MIT-WP

MIT-WORLD PEACE UNIVERSITY, PUNE

First Year B.Tech

SCHOOL OF MECHANICAL ENGINEERING

LABORATORY MANUAL

2020-21

BASIC MECHANICAL ENGINEERING

Course Code: MEE105B

I N D E X

Sr. No.	Name of the Experiment	Page	Date	Signature of Batch I/C
1	Determination of speed ratio in a power transmission system			
2	Demonstration and working of slider crank mechanism			
3	Demonstration of various operations on a lathe machine			
4	Demonstration of robot-assisted welding process			
5	Demonstration of robot-assisted automatic conveyer system			
6	Performance of refrigeration test rig			
7	Trial on reciprocating compressor			
8	Operation of Pelton wheel for hydroelectric power generation			
9	Energy audit of anyone of the laboratories/Residence			
10	Visit to biogas power plant			
11	Working and operation of Boiler /thermal power plant			

CERTIFICATE

This is to certify that Mr./Ms ……………………………………………………………………. of Class **F.Y.B. Tech.** Division ………….. Roll No. …………………. has completed the laboratory work in the subject **BASIC MECHANICAL ENGINEERING** during the trimester I/II/III of the academic year …………………..

Signature of the Faculty **Seal of the Head of School**

MIT-WORLD PEACE UNIVERSITY

F. Y. B. Tech

Trimester: I /II/III **Subject:** BASIC MECHANICAL ENGINEERING

Name ----------------------------- **Division ----**

Roll No --------------------------- **Batch ----**

Experiment No: 01

Name of the Experiment: Determination of speed ratio in a power transmission system

Performed on: --

Submitted on: --

Aim: To study power transmitting elements and determine the speed ratio of a simple gear train

Objective

To understand the working of different power transmitting elements such as Couplings, Gears and Bearings.

Theory

Power transmission is the movement of energy from its place of generation to a location where it is applied to perform useful work. Power is defined formally as units of energy per unit time.

Ex: **Sequence** of **gears and shafts**, through which the **engine power** is transmitted to the **tractor wheels.**

Machine elements used for transmitting the power are called as power transmitting elements. Various power transmitting elements are **gears**, shafts, clutches and brakes, pulleys, belts, chain, and sprocket. One the most commonly used power transmitting elements is a gear. A gear is a toothed wheel that engages with another toothed wheel or with a rack in order to change the speed or direction of transmit motion.

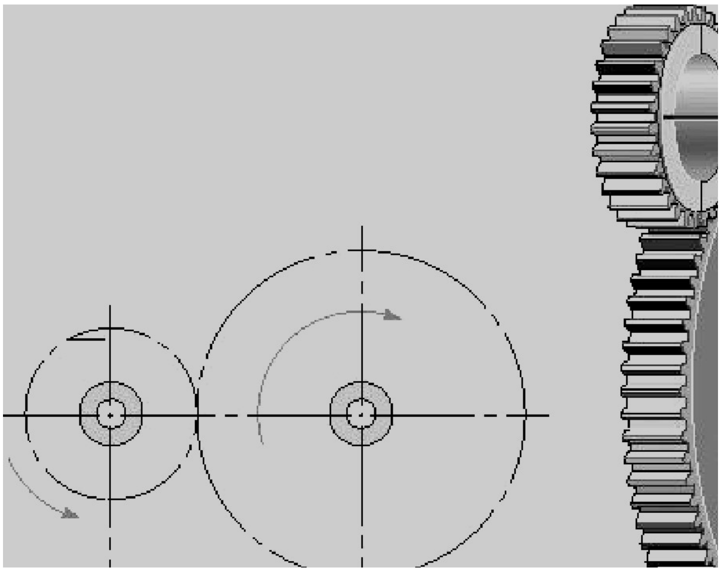
Gears can be classified according to the relative positions of their shaft axes as follows:

1. Parallel shafts

Regard less of the manner of contact, uniform rotary motion between two parallel shafts is equivalent to the rolling of two cylinders, assuming no slipping. Depending upon the teeth of the equivalent cylinder that is straight or helical, following are the main types of gears to join parallel shafts.

Spur Gears

They are straight teeth parallel to the axis and thus, are not subjected to axial thrust due to tooth load. At 6he time of engagement of two gears, the contact extends across the entire width on a line parallel to the axis of rotation. This results in sudden application of the load, high impact stresses and excessive noise at high speeds. Further, if the gears have external teeth on the outer surface of the cylinder, the shafts rotate in the opposite direction. In an internal spur gear, the teeth are formed on the inner surface of an annulus ring. An internal gear can mesh with an external pinion (smaller gear) only and the two shafts rotate in the same direction as shown in the figure below

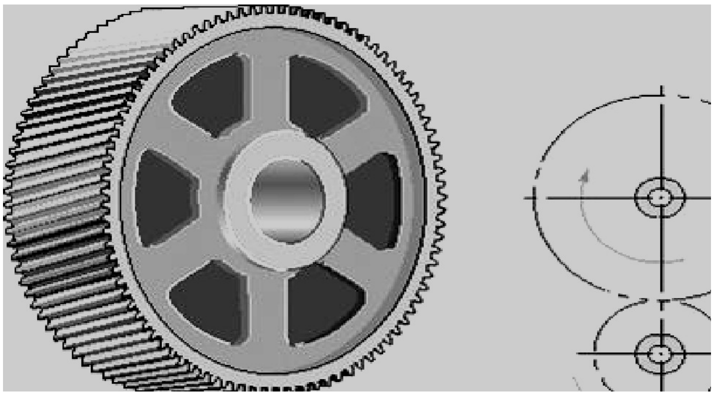


Spur Rack And pinion

Spur Rack is a special case of spur gear where it is made of infinite diameter so that the pitch surface is plane. The spur rack and pinion combination converts rotary motion into translatory motion, or vice versa. It is used in a lathe in which the rack transmits motion to the saddle.

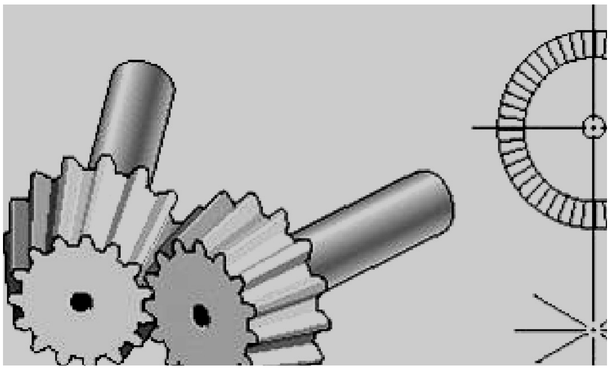
Helical or helical spur gears

In helical gears the teeth are curved, each being in helical in shape. Two mating gears have the same helix angle, but have teeth of opposite hands. At the beginning of engagement contact occurs only at the point of leading edge of the curved teeth, as the gears rotate, the contact extends along a diagonal line across the teeth. Thus, load application is gradual which results in low impact stresses and reduction in noise. Therefore, the helical gears can be used at higher velocities than the spur gear and have greater load carrying capacity. Helical gears have the disadvantage of having in thrust as there is a force component along the gear axis. The bearings and the assemblies mounting the helical gears must be able to withstand thrust loads.



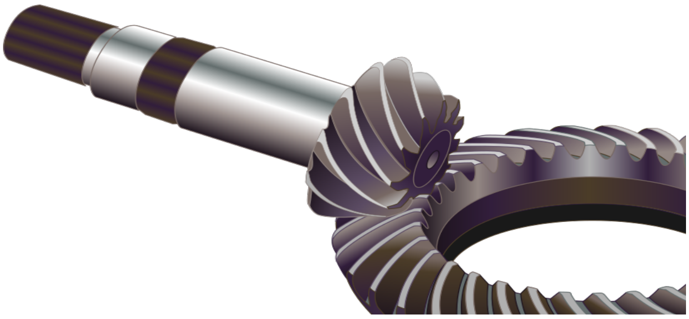
2. Intersecting shafts

Kinematically, the motion between two intersecting shafts is equivalent to the rolling of two cones, assuming no slipping. When teeth formed on the cones are straight, the gears are known as straight bevel and when inclined, they are known as spiral or helical gear. Straight bevel gear The teeth are straight, radial to the point of intersection of the shaft axis and vary in cross section through out their length. Usually, they are used to connect shafts at right angles to each other are known as mitre gears, at the beginning of engagement , straight bevel gear make the line contact similar to spur gear. They can also be internal bevel gears analogous to internal spur gears.



Spiral bevel gear:

When the teeth of a bevel gear are inclined at an angle to the face of the bevel, they are known as spiral bevel or helical bevels. They are smoother in action and quieter than straight tooth bevels as there is gradual load application and low impact stresses. Of course, there exists an axial thrusts calling for stronger bearings and supporting assemblies these are used for the drive to the differential of an automobile.



Determination of speed ratio:

A gear consists of toothed wheels attached to shafts. It creates a mechanical advantage in a range of applications, for example a cyclist uses gears to intensify the power output of his pushing on the pedals. Gears have many properties, one of which is the speed ratio, often known as gear ratio. This is the ratio of the turning speed of the input gear to that of the output gear, in other words, how many time the input gear has to revolve to make the output gear revolve once.

A gear train consists of more than one gear connected to each other, and their teeth interlocked. When two gears of different sizes are connected to each other, the smaller gear turns faster than the larger gear. When the first gear (the driver or input gear) turns, the second gear (the driven or output gear) turns in the opposite direction in response. The ratio between the speeds of the two gears is called the speed ratio or gear ratio. The ratio is determined by the number of teeth on each gear wheel. The speed ratio of two gears is calculated by dividing the angular velocity of the input gear by the angular velocity of the output gear. The speed ratio of the mating gears is inversely proportional to ratio of the number of teeth or the ratio of the pitch circle diameters of the gears.

Speed Ratio of gears = No. of teeth of output gear / No. of teeth of input gear

= Pitch circle Diameter of output gear / Pitch circle diameter of input gear

= Angular velocity of input gear / Angular velocity of output gear

= T2/T1 = D2/D1 = RPM1/RPM2

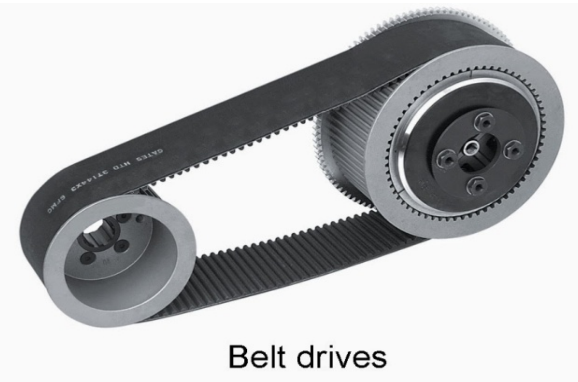
Speed Ratio Example: Consider an input gear with 10 teeth and an output gear with 20 teeth. You find the speed ratio by working out 20 ÷ 10 = 2. This pair of gears has a speed ration of 2, or 2/1. In other words, the input gear revolves twice to make the output gear revolve once.

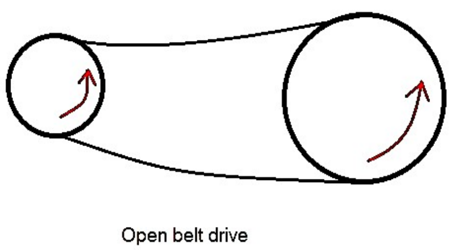
When you couple two gear wheels, their relative sizes determine how fast each will spin. If the driver wheel is smaller than the driven wheel, it will spin more often than the larger one. If the driver wheel is larger, the driven wheel will spin faster.

You could calculate the amount of speeding up and slowing down that a simple gear system produces by comparing the radii of the wheels, but there's an easier way. Because the teeth of both gear wheels interlock, they have to be the same size on both wheels, so you can simply compare the number of teeth on the two wheels. This is actually how you calculate gear ratio. You count the number of teeth on both the driver wheel and on the driven wheel and express these numbers as a ratio, or a fraction.

For example, if the driver wheel has 20 teeth, and the driven wheel has 40, calculate the gear ratio as 40/20, which simplifies to 2/1, or 2:1. (The tooth count on the driven wheel always goes on top of the fraction or first in the ratio). This tells you that, for every rotation of the driven wheel, the driver wheel makes two rotations. Similarly, a ratio of 1/2 tells you that the driven wheel rotates twice for every rotation of the driver wheel -- in other words, the driven wheel spins faster than the motor shaft.

Belt drive:
A belt is a looped strip of flexible material used to mechanically link two or more rotating shafts. A belt drive offers smooth transmission of power between shafts at a considerable distance. Belt drives are used as the source of motion to efficiently transmit power or to track relative movement.



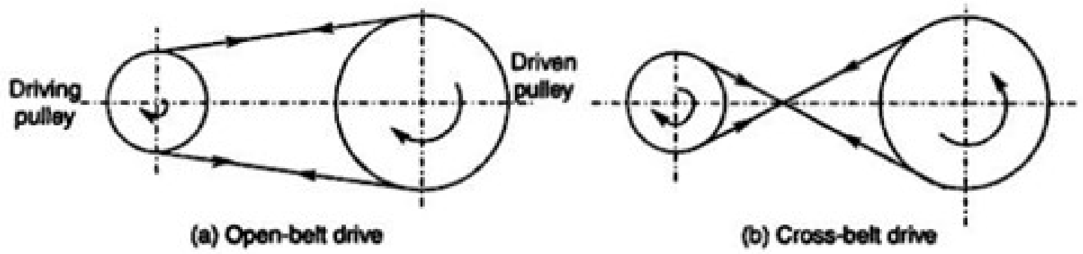


Types of Belt Drives:

In a two pulley system, depending upon the direction of rotation of the belt and the pulley, the belt drives are divided into two types. They are open belt drive and crossed belt drive.

Open belt drives:
An open belt drive is used to rotate the driven pulley in the same direction of driving pulley. In the motion of belt drive, power transmission results one side of pulley more tightened compared to the

other side. In horizontal drives, tightened side is always kept on the lower side of two pulleys because the sag of the upper side slightly increases the angle of folding of the belt on the two pulleys.



Crossed belt drives:
A crossed belt drive is used to rotate driven pulley in the opposite direction of driving pulley. Higher the value of wrap enables more power can be transmitted than an open belt drive. However, bending and wear of the belt are important concerns.

Advantages of belt drives:

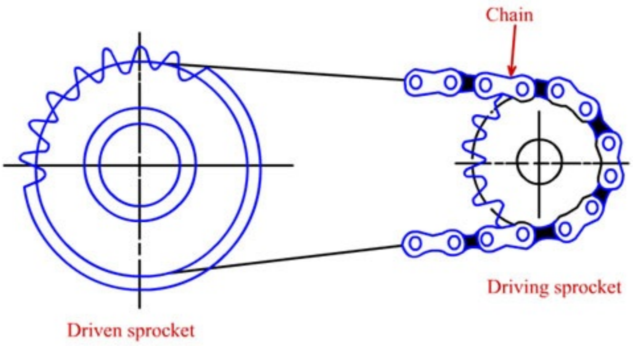
- Belt drives are simple and hence economical.
- They don't need parallel shafts. Idler pulleys can be used to change the belt direction joining the pulleys on two non-parallel shafts.
- Belts drives are provided with overload and jam protection.
- Noise and vibration are damped out. Machinery life is increased because load fluctuations and shocks are absorbed.
- They are lubrication-free. They require less maintenance cost.
- Belt drives are highly efficient in use (up to 98%, usually 95%).
- They are very economical when the distance between shafts is very large.

Disadvantages of belt drives:

- In Belt drives, angular velocity ratio is not necessarily constant or equal to the ratio of pulley diameters, because of slipping and stretching.
- Heat buildup occurs. Speed is limited to usually 35 meters per second. Power transmission is limited to 370 kilowatts.
- Operating temperatures are usually restricted to –35 to 85°C.
- Some adjustment of center distance or use of an idler pulley is necessary for wearing and stretching of belt drive compensation.

Chain drive

A chain drive consists of an endless chain wrapped around sprocket wheels. The chain has a number of links connected by pins. The sprockets have teeth of special profile. Chains are used for power transmission and as conveyors. The chain drives have some features of both belt (flexibility of location of driver and driven) and gear drives (ruggedness). Chain drives are recommended for velocity ratio below 10:1, chain velocity 1550 m/min and power transmission up to 100 kW.

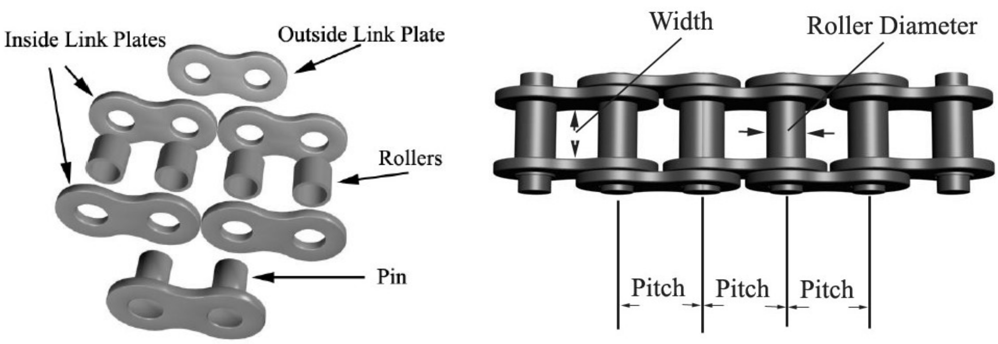


Chain drive

Chains are classified as roller chains and silent chains (inverted tooth or side guide chains).

Roller Chain Construction:

Roller chain is made up of alternate link plates (inner and outer), pins, bushes and rollers as shown in Fig. 16



Chains are sized according to their pitch. The center-to-center distances of the link pins.

Exercises:

1. Driver wheel has 40 teeth, and the driven wheel has 60, calculate the gear ratio and also calculate the RPM of driven wheel if the driver is rotating at 600 RPM.

2. Find the number of teeth required on driven gear to reduce the RPM by half, if number of teeth on driver gear is 80.

3. Suggest type of gear pair used if the two shafts are intersecting perpendicularly.

4. Compare: a) Gear drive with Belt drive b) Belt drive with chain drive

LABORATORY WORK CONTINUOUS ASSESSMENT RUBRIC

COURSE: **EXPT NO.:**

EVALUATOR: **DATE:**

STUDENT:

DIMENSION	**SCALE**			**SCORE 5 each**
	1	3	5	
Regularity and punctuality	Not attentive during practical session. Not particular about timely submission. Submission delayed more than 3 days.	Attentive during practical session but not punctual in submission. Submission late by up to 3 days.	Attentive during practical session and punctual about submission. Submission on or before due date	
Understanding the Objective of experiment.	Does not show any understanding of the objective and cannot relate it to an appropriate theory topic No sketches or no / improper description.	Understands objective but cannot place it in context of a theory topic. Some questions not satisfactory. Incomplete or incorrect sketches or improper description.	Understands objective and can relate it to an appropriate theory topic. Answers all the questions satisfactorily. Completes the assignment with neat sketches wherever necessary and proper description.	
Initiative and Analysis	Incomplete work. No initiative to find answers. Not able to analyze the available answers for correctness.	Completes the assignment. Finds out answers from available sources – books, web, friends. Can't decide correctness of the information available.	Completes the assignment. Takes initiative to find out answers from available sources – books, web. Ability to find correct answer.	
			Total out of 15	

MIT-WORLD PEACE UNIVERSITY

F. Y. B. Tech

Trimester: I /II/III **Subject:** BASIC MECHANICAL ENGINEERING

Name ----------------------------- **Division ----**

Roll No --------------------------- **Batch ----**

Experiment No: 02

Name of the Experiment: Demonstration and working of slider crank mechanism

Performed on: ---

Submitted on: ---

Aim: To study the working principle and construction of a slider crank mechanism

Objective: To understand working of slider crank mechanism and its inversions.

Theory: Slider-crank Mechanism is an arrangement of mechanical parts designed to convert straight line motion into rotary motion, as in a reciprocating engine. It is used to convert rotary motion to straight line motion as in a reciprocating pump. Slider-crank mechanism is used to transform rotational motion into translational motion by means of a rotating driving beam, a connection rod and a sliding body

Links and joints:

A mechanical linkage is an assembly of bodies connected to manage forces and movement. The movement of a body or link is studied using geometry so the link is considered to be rigid. The connections between links are modeled as providing ideal movement, pure rotation or sliding and are called joints. A linkage modelled as a network of rigid links and ideal joints is called a kinematic chain.

Kinematic link:

Each part of a machine that undergoes relative motion with respect to some other part, is called kinematic link (or kinematic element). Kinematic links help in the transmission of motion, from one machine part to another. The connecting rods shown in the image below are individual kinematic links. They are used for transmitting motion from piston to crankshaft in an engine. Kinematic links form the backbone of any mechanical system.

Types of Kinematic links:

Based on rigidity, kinematic links can be broadly classified into three types.

1. Rigid link
2. Flexible link and
3. Fluid link

Kinematic Pair:

A kinematic pair or simply a pair is a joint of two links having relative motion between them. In slider-crank mechanism, link 2 rotates relative to link 1 and constitutes a revolute or turning pair. Link 4 (slider) reciprocates relative to link 1 and is a sliding pair. Kinematic pairs can be classified according to Nature of contact and Nature of relative motion

Kinematic pair according to nature of contact

a) **Lower pair:** A pair of links having surfaced or area contact between the members is known as a lower pair. The contact surfaces of the two links are similar.

Example: Nut turning on a screw, shaft rotating in a bearing, all pairs of **a slider-crank mechanism, universal joint etc.**

b) **Higher pair:** When a pair has appointed or line contact between the links, it is known as higher pair. The contact surfaces of the two links are dissimilar.

Example: wheel rolling on a surface, cam and follower pair, tooth gears, balls and roller bearings, etc.

Kinematic pairs according Nature of relative motion

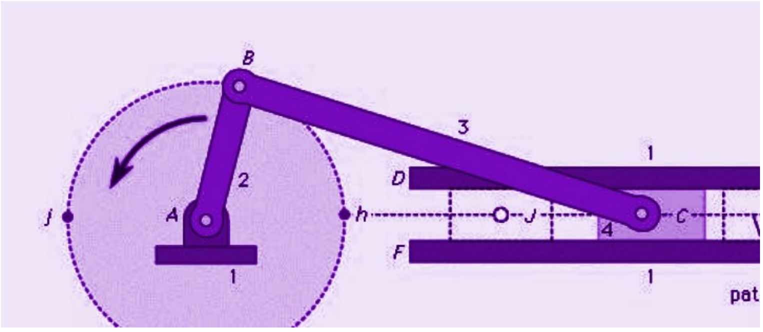
a) **Sliding pair:** If two links have a sliding motion relative to each other, they form a sliding pair. A rectangular rod in a prism is a sliding pair.

b) **Turning pair:** when one link has a turning or revolving motion relative to each other, they constitute a turning pair or revolving pair. In slider-crank mechanism, all pairs except the slider and guide pair are turning pairs. A circular shaft revolving inside a bearing is a turning pair.

c) Rolling pair: when the links of a pair have a rolling motion relative to each other, they form a rolling pair, e.g. a rolling wheel on a flat surface, ball and roller bearing, the ball and the shaft constitute one rolling pair whereas the ball and the bearing is the second rolling pair.

d) Screw pair: If two mating links have turning as well as sliding motion between them, they form a screw pair. This is achieved by cutting matching threads on the two links. The lead screw and the nut of a lathe is a screw pair.

e) **Spherical pair:** when one link in the form of a sphere turns inside a fixed link, it is spherical pair. The ball and socket joint is a spherical pair.



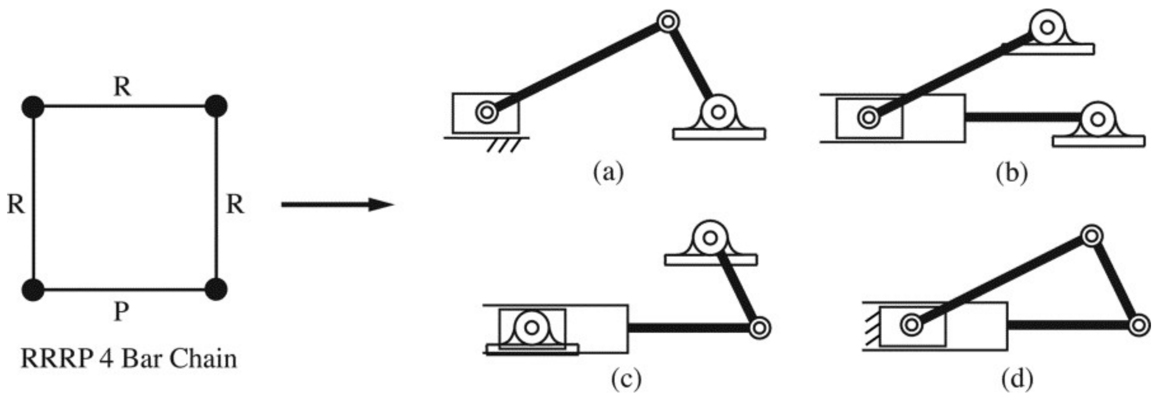
Slider-Crank Mechanism: The basic nature of the mechanism and the relative motion of the parts can best be described with the aid of the accompanying figure. the moving parts are lightly shaded. The darkly shaded part 1, the fixed frame or block of the pump or engine, contains a cylinder, depicted in cross section by its walls DE and FG, in which the piston, part 4, slides back and forth. The small circle at A represents the main crankshaft bearing, which is also in part 1. The crankshaft, part 2, is shown as a straight member extending from the main bearing at A to the crankpin bearing at B, which connects it to the connecting rod, part 3. The connecting rod is shown as a straight member extending from the crankpin bearing at B to the wrist-pin bearing at C,which connects it to the piston, part 4, which is shown as a rectangle. The three bearings shown as circles at A, B, and C permit the connected members to rotate freely with respect to one another. The path of B is a circle of radius AB; when B is at point h the piston will be in position H, and when B is at point j the piston will be in position J. On a gasoline engine, the head end of the cylinder (where the explosion of the gasoline-air mixture takes place) is at EG; the pressure produced by the explosion will push the piston from position H to position J; return motion from J to H will require the rotational energy of a flywheel attached to the crankshaft and rotating about a bearing collinear with bearing A. On a reciprocating piston pump the crankshaft would be driven by a motor.

A slider crank mechanism converts circular motion of the crank into linear motion of the slider. In order for the crank to rotate fully the condition L> R+E must be satisfied where R is the crank length, 'L' is the length of the link connecting the crank and slider and 'E' is the offset of the slider.

The total distance covered by the slider between its two extreme positions is called the path length.

Example: Internal combustion engines are a common example of this mechanism, where combustion in a **cylinder** creates pressure which drives a **piston**. The linear motion of the piston is then converted into rotational motion at the crank through **connecting rod**. As the geometry of the crank forces the conversion of linear motion to rotational, shaking forces are generated and applied to the crank's housing. The shaking forces result in vibrations which impede the operation of the engine.

Applications: Mechanisms obtained by fixing different links of slider crank chain are as follows:



1. **First inversion (a)**

This inversion is obtained when link 1 (ground body) is fixed. Application- Reciprocating engine, reciprocating compressor etc

2. **Second inversion (b)**

This inversion is obtained when link 2 (crank) is fixed. Application-Whitworth quick return mechanism, Rotary engine, etc...

3. **Third inversion (c)**

This inversion is obtained when link 3 (connecting rod) is fixed. Application- Slotted crank mechanism, Oscillatory engine etc..,

4. **Fourth inversion (d)**

This inversion is obtained when link 4 (slider) is fixed. Application- Hand pump, pendulum pump or Bull engine, etc. revolver mechanisms

Conclusion: The dynamic behaviour of a slider-crank mechanism with a flexible connecting rod is investigated. Slider-crank mechanism converts rotary motion into reciprocating motion by means of a rotating driving beam, a connection rod & sliding body. The use of this mechanism in the wide range of machines like pumps and compressors is observed.

Questions

1. Define: Kinematic link, Kinematic pair, Kinematic chain & Mechanism.
2. What are various inversions of slider crank mechanism? Give one example each with neat sketch.
3. What are various inversions of Grashof's four bar mechanism?

- **LABORATORY WORK CONTINUOUS ASSESSMENT RUBRIC**

- **COURSE:** **EXPT NO.:**
- **EVALUATOR:** **DATE:**
- **STUDENT:**

DIMENSION	**SCALE**			**SCORE 5 each**
	1	3	5	
Regularity and punctuality	Not attentive during practical session. Not particular about timely submission. Submission delayed more than 3 days.	Attentive during practical session but not punctual in submission. Submission late by up to 3 days.	Attentive during practical session and punctual about submission. Submission on or before due date	
Understanding the Objective of experiment.	Does not show any understanding of the objective and cannot relate it to an appropriate theory topic No sketches or no / improper description.	Understands objective but cannot place it in context of a theory topic. Some questions not satisfactory. Incomplete or incorrect sketches or improper description.	Understands objective and can relate it to an appropriate theory topic. Answers all the questions satisfactorily. Completes the assignment with neat sketches wherever necessary and proper description.	
Initiative and Analysis	Incomplete work. No initiative to find answers. Not able to analyze the available answers for correctness.	Completes the assignment. Finds out answers from available sources – books, web, friends. Can't decide correctness of the information available.	Completes the assignment. Takes initiative to find out answers from available sources – books, web. Ability to find correct answer.	
			Total out of 15	

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F. Y. B. Tech

Trimester: I /II/III **Subject:** BASIC MECHANICAL ENGINEERING

Name ----------------------------- **Division ----**

Roll No --------------------------- **Batch ----**

Experiment No: 03

Name of the Experiment: Demonstration of various operations on a lathe machine

Performed on: ---

Submitted on: ---

Aim: To study the various operations such as turning, step turning, facing, boring, taper turning, knurling, grooving, threading of center lathe

THEORY: A product is made up of many components which are manufactured by various manufacturing processes such as casting, forging, welding; machining etc. depends on the application and cost of that particular component. In the machining process various operations come like turning, step turning, facing, boring, taper turning, knurling, grooving, threading. All these operations can be done on center lathe hence center lathe is one of the important types of machines. In this practical we are going to study the operations which are mentioned above. Lathe is a machine tool which rotates the work piece on its axis to perform various operations such as cutting, sanding, knurling, drilling or deformation with tools that are applied to the work piece to create an object which has symmetry about an axis of rotation. Examples of objects that can be produced on a lathe include candlestick holders, gun barrels, sticks, table legs, bowls, baseball bats, musical instruments (especially woodwind instruments), crankshafts and camshafts.

Components of a Lathe machine and their function:

Bed: Almost all lathes have a horizontal beam is called as bed. It has guide ways on it for sliding and supporting tail stock and carriage.

Head Stock: At one end of the bed (almost always the left, as the operator faces the lathe) is a headstock. It contains drive mechanism with necessary speed change arrangement to achieve different speeds. It also has chuck which is used to hold the job.

Tail Stock: It is placed opposite to headstock. It can move along guide ways. Its main applications are to hold long jobs to avoid vibrations and excessive deformation and for drilling axial holes in the work piece it can also hold the tools such as drill, reamer, tap to do the operations like drilling, reaming etc.

Carriage: It is located between headstock and tailstock. It can be moved in a longitudinal direction and can be fixed at any position. Carriage has following parts

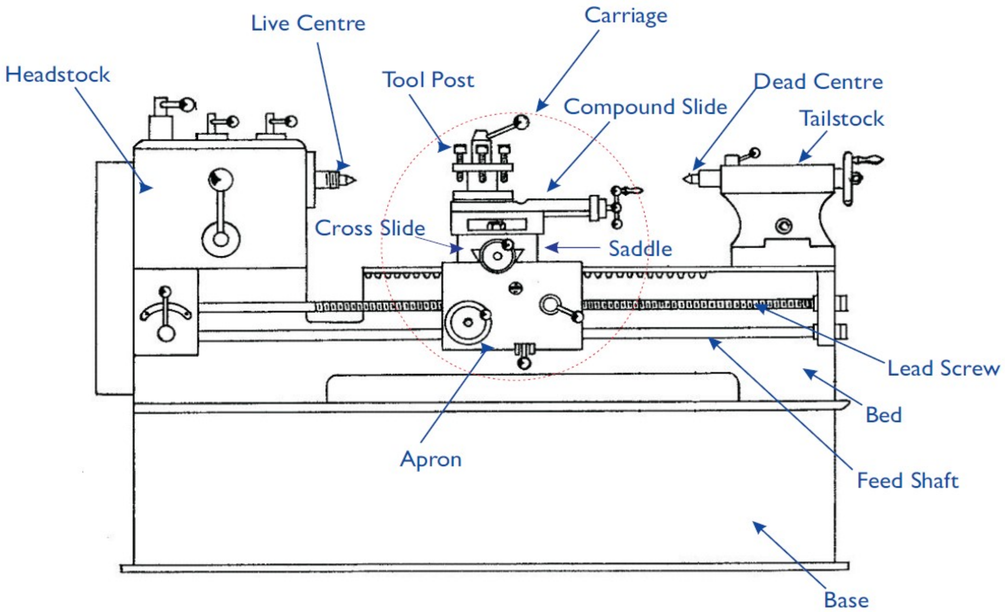
a. Saddle: Its base portion, located across the lathe bed and carries cross slide and tool post, it can be moved longitudinally along the bed.

b. Apron: it is attached to the saddle and appears as hanging on the front side. It consists of gears for motion transmission.

C: Cross Slide: it is mounted on top of the saddle and acts as support to compound rest

D: Compound Rest: It is mounted on a cross slide and it consists of swivel and top slide. The tool post is mounted on the top slide.

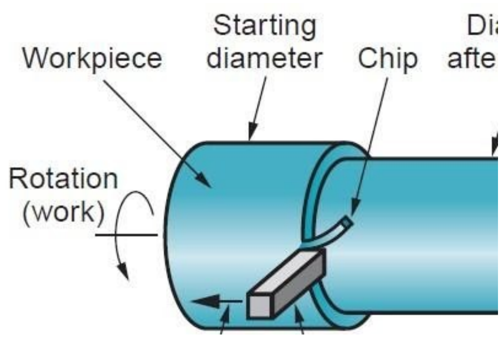
E: Tool-Post: it is used to hold the tool position the tool as per the requirement



Center lathe Machine

Various Lathe Operations

Turning: This is the basic operation of lathe machines to produce cylindrical surfaces. The tool is fed parallel to the rotating work axis to create cylindrical surfaces.



(a) Facing: The tool is fed radially into the rotating work on one end to create a flat surface.

(b) Taper turning: Instead of feeding the tool parallel to the axis of rotation of the work, the tool is fed at an angle, thus creating a tapered cylinder or conical shape.

(c) Contour turning (profiling): Instead of feeding the tool along a straight line parallel to the axis of rotation as in turning, the tool follows a contour that is other than straight.

(d) Form turning (forming): The tool has a shape that is imparted to the work by plunging the tool radially into the work.

(e) Chamfering: The cutting edge of the tool is used to cut an angle on the corner of the cylinder, forming what is called a chamfer.

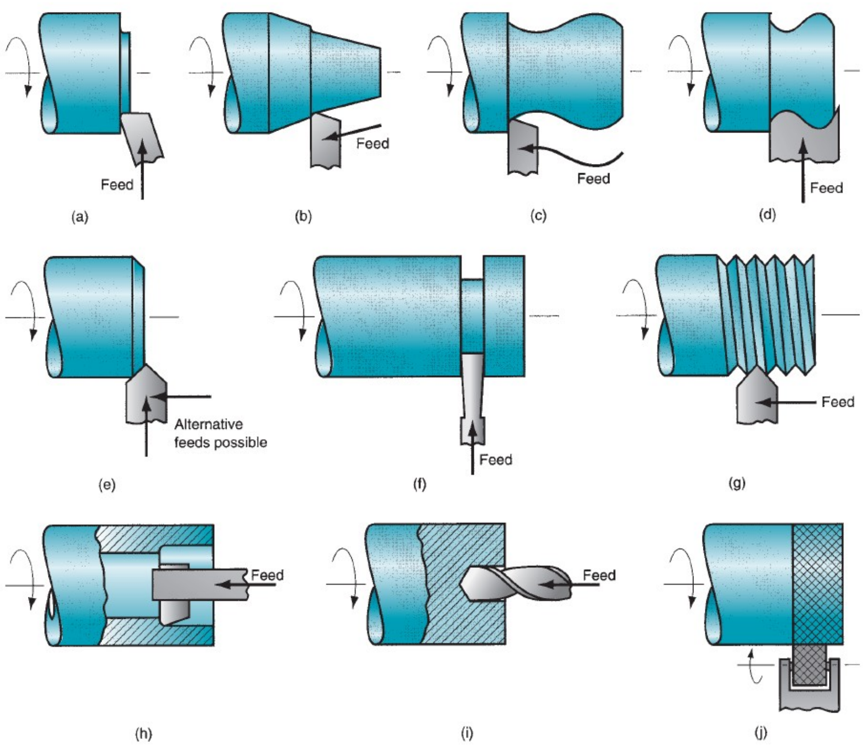
(f) Cutoff: The tool is fed radially into the rotating work at some location along its length to cut off the end of the part. This operation is sometimes referred to as parting.

(g) Threading: A pointed tool is fed linearly across the outside surface of the rotating work part in a direction parallel to the axis of rotation at a large effective feed rate, thus creating threads in the cylinder.

(h) Boring: A single-point tool is fed linearly, parallel to the axis of rotation, on the inside diameter of an existing hole in the part.

(i) Drilling: Drilling can be performed on a lathe by feeding the drill into the rotating work along its axis. Reaming can be performed in a similar way.

(j) Knurling: This is not a machining operation because it does not involve cutting of material. Instead, it is a metal forming operation used to produce a regular crosshatched pattern in the work surface.



Questions

1. List out the various types of lathe. Give one line description of each.
2. How is the size of a lathe specified? Explain with sketch.
3. What are different components mounted on the carriage of a lathe? Explain each component with

LABORATORY WORK CONTINUOUS ASSESSMENT RUBRIC

COURSE: **EXPT NO.:**

EVALUATOR: **DATE:**

STUDENT:

DIMENSION	**SCALE**			**SCORE 5 each**
	1	3	5	
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MIT-WORLD PEACE UNIVERSITY

F. Y. B. Tech

Trimester: I /II/III **Subject:** BASIC MECHANICAL ENGINEERING

Name ----------------------------- **Division ----**

Roll No --------------------------- **Batch ----**

Experiment No: 04

Name of the Experiment: Demonstration of Robot-Assisted Welding Process

Performed on: --

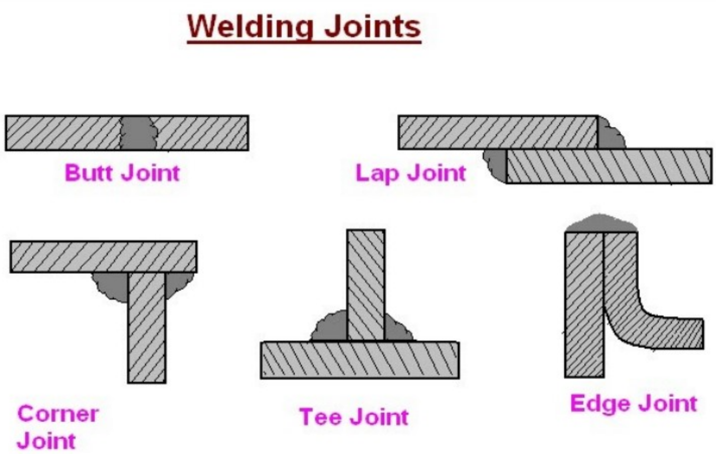
Submitted on: --

Introduction:

Welding is a fabrication process whereby two or more parts are fused together by means of heat and pressure. A strong joint is formed as the part cools. It is generally used on metals and thermoplastics.

The parts that are joined are known as parent metals. The base of the parent metal is melted and a filler material is added to help form the joint. A shielding gas is also required to protect the weld area from atmospheric gases. Different energy sources like gas flame, electric arc, laser, electron beam, friction, ultrasound, etc. are used for welding.

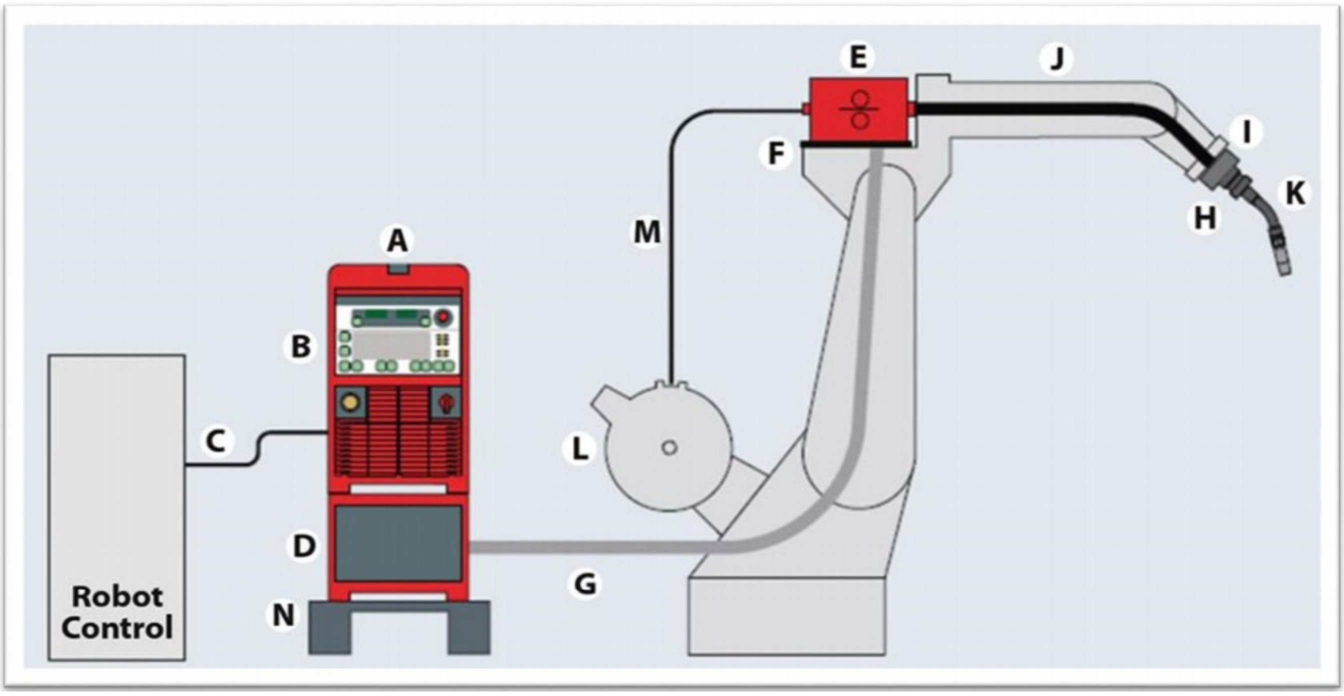
Different types of welding joints are as show in the figure below:



Need of Robotic Welding: Welding is a hazardous process and precautions are required to avoid burns, electric shocks, vision damage, inhalation of poisonous gases and fumes and exposure to radiations. Hence it is desirable to automate the process to require minimal human intervention.

What is Robotic Welding: Robotic welding is the complete automation of welding process by use of mechanized programmable tools. It can perform the welding and also handle the part by itself. This system has filled the gap due to shortage of labour and has improved the accuracy and the productivity. It has a wide range of application in automobile, manufacturing, fabrication, etc.

Components of Robotic Welding: The robotic welding system consists of a wide range of components working together to weld pieces. Some components may differ according to the type of welding operation.



The components of robotic welding machine are labelled in the diagram as follows:

• **Welding Power Source (A):** It provides the power to the system for working of all components. It size and capacity varies according to the requirement.

• **Welding Robot (J):** The robot is the main component that performs the welds. It has an arm that can move in three dimensions for rectilinear types and through more planes in articulating versions. Its selection depends upon its reach, weight – carrying capacity and speed of operation. It is equipped with various mechanical systems, electronic hardware, cables and sensors.

• **Robot Controller (B) and Interface (C):** The controller is the brain of the system. It has a software program that controls the Robot. It processes the data and gives instructions like parts movement, robot tooling, gripping, etc. The interface allows the user to set and monitor parameters that affect the weld.

• **Wire Feeder(E):** It supplies the wire to the torch for welding process. Its supply rate depends upon the speed of operation.

• **Torch(K):** It uses the power flowing in the electrode to heat up and join the materials together. Shielding apparatus and cooling unit (D) is also included in it.

- **Work Area:** The parts are placed and held here for the robot to weld.
- **Safety Features:** Robotic welding machine has safety features like fencing, access door, shields, alarms, interlocks, etc. to prevent any harm to operators and workers.
- **Wire Cleaner:** The cleaner is used to remove spatter from the torch between work cycles prolonging equipment life span.

Advantages of Robotic Welding over Manual Welding

- Increased efficiency due to longer working hours and high speed
- Better accuracy due to no human errors
- Less waste due to precision
- Enhanced Safety due to no direct human contact and safety features.
- Once installed, robotic welding are cost effective due to less man power requirement and more efficiency.

Disadvantages of Robot Welding over Manual Welding

- Very high investment cost for setting up the machinery
- Less flexibility due to fixed programs
- Not feasible for small projects and applications due to more cost and time to set up and program

Future of Robotic Welding

Since the market of manufacturing is continuously growing the demand for robotic welding is also increasing. There is immense scope for development in this field. Artificial intelligence and sensing may be embedded so that the robot would determine the parameters for welding. Collaborative robots may also be possible that work side by side with people to accomplish the task. But it may lead to decline in jobs for manual welders. Also, the investment cost may lower due to development in new technology making it more widely used.

Conclusion:

Robotics is playing a very important in improving our standard of living. It is becoming crucial in the manufacturing sector also to meet the new standards of accuracy, quality and speed. A substantial opportunity in technology exists to relive people from monotonous, repetitive work. Welding is a basic process with a widespread application. But manual Welding is a hazardous for the workers and also requires special skills. Hence, robotic welding is more sought out for nowadays though it cannot fully replace manual welding. It is transforming the industry towards a better future yet a lot more has to be explored in this field to make it feasible for all applications.

Questions:

1. Explain various types of welding joints with sketch.

2. Name 5 industries manufacturing robotic arms.

3. Write a short note on applications of robotic assisted welding.

LABORATORY WORK CONTINUOUS ASSESSMENT RUBRIC

COURSE: **EXPT NO.:**

EVALUATOR: **DATE:**

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MIT-WORLD PEACE UNIVERSITY

F. Y. B. Tech

Trimester: I /II/III **Subject:** BASIC MECHANICAL ENGINEERING

Name ----------------------------- **Division ----**

Roll No --------------------------- **Batch ----**

Experiment No: 05

Name of the Experiment: Demonstration of Robot-Assisted Automatic Conveyor System

Performed on: ---

Submitted on: ---

Aim: To study Conveyor Systems and Robot Assisted Material Systems

Theory: A conveyor system is a common piece of mechanical handling equipment that moves materials from one location to another. Conveyors are especially useful in applications involving the transport of heavy or bulky material. Conveyor systems allow quick and efficient transport for a wide variety of material, which make them very popular in the material handling and packaging industries. They also have popular consumer applications, as they are often found in supermarkets and airports, constituting the final leg of item/ bag delivery to customers. Many kinds of conveying systems are available and are used according to the various needs of different industries. There are chain conveyors (floor and overhead) as well. Chain conveyors consist of enclosed tracks, I-Beam, towline, power & free, and hand pushed trolleys.

Eg. Roller conveyor for carton transport in the apparel industry

Advantages of Conveyor Systems

Conveyor systems are used widespread across a range of industries due to the numerous benefits they provide.

Conveyors are able to safely transport materials from one level to another, which when done by human labor would be strenuous and expensive.

They can be installed almost anywhere, and are much safer than using a forklift or other machine to move materials.

They can move loads of all shapes, sizes and weights. Also, many have advanced safety features that help prevent accidents.

There are a variety of options available for running conveying systems, including the hydraulic, mechanical and fully automated systems, which are equipped to fit individual needs.

Design and Selection of Conveyor Systems

Conveyors can be linked together with other machinery to become an integral component of a processing or packaging line. The best way to accomplish this is to consider following variables to envisage how the conveyors should interact with the assembly line they are integrating with:

· What are the goals and objectives for processing/assembly line?

· What is the products that need to be moved?

· What is the weight, size and packaging of the products?

· What is the rate of production for the application (desired speed of the conveyors)?

· How are the conveyors going to integrate with other equipment/machinery on the line?

· Are there any product transfers involved?

· What is the projected product flow of the application (sorting, accumulation, curves, inclines, declines etc.)?

· What type of environment will the conveyor be operating in? If it will require cleaning, how extensive does that cleaning need to be?

· Will robotics be integrated with the conveyor system?

All components within an assembly automation application, including conveyors, should work together to best augment the overall operation. Answering those questions will help to take a critical look at the conveyor system to determine where improvements in product flow and handling can be made.

Industry Applications

Conveyor systems are commonly used in many industries, including the Mining, automotive, agricultural, computer, electronic, food processing, aerospace, pharmaceutical, chemical, bottling and canning, print finishing and packaging. Although a wide variety of materials can be conveyed, some of the most common include food items such as beans and nuts, bottles and cans, automotive components, scrap metal, pills and powders, wood and furniture and grain and animal feed. Many factors are important in the accurate selection of a conveyor system. It is important to know how the conveyor system will be used beforehand. Some individual areas that are helpful to consider are the required conveyor operations, such as transport, accumulation and sorting, the material sizes, weights and shapes and where the loading and pickup points need to be. Conveyors are built to required specifications to improve efficiency and output of production line.

Latest Trends in Conveyor Systems

1. Conveyors for Flexible Assembly lines: Modern production facilities show a growing trend of flexible assembly lines. Assembly lines need to be flexible to accommodate different applications. The supporting conveyor system needs to be just as flexible. Modular conveyors are mobile and can be easily moved from one line to another. The conveyor's guiding, transfers and other accessories may need to be adjusted.

2. Conveyors are continuing to play a greater role in robotic applications. Robotic movements are precise and exact – conveyors need to operate to that same level of accuracy. Robotic applications often require product to be in an exact spot on the conveyor at the right time. But to do that successfully requires a conveyor system that's efficient, reliable and engineered to work in conjunction with robotics. Servo motor precision move conveyors deliver accurate alignment of time and distance that provide indexing repeatability of +/- .040", all at a rate of 100 indexes per minute. It's important to select a conveyor to perfectly match the application requirements.

Robotic Material Handling and Tending:

Robotic material handling and tending systems are commonplace in the industrial sector. Material handling refers to robotic arms moving production parts, typically on or off a conveyor belt or to hold a part in place for production. Machine tending is similar, but more specific, referring to a robotic arm to load and unload a stationary production machine.

Both robotic material handling and machine tending systems are in high demand as they reliably deliver productivity gains in a wide range of applications.

The Benefits of Robotic Material Handling and Machine Tending Systems

Much of the benefits of these systems comes from drastically increased uptime. Manual material handling and tending is slow, inconsistent and less productive. Robots can work around the clock, besides small periods of downtime for maintenance, with high levels of consistency.

In addition to increased uptime, robots are typically much faster than manual processes. Decreasing the cycle time of a production part impacts productivity in a positive way. The benefit of shorter cycle times compounds over time and are extremely valuable to manufacturers.

Questions

1. What are the advantages of Robot assisted conveyor system over normal conveyor system?
2. Name two vendors for Robotic conveyor system.
3. What are the applications of Robotic conveyor systems?

LABORATORY WORK CONTINUOUS ASSESSMENT RUBRIC

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MIT-WORLD PEACE UNIVERSITY

F. Y. B. Tech

Trimester: I /II/III **Subject:** BASIC MECHANICAL ENGINEERING

Name ----------------------------- **Division** ----

Roll No --------------------------- **Batch** ----

Experiment No: 06

Name of the Experiment: Demonstration on Refrigeration Test Rig

Performed on: ---

Submitted on: --

Aim: To Study and understand the working principle and components of refrigerator.

Theory: Refrigeration is defined as an art of producing and maintaining temperature in a space below atmospheric temperature. A refrigerator is equipment used to remove the heat continuously from space (Sink) & maintain the temperature below atmospheric temperature and reject heat to the atmosphere (source).

Artificial methods of obtaining refrigeration can be enumerated as:

- Vapour compression cycle
- Vapour absorption cycle
- Air or Gas cycle refrigeration
- Steam jet refrigeration
- Non-conventional methods

The first two methods are used extensively on commercial basis. The first method i.e. "Vapour Compression Cycle" is most widely used system worldwide and we will limit our scope of study to this method only.

For obtaining refrigeration, heat is to be removed from a substance or space maintained at a lower temperature. In order to absorb this heat at lower temperature, the working medium, the refrigerant liquid, has to boil at the temperature lower than the space temperature so that it absorbs the latent heat from the refrigerated space. The heat exchanger placed inside the refrigerated space is called evaporator as the refrigerant liquid evaporates here. The pressure of the refrigerant liquid has to be low enough so that it can boil at lower temperature.

The vapour coming from the evaporator is at a low temperature and low pressure. In order to reuse the same refrigerant in the evaporator, it has to undergo a cyclic process. A compressor is used to raise the temperature and pressure. The compressor achieves two functions – it continuously sucks and removes vapour from the evaporator thus maintaining a low pressure in the evaporator, and it also raises the temperature and pressure of the vapour so that it can reject heat in the condenser.

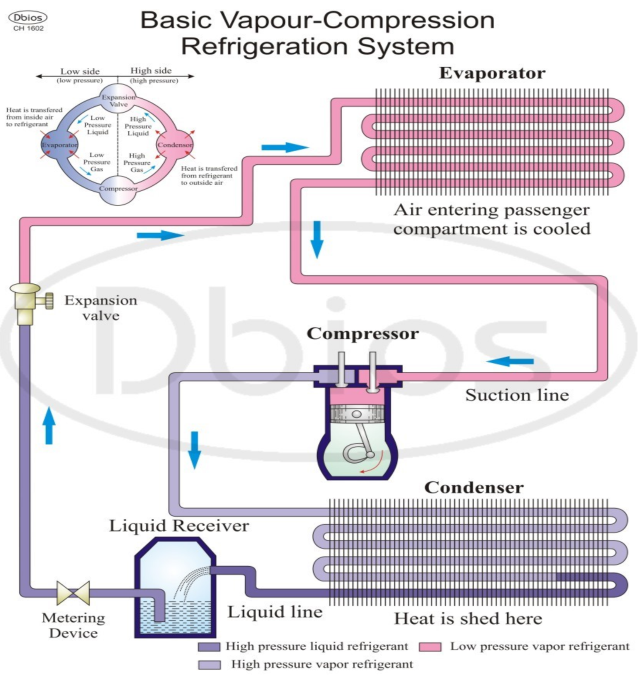
Due to high pressure after compression, the condensing temperature of the refrigerant increases above the surrounding ambient temperature. Condenser is also a heat exchanger like the evaporator. The high temperature high pressure vapour flows on one side and ambient air or water flows on the other side. The temperature of refrigerant vapour is higher than the surrounding medium (ambient air / water), so it rejects heat to this medium and gets cooled down to its saturation temperature and further rejection of heat condenses it to liquid. At the outlet of the condenser, the refrigerant is high temperature, high pressure liquid.

This high temperature high pressure liquid is made to flow through a restricted path which causes the pressure drop. Expansion device is the component used to create obstruction to flow of liquid and also to meter the refrigerant flow through the evaporator in response to varying load. The expansion device could be a capillary tube or a thermostatic expansion valve. When the high temperature high pressure liquid flows through the expansion device, its pressure drops to the evaporator pressure and the temperature also is lowered. The process occurs without any heat or work exchange and is called throttling. In throttling a small part of liquid is converted to vapour, this is called flashing.

This low temperature, low pressure liquid with a small amount of vapour enters the evaporator for extracting heat from low temperature surrounding. The cycle repeats.

Refrigeration Effect and COP

Refrigeration effect is the removal of heat from a body or space at low temperature. This occurs in evaporator. The amount of heat extracted at low temperature in the evaporator is called the refrigeration effect. Work is required to be done on the refrigerant to compress it. The net work input is the net work required for the compression. The performance of a refrigeration system can be evaluated by taking a ratio of refrigeration effect to net work input. This is termed as Coefficient of Performance or COP.



Theoretical Simple Saturated Vapour Compression Cycle

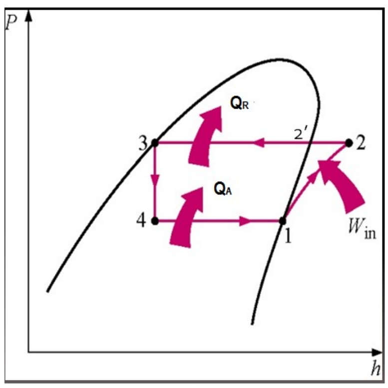
The four processes in a theoretical Vapour Compression Cycle are:

1-2: Reversible adiabatic or isentropic compression of refrigerant vapour.

2-3: Reversible heat rejection at constant pressure (condensation from vapour to liquid)

3-4: Irreversible expansion at constant enthalpy – (throttling)

4-1: Reversible heat absorption at constant pressure (evaporation from liquid to vapour)



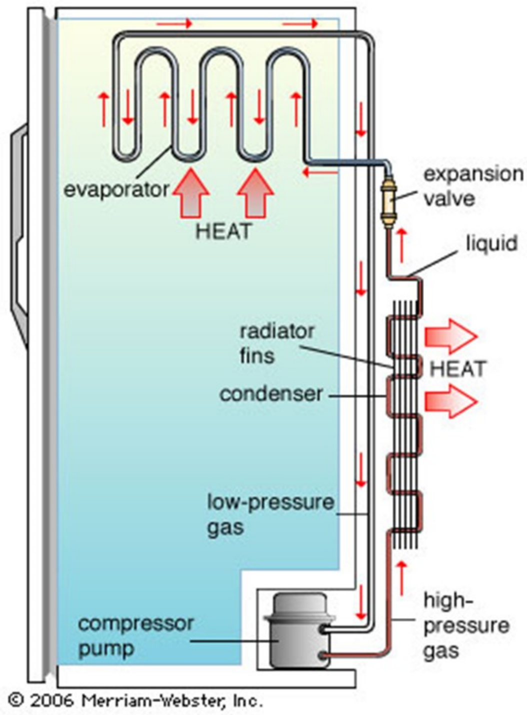
Heat rejected in condenser = QR = q2-3 = (h2-h3) …. on unit bass basis

Refrigeration effect = Heat absorbed in evaporator = QA = q4-1 = (h1-h4)

Net work input, Win = Heat rejected - Heat absorbed = QR - QA = (h2-h3) - (h1-h4) = (h2-h1)

COP = Refrigeration effect / Net work input = (h1-h4) / (h2-h1)

Domestic Refrigerator:



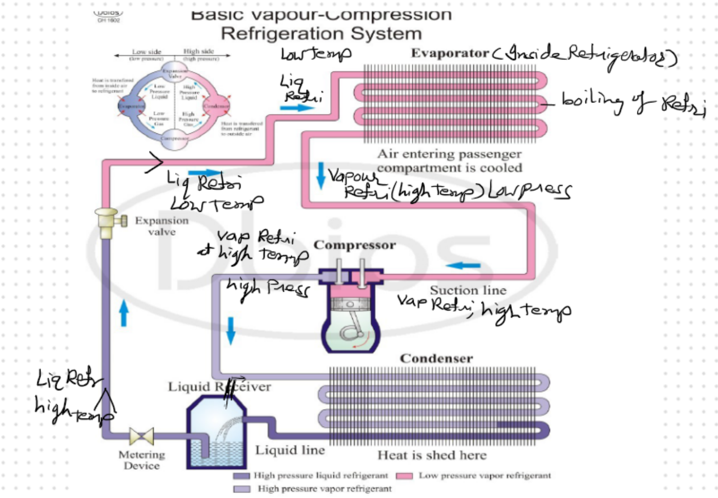
The basic components are
i) Evaporator
ii) Compressor
iii) Condenser
iv)Expansion device

The evaporator (part of the freezer cabinet) where the refrigerant (working fluid) evaporates absorbs the latent heat of vaporization. In modern frost free refrigerators, the evaporator is located outside the cabinet, as fan circulates air from evaporator to the freezer. Just below the freezer, there is a chiller tray. Further below are compartments with progressive higher temperature. The cold air being heavier flows down from the freezer to the bottom of the refrigerator. The warm air being lighter flows upward from vegetable box to freezer gets cooled & flows down again. Thus natural convection current is set up which maintains a temperature gradient between top & bottom of refrigerator

The temperature maintain in the freezer is - 15°C. The condenser is usually a wire & tube type mounted at the back of the refrigerator. Having no fan, the refrigerator vapor is condensed with the help of surrounding air which rises above by natural convection as it gets heated after absorbing the latent heat of condensation from refrigerant. After condensation, the high pressure liquid refrigerant is reduced to the low pressure of the evaporator by passing through liquid. Refrigerant is reduced to the low pressure of the evaporator by passing through an expansion device (throttle) valve or capillary tube and cycle is completed.

Questions

1. Define :Refrigerant, COP, Tons of Refrigeration
2. Explain with neat sketch the principle and working of household Refrigerator.
3. Explain with neat sketch the principle and working A/C.



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1 tonne of refrigeration is the rate of heat removal required to freeze a metric ton (1000 kg) of water at 0°C in 24 hours. Based on the heat of fusion being 333.55 kJ/kg, 1 tonne of refrigeration = 13,898 kJ/h = 3.861 kW.

MIT-WORLD PEACE UNIVERSITY

F. Y. B. Tech

Trimester: I /II/III   Subject: BASIC MECHANICAL ENGINEERING

Name ----------------------------   **Division ----**

Roll No ---------------------------   **Batch ----**

Experiment No: 07

Name of the Experiment: Trial on Reciprocating Compressor

Performed on: ---

Submitted on: ---

Aim: To calculate the compression ratio for the Air-compressor

About the compressor: An Air compressor is a device, which intakes the air from the atmosphere, compresses it and delivers it to a reservoir tank. It compresses the air by the means of a reciprocating piston, which reciprocates inside a cylinder. It can be single stage or multi stage. It can be single acting or double acting. Two-stage air compressor test rig consists of two cylinders and pistons and a reservoir tank. An A.C motor drives it. Thermometers are provided at inlets and outlets. To find out the inlet volume of air an orifice meter is provided. To stream line the intake a diaphragm base manifold is provided. Pressure gauge is provided at reservoir tank. Safety valve and auto power switch are provided for the safety of the operation.

Specifications:

MOTOR	3 H.P
MODEL	AB 7.75
COMPRESSOR	DOUBLE STAGE SINGLE ACTING
CLYINDER NO 1	DIAMETER 93.5mm, STROKE 78mm
ENERGY METER	3200 PULSES/kWh CONSTANT (EMC)

Theory: In two stages compressor air is partially compressed in low-pressure cylinder this air is passed through between the first stage and the second stage so that air at the inlet of the second stage is at lower temperature than the first stage outlet. This is done to reduce the work of compressor in second stage. Final compression is completed in the second stage. Also the compressors are provided with clearance volume, two stage compressors can achieve higher volumetric efficiency than a single stage compressor because of lower compression per stage. As the compressed air is used in a wide range in industrial, domestic, aeronautics Fields, etc. so compressors are applied in a wide range. Compressors are used where the air is required at high pressure.

UTILITIES REQUIRED

a. Electric supply: Single phase 220v AC, 50 Hz
b. Space required: 2.5 X1.5 X3.0 m

PROCEDURE

a. Close the outlet valve of tank and start compressor

b. Let the receiver pressure rise up to 2 Kg/cm^2, now open the delivery valve so that constant delivery pressure is achieved

c. Wait for some time and see that delivery pressure remains constant, now note down the pressure.

d. Record the energy meter pulses/time to find out the input power.

e. Record the manometer reading to find out the volume of air input.

f. Record the temperature of inlet and before second stage and after second stage

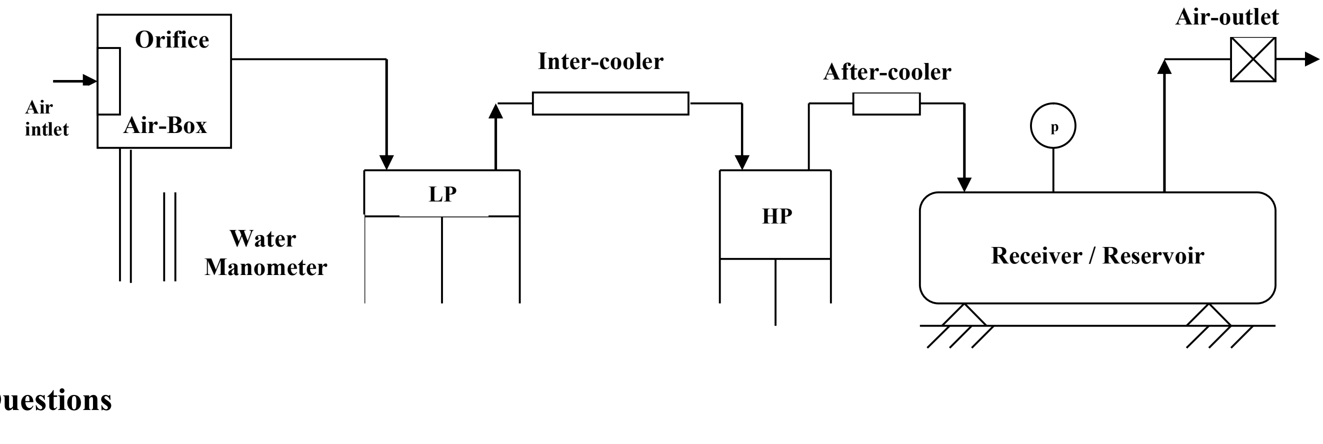
g. Find out the rpm of compressor with the help of rpm indicator.

h. Find out the volumetric efficiency and isothermal power by given formulae

i. Repeat the procedure for different delivery pressures

- The compression ratio of compressor, r = Gauge pressure + atmospheric pressure / Atmospheric pressure

Air Compressor Set-up



Questions

1. How the air compressors are classified?
2. What is volumetric efficiency of air compressor?
3. What is isothermal efficiency of air compressor?

- **LABORATORY WORK CONTINUOUS ASSESSMENT RUBRIC**

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MIT-WORLD PEACE UNIVERSITY

F. Y. B. Tech   Trimester: I /II/III

Subject: BASIC OF MECHANICAL ENGINEERING

Name ---   **Division** -----

Roll No ----------------------------   **Batch** -----

Experiment No: 08

Name of the Experiment: PELTON WHEEL & HYDRO-ELECTRIC POWER PLANT
Performed on: ---
Submitted on: ---

Aim: To Study operation of Pelton wheel for hydroelectric power generation

Objective

To understand working principle of Hydro-Electric power plant, layout of hydro-electrical power plant. To understand the working of different types of hydraulic turbine and its different component.

Theory

Overview:

In hydroelectric power plants the potential energy of water due to its high location is converted into electrical energy. The total power generation capacity of the hydroelectric power plants depends on the head of water and volume of water flowing towards the water turbine.

The hydroelectric power plant, also called as dam or hydropower plant, is used for generation of electricity from water on large scale basis. The dam is built across the large river that has sufficient quantity of water throughout the river. In certain cases where the river is very large, more than one dam can built across the river at different locations.

Working Principle of Hydroelectric Power Plant:

The water flowing in the river possesses two type of energy: the kinetic energy due to flow of water and potential energy due to the height of water. In hydroelectric power plants or dams potential energy of water is utilized to generate electricity.

The formula for total power that can be generated from water in hydroelectric power plant due to its height is given by : P = Q ρ g H η

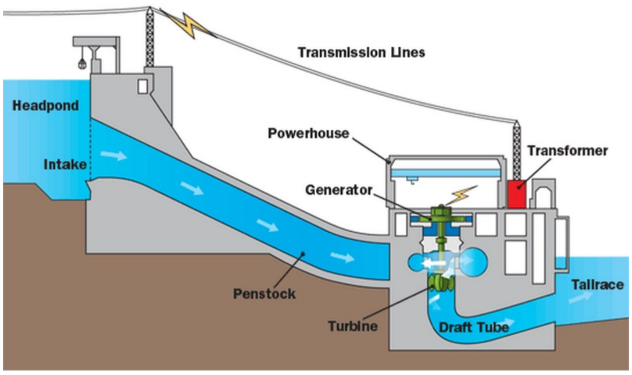
P = electric power in kVA
Q = flow rate in the pipe (m3/s)
ρ = density (kg/m3)
g = Acceleration of gravity (m/s^2)
H = waterfall height (m)
η = efficiency ratio (usually between 0,7 and 0,9)

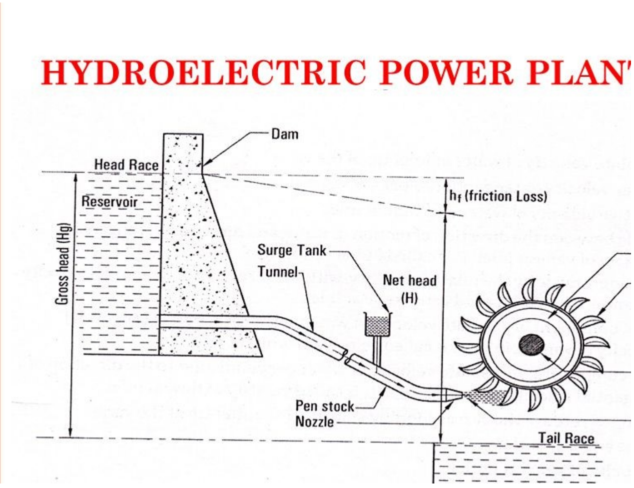
H is also called head of water. It is difference in height between the source of water (from where water is taken) and the water's outflow (where the water is used to generate electricity, it is the place near the turbines).

The formula clearly shows that the total power that can be generated from the hydroelectric power plants depends on two major factors: the flow rate of water or volume of flow of water and height or head of water. More the volume of water and more the head of water more is the power produced in the hydroelectric power plant.

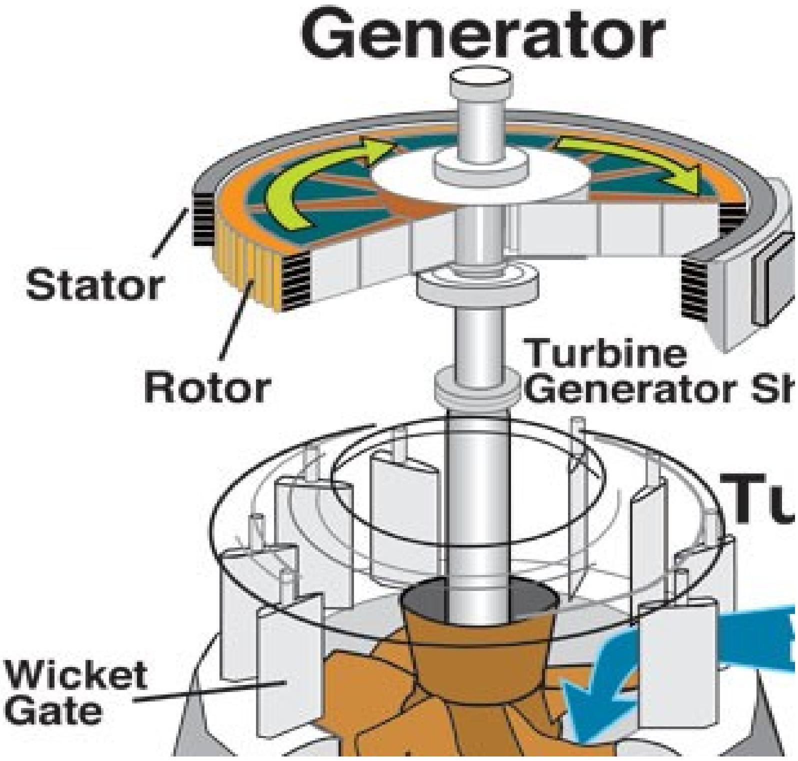
To obtain the high head of water the reservoir of water should as high as possible and power generation unit should be as low as possible. The maximum height of reservoir of water is fixed by natural factors like the height of river bed, the amount of water and other environmental factors. The location of the power generation unit can be adjusted as per the total amount of power that is to be generated. Usually the power generation unit is constructed at levels lower than ground level so as to get the maximum head of water.

The total flow rate of water can be adjusted through the penstock as per the requirements. If more power is to be generated more water can be allowed to flow through it.



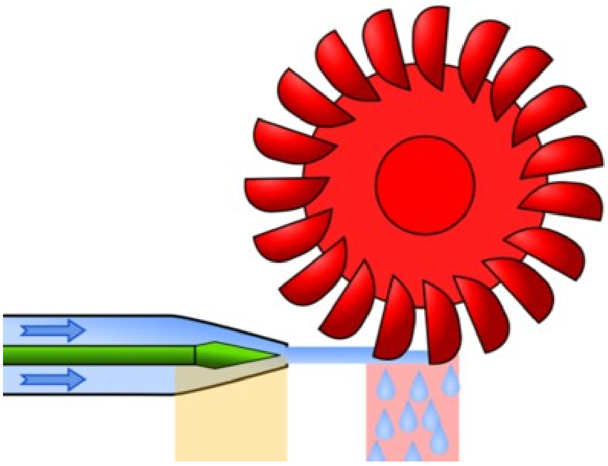


Schematic Diagram of a conventional hydroelectric dam



A typical Kaplan Turbine and Electricity Generator


Pelton Turbine


A Schematic Diagram : Pelton Wheel

Pelton Turbine

A Pelton turbine or Pelton wheel is a type of hydro turbine (specifically an impulse turbine) used in hydroelectric plants. These turbines are generally used for sites with heads greater than 300 meters. The water in the dam flows through the penstock to specialized nozzle. In the nozzle the entire pressure head (potential head) is converted into kinetic energy. The water jet emerging out of the nozzle impinges on the blades (buckets) of the turbine. The direction of water jet is changed by almost 180 degrees due to the shape of the buckets. The velocity of water jet becomes zero and it falls down after striking the buckets. Due to this the entire kinetic energy is converted in to mechanical energy at shaft. The shaft is connected to an electricity generator to produce electricity.

To prevent irregularities in pressure, the penstock is fitted with a surge tank that absorbs sudden fluctuations in water that could alter the pressure. As this turbine rotates due to striking action of high speed jet, the Pelton turbine is known as an impulse turbine.

Layout of Hydroelectric 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. The different parts of a hydroelectric power plant are:

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 Tunnel**: 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.
   - Pressure Shaft/penstock is enclosed pipe/channel used to deliver/feed water to hydraulic turbines in respect of hydro power plant.

- Pressure tunnels must be kept far below the lowest possible hydraulic gradient to avoid, the creation of vacuum and the consequent risks of unstable flow, cavitation and collapse of lining.
- Total friction losses in the tunnel must not be great enough to impair the output and the regulation of machines.

4. **Power house**: Power house is a station for generation of electricity. It houses equipment and personnel working in a power generating station. Essential components of the power house are:
   a) Machine hall.
   b) Unloading and erection bay.
   c) Annexes or Extensions
   d) Passages or ducts for cables, bus-bars and pipes
   e) Control room
   f) Workshop
   g) Storage space
   h) Office and administrative accommodation.
5. **Generating Equipment**:
   Estimating total capacity of Plant:
   i. Head Available: Firm and Secondary Power
   ii. Load Factor: Industrial and Domestic Load
   iii. Cost Estimate: Capital Charges + Depreciation + O&M
   iv. Revenue to be expected.

   Estimating No. of Generating Sets:
   i. Cost of Initial Installation.
   ii. Cost of Operation.
   iii. Reliability of Supply.
      a. Isolated distribution system
      b. Interconnected system.
   iv. Shaft arrangement
   v. Auxiliary plant

6. Hydro turbines

Classified into two categories:

Impulse Turbine: (Pelton Wheel)

i. Uses the velocity of water to move the runner & discharges to atmospheric pressure.
ii. The water stream hits each bucket on the runner.
iii. There is no suction on the down side of the turbine.
iv. Water flows out the bottom of the turbine housing after hitting the runner.
v. Generally suitable for high head, low flow applications.

Reaction Turbine: (Francis Turbine, Kaplan Turbine)

i. Develops power from the combined action of pressure and moving water
ii. Runner is placed directly in the water stream flowing over the blades rather than striking each individually
iii. Used for sites with lower head and higher flows

Types of Hydro-electric Power Plants:

Conventional Power Plants:

Most hydroelectric power comes from the potential energy of dammed water driving a water turbine and generator. The power extracted from the water depends on the volume and on the difference in height between the source and the water's outflow. This height difference is called the head. The amount of potential energy in water is proportional to the head. To deliver water to a turbine while maintaining pressure arising from the head, a large pipe called a penstock may be used.

Pumped-Storage Power Plant:

This method produces electricity to supply high peak demands by moving water between reservoirs at different elevations. At times of low electrical demand, excess generation capacity is used to pump water into the higher reservoir. When there is higher demand, water is released back into the lower reservoir through a turbine. Pumped-storage schemes currently provide the most commercially important means of large-scale grid energy storage and improve the daily capacity factor of the generation system.

Run-of-the-river Power Plant:

Run-of-the-river hydroelectric stations are those with comparably smaller reservoir capacities, thus making it impossible to store water.

Tidal Power Plant:

A tidal power plant makes use of the daily rise and fall of water due to tides; such sources are highly predictable, and if conditions permit construction of reservoirs, can also be dispatchable to generate power during high demand periods. Less common types of hydro schemes use water's kinetic energy or undammed sources such as undershot waterwheels.

Advantages & Disadvantages of Hydro-Electric Power Plants

Advantages:

- Renewable, non-radioactive & non-polluting source of Energy
- Reliable, clean and efficient Energy Source.
- Low cost of generation
- Low operation & maintenance charges
- Inherent ability for quick starting, stopping & instantaneous load acceptance/ rejection
- Meet peak load requirement.
- Avoided Green House Gas (GHG) emissions from equivalent thermal and other fuel based power projects
- Increase in Agriculture Productivity through development of irrigation and multipurpose schemes
- Flood Mitigation through large storage dams

Disadvantages:

- Ecosystem damage and loss of land
- Siltation
- Flow shortage
- Methane emissions (from reservoirs)
- Relocation
- Failure hazard

Questions

1. Draw the line diagram of hydro-electric power plant.
2. For a hydroelectric power plant the available head is 200 m, water flow rate is 500 m3/sec and operating efficiency is 90%. How much power is generated?
3. What are the disadvantages of hydroelectric power plants?

LABORATORY WORK CONTINUOUS ASSESSMENT RUBRIC

- **COURSE:** **EXPT NO.:**
- **EVALUATOR:** **DATE:**
- **STUDENT:**

DIMENSION	**SCALE**			**SCORE 5 each**
	1	3	5	
Regularity and punctuality	Not attentive during practical session. Not particular about timely submission. Submission delayed more than 3 days.	Attentive during practical session but not punctual in submission. Submission late by up to 3 days.	Attentive during practical session and punctual about submission. Submission on or before due date	
Understanding the Objective of experiment.	Does not show any understanding of the objective and cannot relate it to an appropriate theory topic No sketches or no / improper description.	Understands objective but cannot place it in context of a theory topic. Some questions not satisfactory. Incomplete or incorrect sketches or improper description.	Understands objective and can relate it to an appropriate theory topic. Answers all the questions satisfactorily. Completes the assignment with neat sketches wherever necessary and proper description.	
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			Total out of 15	

MIT-WORLD PEACE UNIVERSITY

F. Y. B. Tech

Trimester: I /II/III **Subject:** BASIC MECHANICAL ENGINEERING

Name ----------------------------- **Division ----**

Roll No --------------------------- **Batch ----**

Experiment No: 09

Name of the Experiment: Energy Audit of Anyone of the Laboratories/Residence

Performed on: ---

Submitted on: ---

Aim: To conduct energy audit of laboratories for Energy Assessment and Savings Opportunity Identification.

Objective:

1) Describe the theoretical framework for a building audit.
2) Develop a building audit plan and schedule
3) Obtaining a detailed idea about the various end use energy consumption activities and identifying, enumerating and evaluating the possible energy savings opportunities.
4) To minimize energy costs / waste without affecting production & quality

Theory: In any industry, the three top operating expenses are often found to be energy (both electrical and thermal), labour and material. If one were to relate to the manageability of the cost or potential cost savings in each of the above components, energy would invariably emerge as a top ranker, and thus energy management function constitutes a strategic area for cost reduction. Energy Audit will help to understand more about the ways energy and fuel are used in any industry, and help in identifying the areas where waste can occur and where scope for improvement exists. The Energy Audit would give a positive orientation to the energy cost reduction, preventive maintenance and quality control programs which are vital for production and utility activities. Such an audit programme will help to keep focus on variations which occur in the energy costs, availability and reliability of supply of energy, decide on appropriate energy mix, identify energy conservation technologies, retrofit for energy conservation equipment etc. In general, Energy Audit is the translation of conservation ideas into realities, by lending technically feasible solutions with economic and other organizational considerations within a specified time frame. The primary objective of Energy Audit is to determine ways to reduce energy consumption per unit of product output or to lower operating costs. Energy Audit provides a “bench-mark" (Reference point) for managing energy in the organization and also provides the basis for planning a more effective use of energy throughout the organization.

Thus Energy Audit can be classified into the following two types.

A) Preliminary Audit

B) Detailed Audit

Preliminary Audit

Preliminary energy audit is a relatively quick exercise to:

• Establish energy consumption in the organization
• Estimate the scope for saving
• Identify the most likely (and the easiest areas for attention
• Identify immediate (especially no-/low-cost) improvements/ savings
• Set a 'reference point'
• Identify areas for more detailed study/measurement
• Preliminary energy audit uses existing, or easily obtained data

Detailed Energy Audit

A comprehensive audit provides a detailed energy project implementation plan for a facility, since it evaluates all major energy using systems. This type of audit offers the most accurate estimate of energy savings and cost. It considers the interactive effects of all projects, accounts for the energy use of all major equipment, and includes detailed energy cost saving calculations and project cost. In a comprehensive audit, one of the key elements is the energy balance. This is based on an inventory of energy using systems, assumptions of current operating conditions and calculations of energy use. This estimated use is then compared to utility bill charges. Detailed energy auditing is carried out in three phases: Phase I, II and III.

Phase I - Pre Audit Phase
Phase II - Audit Phase
Phase III - Post Audit Phase

Phase I -Pre Audit Phase Procedure

- To finalize Energy Audit team
- To identify the main energy consuming areas/plant items to be surveyed during the audit
- To identify any existing instrumentation/ additional metering required.

- To decide whether any meters will have to be installed prior to the audit. Eg. kWh, steam, oil or gas meters.
- To identify the instrumentation required for carrying out the audit.
- To plan with time frame
- To collect macro data on plant energy resources, major energy consuming centers
- To create awareness through meetings/ programme

Phase-II Audit Phase Procedure

- Preliminary Client Meeting and Historical Data Analysis
- Conduct a Walk-through Inspection
- Analyze Energy Consumption and Costs
- Compare Energy Performance
- Establish the Audit Scope
- Profile Energy Use Patterns
- Identify Energy Management Opportunities
- Assess the Benefits
- Report for Action

Instrumentation for auditing

- Electric Power Meter
- Lux meter
- Combustion Analyzer
- Digital Thermometer
- Psychrometer (Humidity Measurement)
- Air Flow Measurement Devices
- Tachometer

The Economic viability often becomes the key parameter for the management acceptance. The economic analysis can be conducted by using a variety of methods. Example: Pay back method, Internal Rate of Return method, Net Present Value method etc. For low investment short duration measures, which have attractive economic viability, simplest of the methods, payback is usually sufficient. A sample worksheet for assessing economic feasibility is provided below:

Conclusion: We have studied and understood the meaning of energy audit, types of energy audit and significance of energy audit.

Assignment: (PBL) Conduct preliminary energy audit for your residence & cross check with your monthly Electricity bill.

- **LABORATORY WORK CONTINUOUS ASSESSMENT RUBRIC**

- **COURSE:** **EXPT NO.:**
- **EVALUATOR:** **DATE:**
- **STUDENT:**

DIMENSION	**SCALE**			**SCORE 5 each**
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MIT-WORLD PEACE UNIVERSITY

F. Y. B. Tech

Trimester: I /II/III **Subject:** BASIC MECHANICAL ENGINEERING

Name ----------------------------- **Division ----**

Roll No --------------------------- **Batch ----**

Experiment No: 10

Name of the Experiment: Visit to Biogas Power Plant

Performed on: ---

Submitted on: --

AIM : To Study Working Operation of Biogas Plant for Waste recycling.

Objectives: To understand the working principle of a biogas plant and study how biodegradable waste can be used to produce useful Fuel using Biogas Plant. To understand the working of different components used in Biogas plants.

Theory: Biomass in any form is ideal for the bio-methanation concept, which is the central idea of the Bio Energen - biogas plants. Major components of a Biogas plant include a mixer/ pulper for crushing solid waste, a pre-mix tank/ a pre-digester tank, an air compressor, a solar water heater, a main digestion tank, manure pits, a tank for recycling water, a water pump and gas utilization system.

The segregated biodegradable waste will be shredded through a mixer and converted into slurry from a slurry preparation tank. The slurry is aerobically digested for a limited period of time (48-72 hours). The partially digested slurry then flows into an aerobic anaerobic digester. The internal baffle system ensures three-phase separation into solid, liquid and biogas. The solids settle down at the bottom of the digester and are almost completely digested. The liquid overflows into the recycle chamber, which is partly recycled. The biogas is collected into a gas holder, and then used for cooking feed. The digesters are totally covered and this being an aerobic digestion plant, there is no foul odour at the plant site.

PROCESS DESCRIPTION

Feed Preparation Unit:

Segregation Platform- The biodegradable waste collected from the city/Factory/ complex etc. shall be delivered to feed preparation unit consisting of fine segregation unit where all the material received at plant site will be segregated to remove non- biodegradable matter such as plastics, glass, metals, coconut and egg shells etc. The segregated biodegradable waste will be mixed with fresh water in desired concentration of 23-35% solids. The feed will be crushed in the mechanical mixer to make the uniform flow-able slurry of the biodegradable waste. The mixing serves the following objectives.

1. To prepare feedstock with uniform characteristics.
2. To prepare feedstock of desirable concentration.
3. To prevent settling of solids in the tank.

Mechanical Mixer- A mixer, tungsten carbine steel tips incorporated with unique chopper plate to cut fibrous material without clogging is used for making the slurry paste and additional mixing.

High Rate Anaerobic Digestion

The Principle: the basic concept of Bio gas plant Design is based on a dual process employing partial aerobic digestion followed by anaerobic digestion. This process is specifically developed by BARC for treating biodegradable waste. A major impediment in anaerobic digestion of organic solids has been inability of digesters to minimize to maintain optimum concentration of suspended solids for biomethanation fermentation process. The biomethanation of organic solids proceeds in three distinctive stages namely;

- Hydrolysis of organic solids
- Acidification of hydrolyzed products
- Biomethanation of acidified slurry

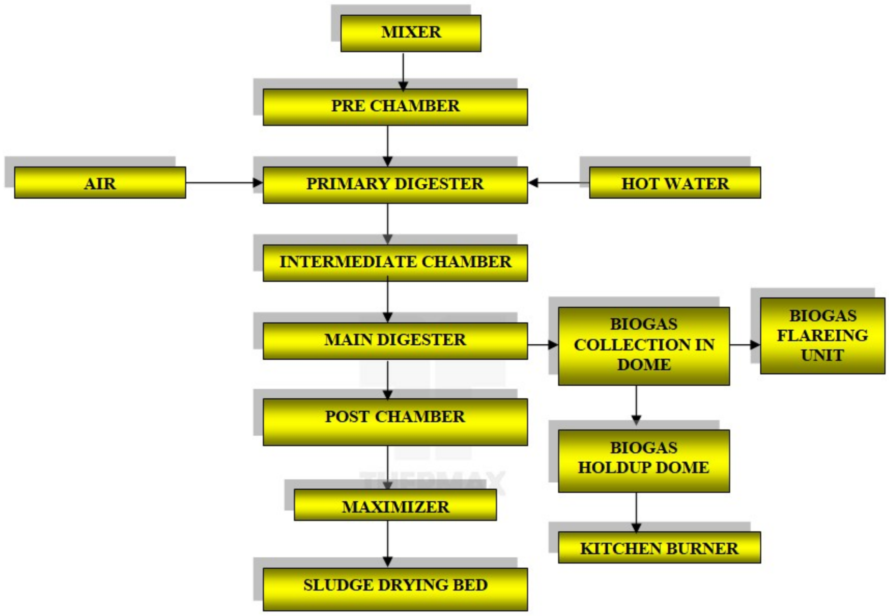
Biogas Storage Section

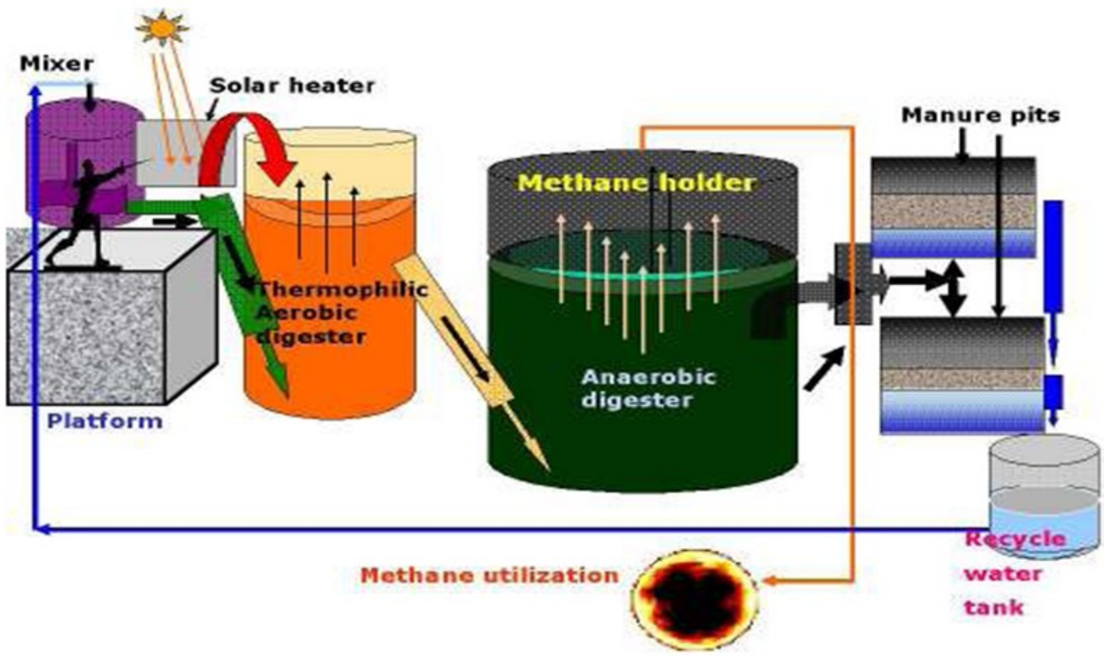
- Biogas Storage: the biogas generated in the digester will be stored in MS gas holder mounted on the digesters. It is mounted on top of the digester and along its periphery. The inlet and outlet connections are provided at the bottom of the gas holder. The gas is stored in the gas holder at NTP conditions. Suitable moisture traps and valves are used to remove the moisture.

Organic manure production Section: The outlet coming slurry from the digester will be dewatered in the slurry beds. The sludge drying beds are made in brickwork. The two sections of sludge drying beds are made alternatively. The dried residue is directly used as organic manure and the separated water will go to the recycling chamber.

Gas Utilization System: The biogas generated can be used for cooking. It will have all the standard requisite accessories and the prices will be extra depending on the type of utilization.

PROCESS BLOCK DIAGRAM





Description	Qty.	Size / Capacity	Moc	Kw	Make
Mixer	1 NO	Suitable	Blade – SS304	2.2	Crush all
Main Digester Dome	1 NO	Dia. 3.96m × 2.0m	MS-FRP	--	Thermax
Solar System	1 NO	300 LPD Cap.	--	--	TATA BP
Auxiliary Heating (Standby System)	1 NO	300 LPD Cap.	--	--	TATA BP
Over Head Tank	1 NO	300 ltr	LDPE	--	Perfect
Compressor	1 NO	4.90 M3/HR	CI	2.2	Ingersoll Rand
Air grid for pre-digester	1 LOT	Suitable	HDPE	--	Thermax approved vendor
Biogas Holdup Dome	1 NO	Dia. 3.86 m x 2.5 m	MS-FRP	--	Thermax
Flow meter	1NO	10m3/hr	--	--	Pune gas
Biogas Flareing Unit	1 NO	10m3/hr	--	--	Energy Equipment and System
Biogas Burner	1 NO	5 m3/hr	Steel Body	--	J.K. Engg
Maximizer	1 NO	50 m3/hr	--	--	Thermax
Piping for Carrying Biogas up to Kitchen burner	2 NO	12 mts.	CI	--	Thermax approved vendor

Questions:

1. What is meant by the renewable and non-renewable energy sources? List various sources under each category.
2. What is the share of various primary energy sources in India? How the energy is consumed for various sectors in India? Show a pie chart.
3. What are the main components of biogas power plant and their functions?

- **LABORATORY WORK CONTINUOUS ASSESSMENT RUBRIC**

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MIT-WORLD PEACE UNIVERSITY

F. Y. B. Tech

Trimester: I /II/III **Subject:** BASIC MECHANICAL ENGINEERING

Name ----------------------------- **Division ----**

Roll No --------------------------- **Batch ----**

Experiment No: 11

Name of the Experiment: Working and Operation of Boiler /Thermal Power Plant

Performed on: ---

Submitted on: ---

Aim: To study different components of boiler and its significance in a thermal power plant

Objective: To understand working of boiler and its significance in a thermal power plant

Boiler and Auxiliaries: A Boiler or steam generator essentially is a container into which water can be fed and steam can be taken out at desired pressure, temperature and flow. This calls for application of heat on the container. For that the boiler should have a facility to burn a fuel and release the heat. The functions of a boiler thus can be stated as:-

1) To convert chemical energy of the fuel into heat energy
2) To transfer this heat energy to water for evaporation and to steam for superheating.

The basic components of Boiler are: -

1) Furnace and Burners
2) Steam and Superheating

We have used a Sterling boiler manufactured by M/s. LIPI Boilers (P) Ltd, Aurangabad with steam turbine to conduct trials. The specifications of the plant are as follows:

Type of Boiler: Water tube with a superheater and economizer

1) Steam Pressure – 10 bar
2) Steam Temperature – 250 °C (Superheated)
3) Capacity – 1000 kg/hr
4) Fuel Used – Light Diesel Oil

5) Water Drum : Length – 1730 mm, Diameter – 760 mm
6) Steam Drum - Length – 1730 mm, Diameter - 760 mm
7) Boiler Heating Surface Area – 41 m^2

Economiser: It is located near the steam drum in the boiler. It is there to improve the efficiency of boiler by extracting heat from flue gases to heat water and send it to boiler drum.

Advantages of Economiser include

1) Fuel economy: – used to save fuel and increase overall efficiency of boiler plant.
2) Reducing size of boiler: – as the feed water is preheated in the economiser and enter boiler tube at elevated temperature. The heat transfer area required for evaporation reduced considerably.

Economiser Specifications:
- Maximum working pressure – 13.5 bar
- Maximum temperature of water – 5 °C
- Heating surface area – 8.78 m^2

Superheater: It is also located near the steam drum in the boiler. It converts the saturated steam to dry steam. It is used increase efficiency by extracting heat from the flue gases to heat the saturated steam.

Advantages of a superheater include

1) Reduced fuel consumption – saves the fuel that would be required to convert the saturated steam to dry steam.
2) Reduced water consumption – Dry steam produces more useful work. Thus this permits the reduction in required mass flow rate of steam consequently a reduction in supply water.

Superheater Specifications

1) Superheater safety valve pressure – 10.5 bar
2) Superheater outlet temperature – 250 °C
3) Superheater heating surface area – 4 in^2

Fan or draught system:

In a boiler it is essential to supply a controlled amount of air to the furnace for effective combustion of fuel and to evacuate hot gases formed in the furnace through the various heat transfer area of the boiler. This can be done by using a chimney or mechanical device such as fans which acts as pump.

i) Natural draught: When the required flow of air and flue gas through a boiler can be obtained by the stack (chimney) alone, the system is called natural draught. When the gas within the stack is hot, its specific weight will be less than the cool air outside; therefore the unit pressure at the base of stack resulting from weight of the column of hot gas within the stack will be less than the column of extreme cool air. The difference in the pressure will cause a flow of gas through opening in base of stack. Also the chimney is form of nozzle, so the pressure at top is very small and gases flow from high pressure to low pressure at the top.

ii) Mechanized draught: There are 3 types of mechanized draught systems

1) **Forced draught system:** In this system a fan called Forced draught fan is installed at the inlet of the boiler. This fan forces the atmospheric air through the boiler furnace and pushes out the hot gases from the furnace through superheater, reheater, economiser and air heater to stacks.
2) **Induced draught system:** Here a fan called ID fan is provided at the outlet of boiler, that is, just before the chimney. This fan sucks hot gases from the furnace through the superheaters, economiser, reheater and discharges gas into the chimney. This results in the furnace pressure lower than atmosphere and affects the flow of air from outside to the furnace.
3) **Balanced draught system:** In this system both FD fan and ID fan are provided. The FD fan is utilized to draw control quantity of air from atmosphere and force the same into furnace. The ID fan sucks the product of combustion from furnace and discharges into chimney. The point where draught is zero is called balancing point.

- **Steam Turbine: :**Steam turbines have been used predominantly as prime mover in all thermal power stations. The steam turbines are mainly divided into two groups: -
  1. Impulse Turbine
  2. Impulse-Reaction Turbine

     Our setup uses an impulse turbine with a maximum power delivery capacity of 3kW
- **Condenser:** The condenser condenses the steam from the exhaust of the turbine into liquid to allow it to be pumped. If the condenser can be made cooler, the pressure of the exhaust steam is reduced and efficiency of the cycle increases. The functions of a condenser are:-

  1) To provide lowest economic heat rejection temperature for steam.

  2) To convert exhaust steam to water for reserve thus saving on feed water requirement.

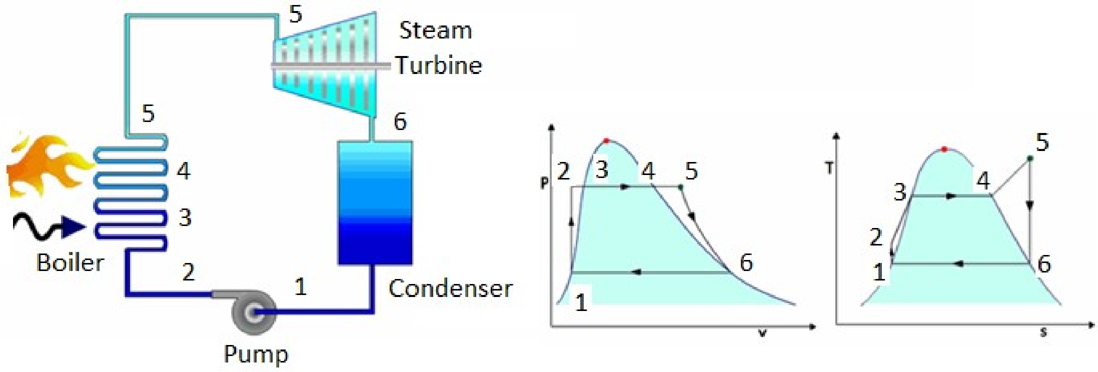
  3) To introduce make up water.

  We have in use a shell and tube type condenser.

Thermal Power Plant

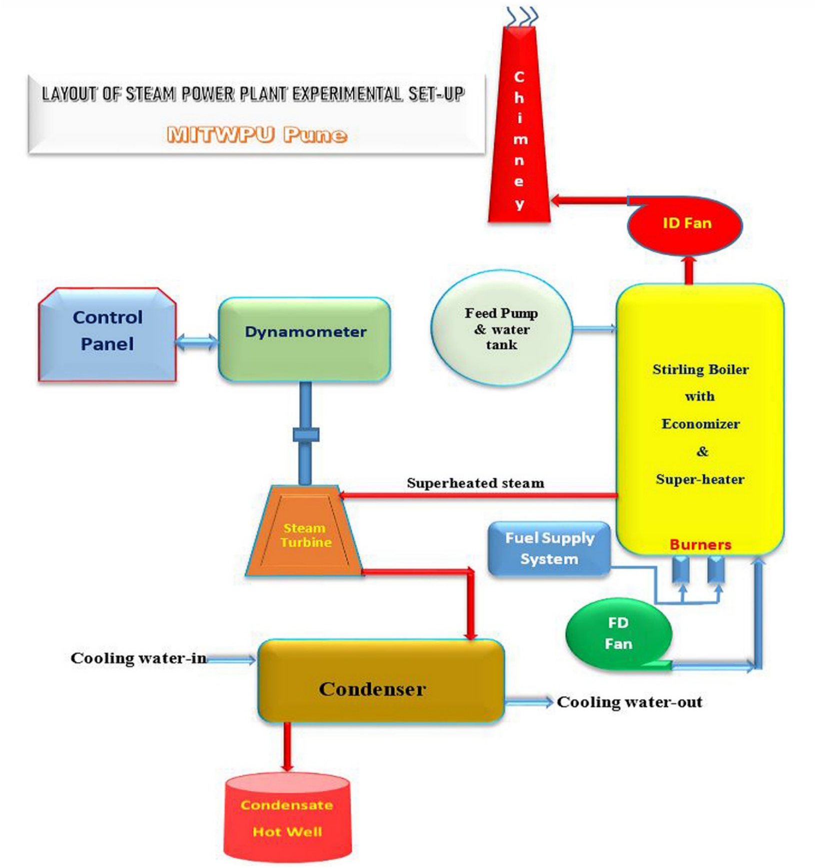
Thermal power plant is the most conventional source of electric power generation. At present about 55% of total electricity production in India is from Coal Based Thermal Power Stations. A coal based thermal power plant converts the chemical energy of the coal into electrical energy. This is achieved by burning coal in the furnace releasing the heat of combustion, which raises steam in the boiler, the high pressure high temperature steam is expanded through the turbine rotating it which is coupled to a generators converting mechanical energy into electrical energy.

The working fluid in the thermal power plant is water / steam. The ideal thermodynamic cycle for the thermal power plant is Rankine Cycle. Referring to fig.1, the process 1-2 is pumping water from condenser pressure to boiler pressure. In boiler the water is heated at constant pressure first to saturation temperature (process 2-3), then it is converted into steam (phase transformation process 3-4) and then it is superheated (process 4-5). The superheated steam then expands in turbine from boiler pressure to condenser pressure (process 5-6) producing mechanical work. The saturated or unsaturated steam coming from turbine condenses in the condenser (process 6-1). The turbine is coupled with generator converting the mechanical energy into electrical energy



Important components of Thermal Power Plant:

1. Boiler
2. Steam Turbine
3. Condenser
4. Pump



Questions: Make a group presentation (PPT) with 3 slides on any one of the following topics

1. Advantages of Thermal Power Plants .
2. Disadvantages of Thermal Power Plants.
3. Heat recovery system in Thermal Power Plants.

- **LABORATORY WORK CONTINUOUS ASSESSMENT RUBRIC**

- **COURSE:** **EXPT NO.:**
- **EVALUATOR:** **DATE:**
- **STUDENT:**

DIMENSION	**SCALE**			**SCORE 5 each**
	1	3	5	
Regularity and punctuality	Not attentive during practical session. Not particular about timely submission. Submission delayed more than 3 days.	Attentive during practical session but not punctual in submission. Submission late by up to 3 days.	Attentive during practical session and punctual about submission. Submission on or before due date	
Understanding the Objective of experiment.	Does not show any understanding of the objective and cannot relate it to an appropriate theory topic No sketches or no / improper description.	Understands objective but cannot place it in context of a theory topic. Some questions not satisfactory. Incomplete or incorrect sketches or improper description.	Understands objective and can relate it to an appropriate theory topic. Answers all the questions satisfactorily. Completes the assignment with neat sketches wherever necessary and proper description.	
Initiative and Analysis	Incomplete work. No initiative to find answers. Not able to analyze the available answers for correctness.	Completes the assignment. Finds out answers from available sources – books, web, friends. Can't decide correctness of the information available.	Completes the assignment. Takes initiative to find out answers from available sources – books, web. Ability to find correct answer.	
			Total out of 15	