The controller and the processor are placed in the same unit. Although these two units are in the same box, and even if they are integrated into the same circuit, they have two separate functions.

Joints and Links

There are various types of joints that are used in the construction of a robot. These joints are called the robot joints. There are majorly five types of robot joints:
1. Rotational joint or the R-joint: This type of joint allows rotary relative motion where the axis of the rotation is perpendicular to the axes of the input link and the output link. This is shown in Fig (a)
2. Linear joint or the L-Joint: This type of joint allows a translational sliding motion between the input and the output links with the axes of the links parallel as shown in the Fig (b).
3. Orthogonal joint or the 0-joint: This type of joint allows a translational sliding motion between the input link and the output link with the axis of the output link perpendicular to the input link as shown in Fig. 5(c).

4. Twisting joint or the T-joint: This type of joint allows rotary motion where the axis of rotation is parallel to the axes of the input and output links as shown in the Fig (d).
5. Revolving joint or the V-joint: In this type of joint, the input link axis is parallel to the rotational axis of the joint whereas the output link axis is perpendicular to the rotational axis of the joint as shown in the Fig (e).

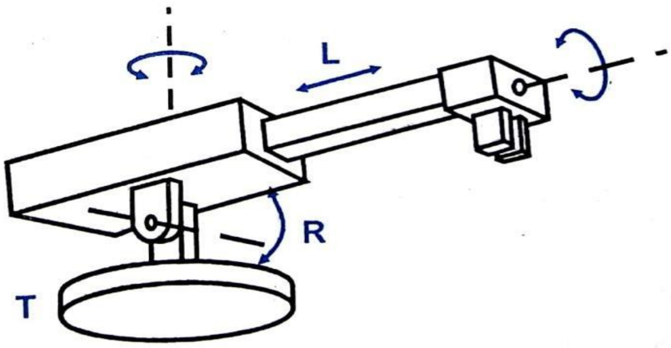


Types of Robot joints

CLASSIFICATION OF ROBOTS BASED ON COORDINATE SYSTEM:

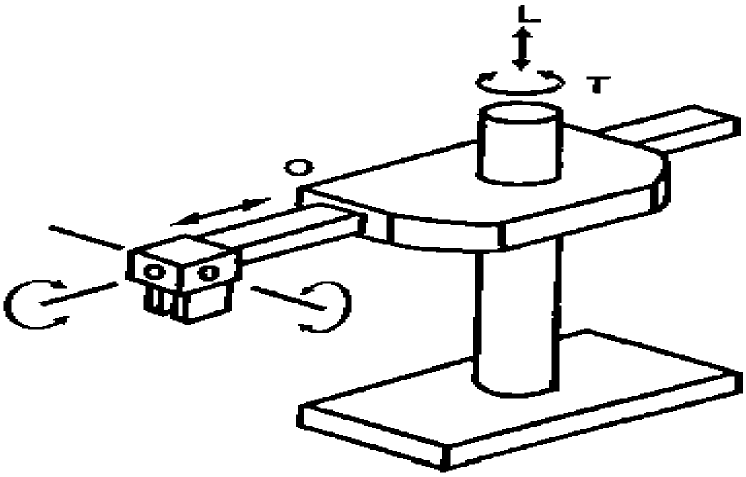
1. Polar configuration
2. Cylindrical configuration
3. Cartesian coordinate configuration
4. Jointed-arm configuration

1. Polar Configuration (Spherical Configuration): The Polar configuration robots also called as the spherical configuration robots consists a sliding arm (L-joint) that is actuated relative to the body and a rotational base along with a pivot, which can rotate about a horizontal axis (R joint) and the vertical axis (T Join This is shown in the Fig



Polar Configuration Robot

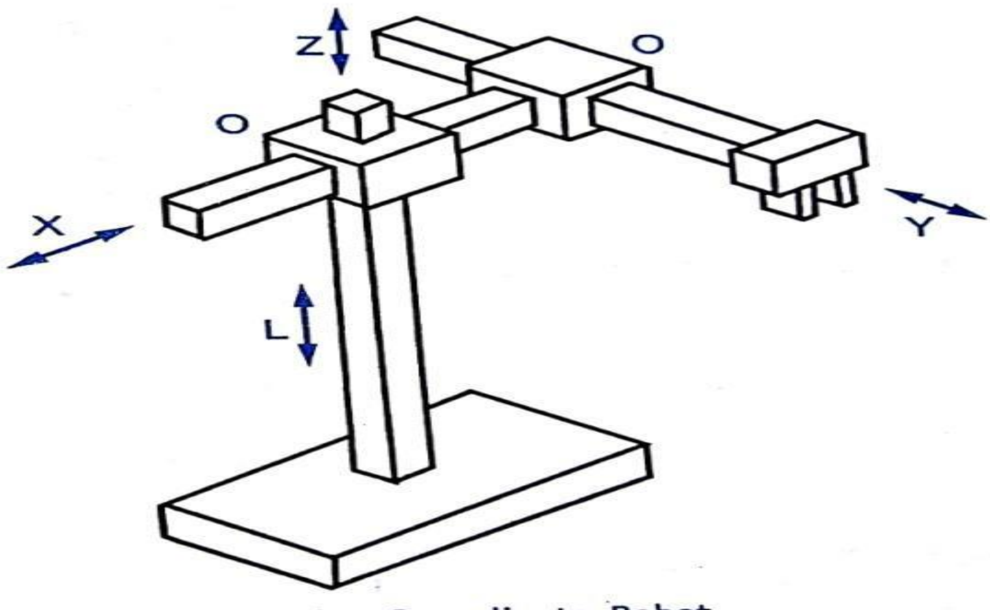
2. Cylindrical Configuration: Robots of the cylindrical configuration consists of a slide in the horizontal position and a column in the vertical position. The arm assembly moves up or down relative to the column using as L-joint. The column is rotated about its axis using the T-joint. The radial movement of the arm is achieved using the o-joint as shown in the Fig



Cylindrical Configuration Robot

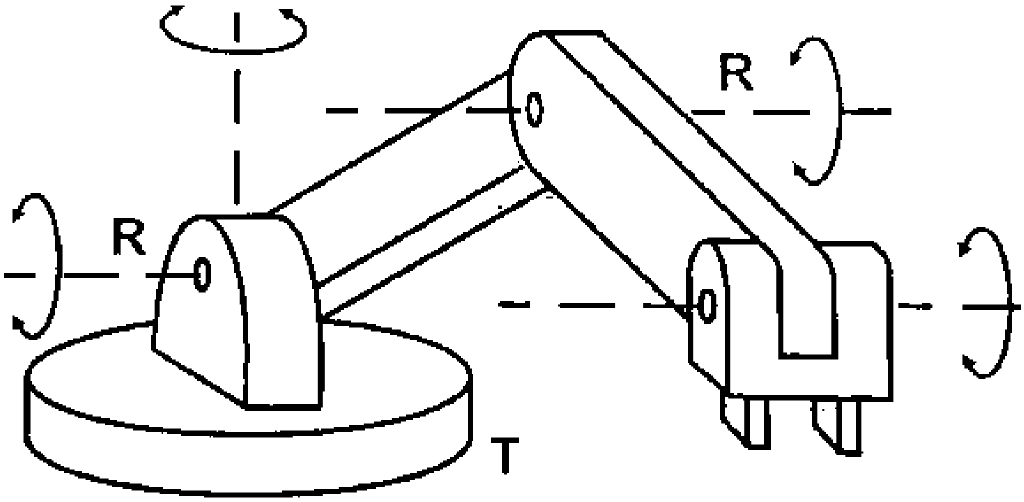
3. Cartesian Co-ordinate Robot

It is also called as a rectilinear robot or a XYZ Robot. It consists of Three Sliding joints along the X, Y and Z direction in three dimensional spaces. There are two orthogonal Joints. Since movement can stop and start and start simultaneously along X, Y and Z axes the motion of the tool tip is smoother.



Cartesian Co-ordinate Robot

4. Jointed-arm Configuration Robot: This type of Configuration resembles the human arm where the column swivels about a base (the column and the base forms a T-joint), the column top connects to the shoulder through a shoulder joint (which is the R-joint) and the shoulder connecting to the elbow through an elbow joint (which is also an R-joint). Thus, this configuration has the capability to be controlled at any adjustments in the work space. This is shown in Fig



Jointed arm Configuration Robot

CLASSIFICATION OF ROBOTS BASED ON CONTROL SYSTEM:

1. Limited sequence robots (Non-servo)

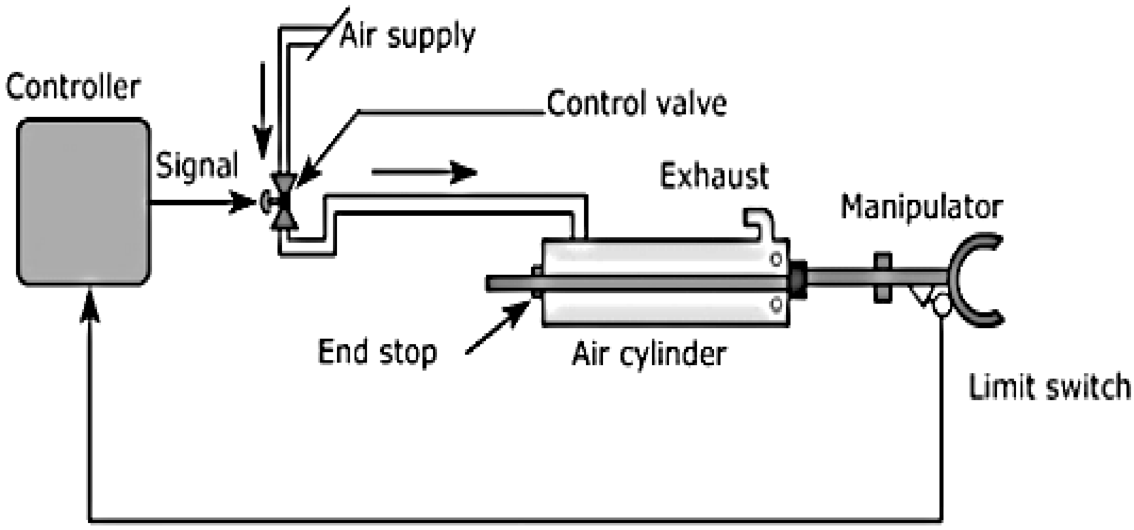
2. Playback robots with point to point (servo)

3. Play back robots with continuous path control,

4. Intelligent robots.

1. Limited sequence robots (Non-servo):-

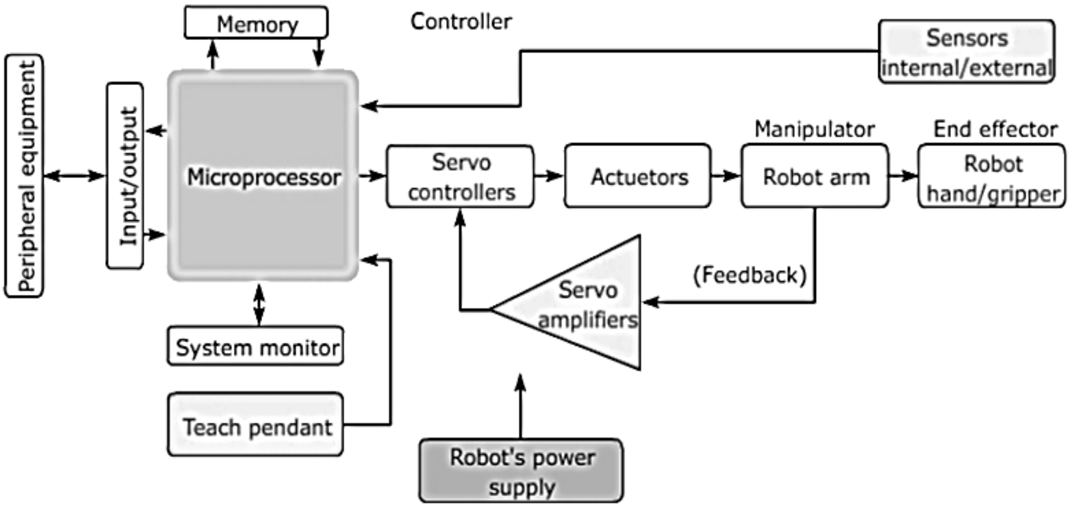
Limited sequence robots do not give servo controlled to inclined relative positions of the joints; instead they are controlled by setting limit switches & are mechanical stops. There is generally no feedback associated with a limited sequence robot to indicate that the desired position, has been achieved generally thin type of robots involves simple motion as pick & place operations.



2. Playback robots with Point to point motion:-

These type robots are capable of controlling velocity acceleration & path of motion, from the beginning to the end of the path. It uses complex control programs, PLC's (programmable logic controller's) computers to control the motion.

The point to point control motion robots are capable of performing motion cycle that consists of a series of desired point location. The robot is tough & recorded, unit.



3. Playback robots with Continuous path motion:-

In this robots are capable of performing motion cycle in which the path followed by the robot in controlled. The robot move through a series of closely space point which describe the desired path.

Ex:- Spray painting, arc welding & complicate assembly operations.

4. Intelligent robots:-

This type of robots not only programmable motion cycle but also interact with its environment in a way that years intelligent. It taken make logical decisions based on sensor data receive from the operation.

There robots are usually programmed using an English like symbolic language not like a computer programming language.

Present Applications of Robots:-

Agriculture, Automobile, Entertainment, Hospitals, Laboratories, Law enforcement, Manufacturing, Military, Mining, Excavation and Exploration, Space and Undersea exploration, Warehousing

(i) Material transfer applications

a).Pick-and-place application: The most common and simplest application here is the pick-and-place application where objects are picked from one location and placed to another location.

b).Palletizing application: Another application that is slightly complex is the "Palletizing application" where the robot stacks products or carton boxes onto a pallet at various positions on the pallet to the required height

c).Depalletizing application: Here the robot picks parts from an orderly stacked pallet to another location.

d). Stacking application: Here, the robots are used to stack parts one upon another. After each placement, the vertical position is re-calculated and the new stacking height is determined.

e). insertion operation: Here, the robots are used to insert parts into the compartments or spaces provided in a carton.

(ii) Machine loading and unloading

1. Die casting: Here the robot is used to safely unload the parts from a die-casting machine with the safety gates closed.

2. Forging: Forging is one of the toughest environments considering the extreme heat, pollution and noise. The use of a robot immensely helps to face the environment of forging. Here the robot loads the red hot billet on to the die of the forging hammer, holds it during the blows and unloads to a safe place away from the hammer.
3. Plastic injection moulding: Here a robot unloads parts from the injection moulding machine, cuts the runner and drops runner to scrap area.
4. Sheet metal press operation (Press working): Here a robot loads a blank into the press, and then after the press stamping operation is performed the robot unloads the scrap and throws it into the scrap area. The stamped parts from the blank falls in the container placed at the back of the machine.
5. Machining operations: Here the robot loads the raw blanks on to the machine tool and unloads the finished parts.
6. Heat treating: Here the robot loads/unloads parts to/from a furnace.
(iii) Processing operations like,
(a) Spot welding
(b) Continuous arc welding
(c) Spray coating
(d) Drilling, routing, machining operations
(e) Grinding, polishing debarring wire brushing
(g) Laser drilling and cutting etc.
(iv) Assembly tasks, assembly cell designs, parts mating.
(v) Inspection, automation

Future Applications of Robots:-

The profile of the future robot based on the research activities will include the following,
(i) Intelligence
(ii) Sensor capabilities
(iii) Telepresence
(iv) Mechanical design
(v) Mobility and navigation (walking machines)
(vi) Universal gripper
(vii) Systems and integration and networking
(viii) FMS (Flexible Manufacturing Systems)
(Ix) Hazardous and inaccessible non-manufacturing environments
(x) Underground coal mining
(xi) Fire fighting operations
(xii) Robots in space
(xiii) Security guards
(xiv) Garbage collection and waste disposal operations
(xv) Household robots
(xvi) Medical care and hospital duties etc.

Advantages of Robots

1. Robots can be substituted for humans to work in hazardous work environments.
2. Robots can produce greater quantity in a short span of time with consistency and accuracy that cannot be matched by humans.
3. Robots can work at constant speeds without any break which is not possible by humans. 4. Robots are capable of lifting heavy loads without getting tired or injured.
5. Robots can work in tight spaces where human reach is not possible.
6. Robots can be re-programmed with changed tooling to take up a different task after the end of a batch or a production run. In such cases, robots are better than fixed automation. 7. Accidents at the workplace is avoided since robots perform the risky jobs which were otherwise done by humans.

8. Since Robots are controlled by computers, they can be integrated to other computer systems to realize Computer Integrated Manufacturing (CIM)
9. The usage of robots produces lesser or no defective parts and hence saves time of rework and money to the organization

Disadvantages of Robots

1. Organizations have to make huge investments to introduce robots at their workplaces.
2. Since parts of a robot are made very precisely, their replacement is very difficult and to maintain, it costs huge amount of money.
3. To program and setup the robotic systems and robots, and to avoid unnecessary future problems and mishaps, it requires highly skilled technical engineers and programmers which again is a significant cost for the organization.
4. Unless the level of the artificial intelligence is highly sophisticated, robots may not be able to respond properly during times of emergency, during times of accidents or when an unexpected variance occurs.