BrownHills
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Bachelor of Technology (B.Tech)
(1st year)

Elements of Mechanical Engineering
(E.M.E - Lab. Manual)

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Experiment No. 1

Objective: To study about various types of Mounting and Accessories of Boilers.

Introduction

Boiler: It is a closed vessel in which steam is produced from water by combustion of fuel.

Classification of Boilers:

1. According to their Axis (Horizontal, Vertical or Inclined)

   i. If the axis of the boiler is horizontal, the boiler is called as horizontal.
   ii. If the axis is vertical, it is called vertical boiler.
   iii. If the axis is inclined it is known as inclined boiler.

2. Fire Tube and Water Tube

   i. In the fire tube boilers, the hot gases are inside the tubes and the water surrounds the tubes, Examples: Cochran, Lancashire and Locomotive boilers.
   ii. In the water tube boilers, the water is inside the tubes and hot gases surround them, Examples: Babcock and Wilcox boiler.

3. Externally Fired and Internally Fired

   i. The boiler is known as externally fired if the fire is outside the shell, Examples: Babcock and Wilcox boiler.
   ii. The furnace is located inside the boiler shell, Examples: Cochran, Lancashire boiler etc.

4. Forced Circulation and Natural Circulation

   i. In forced circulation type of boilers, the circulation of water is done by a forced pump.
   ii. In natural circulation type of boilers, circulation of water in the boiler takes place due to natural convention currents produced by the application of heat, Examples: Lancashire, Babcock and Wilcox boiler etc.

5. High Pressure and Low Pressure Boilers

   i. The boilers which produce steam at pressures of 80 bar and above are called high pressure boilers, Examples: Babcock and' Wilcox boilers.
   ii. The boilers which produce steam at pressure below 80 bar are called low pressure boilers, Examples: Cochran, Lancashire and Locomotive boilers.

6. Stationary and Portable

   i. Stationary boilers are used for power plant-steam, for central station utility power plants, for plant process steam etc.
   ii. Mobile boilers or portable boilers include locomotive type, and other small units for temporary use at sites (Large Ships).

7. Single Tube and Multi-tube Boilers

The fire tube boilers are classified as single tube and multi-tube boilers, depending upon whether the fire tube is one or more than one.

Boiler Mountings: These are the fitting and devices which are necessary for the operation and safety of a boiler.

Boiler Accessories: These are auxiliary plants required for steam boilers for the proper operation and for the increase of their efficiency.

Types of Mountings:

- Safety valves
- Water level indicator
- A pressure gauge
- A steam stop valve
- A feed check valve
- A Fusible plug
- A blow-off cock

Types of Accessories:

- Feed pumps
- Injector
- Economiser
- Air preheater
- Superheater
- Steam separator

Mountings:

1. **SAFETY VALVES**: It is use for release the excess steam when the pressure of steam inside the boiler exceeds the rated pressure. Types of safety valve are the following:
   - Dead weight safety valve
   - Lever safety valve
   - Spring loaded safety valve
   - Gravity safety valve

2. **WATER LEVEL INDICATOR**: It is use to indicate the level of water in the boiler constantly.

3. **PRESSURE GAUGE**: It is use to measure the pressure exerted inside the vessel.

4. **STEAM STOP VALVE**: It is use to regulate the flow of steam from the boiler to the steam pipe.

5. **FEED CHECK VALVE:** It is use to control the supply the water to the boiler and to prevent the escaping of water from the boiler when the pump is stopped.

6. **FUSIBLE PLUG:** It is use to protect the boiler against damage due to overheating for low water level.

7. **BLOW-OFF COCK:** It is use to discharge a portion of water when the boiler is empty when necessary for cleaning, inspection, repair, mud, scale and sludge.

Accessories:

1. **FEED PUMPS**: It is used to deliver feed water to the boiler by the pump.

2. **INJECTOR**: The water is delivered to the boiler by steam pressure; The Kinetic energy of steam is used to increase the pressure and velocity of feed water.

3. **ECONOMISER:** It is a device in which the waste heat of flue gases is utilized for heating the feed water.

4. **AIR PREHEATER**: It is use to increase the temperature of air before it enters the furnace.

5. **SUPERHEATER:** It is use to increase the temperature of steam above it saturation point.

6. **STEAM SEPARATOR**: It is use to separate the water particles from the steam to the steam engine or steam turbine.

Experiment No. 2

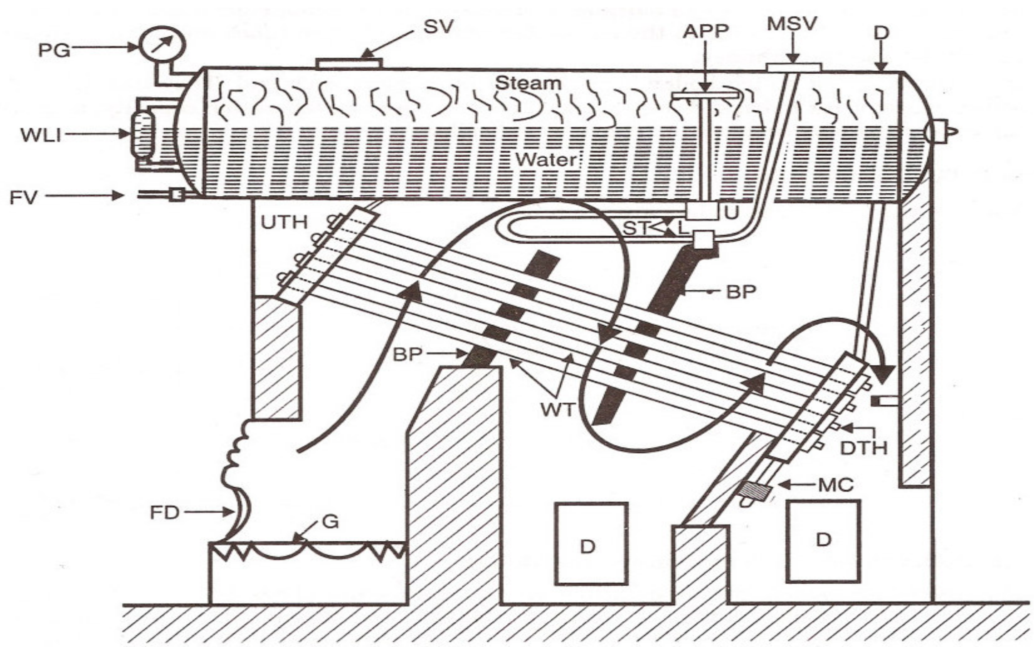
Objective: To study about Babcock and Wilcox boiler and Cochran boiler.

Babcock and Wilcox boiler

Babcock and Wilcox is a water-tube boiler is an example of horizontal inclined tube boiler it also a High Pressure Boiler.

Construction: Babcock and Wilcox boiler with longitudinal drum. It consists of a drum connected to a series of front end and rear end header by short riser tubes. To these headers are connected a series of inclined water tubes of solid drawn mild steel. The angle of inclination of the water tubes to the horizontal is about 15° or more.

Working: The fire door the fuel is supplied to grate where it is burnt. The hot gases are forced to move upwards between the tubes by baffle plates provided. The water from the drum flows through the inclined tubes via down take header and goes back into the shell in the form of water and steam via uptake header. The steam gets collected in the steam space of the drum. The steam then enters through the antipriming pipe and flows in the superheater tubes where it is further heated and is finally taken out through the main stop valve and supplied to the Steam turbine or Steam engine when needed.



D = Drum
DTH = Down take header
WT = Water tubes
BP = Baffle plates
D = Doors
G = Grate
FD = Fire door
MC = Mud collector
WLI = Water level indicator
PG = Pressure gauge
ST = Superheater tubes
SV = Safety valve
MSV = Main stop valve
APP = Antipriming pipe
L = Lower junction box
U = Upper junction box
FV = Feed valve

The pressure of steam in case of cross drum boiler may be as high as 100 bar and steaming capacity upto 27000 kg/h.

At the lowest point of the boiler is provided a mud collector to remove the mud particles through a blow-dawn-cock.

Cochran boiler

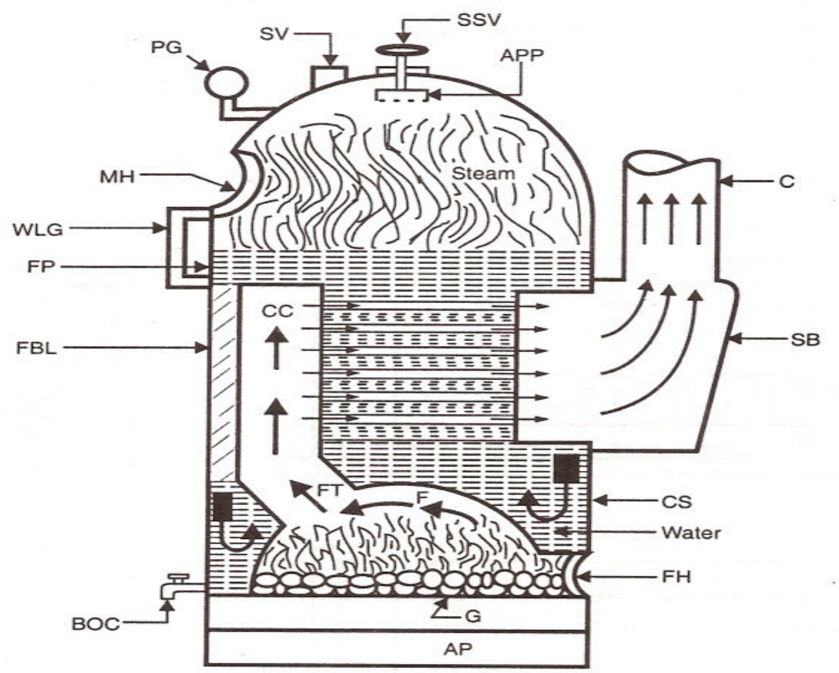
It is one of the best types of vertical multi-tubular boiler, and has a number of horizontal fire tubes it also a Low Pressure Boiler.

Construction: Cochran boiler consists of a cylindrical shell with a dome shaped top where the space is provided for steam. The furnace is one piece construction and is seamless. Its crown has a hemispherical shape and thus provides maximum volume of space.

Working: The fuel is burnt on the grate and ash is collected and disposed of from ash pit. The gases of combustion produced by burning of fuel enter the combustion chamber through the flue tube and strike against fire brick lining which directs them to pass through number of horizontal tubes, being surrounded by water. After which the gases escape to the atmosphere through smoke box and chimney.

Specifications:

Shell diameter	2.75 m
Height	5.79 m
Working pressure	6.5 bar (max. pressure = 15 bar)
Steam capacity	3500 kg/hr (max. capacity = 4000 kg/hr)
Heating surface	120 m^2
Efficiency	70 to 75% (depending on the fuel used)



CS = Cylindrical shell	*FT* = Flue tube
CC = Combustion chamber	*SB* = Smoke box
FBL = Fir brick lining	*C* = Chimney
F = Furnace (dome shaped)	*FH* = Fire hole
BOC = Blow off cock	*G* = Grate
SSV = Steam stop valve	*AP* = Ash pit
APP = Antipriming pipe	*SV* = Safety valve
PG = Pressure gauge	*MH* = Man hole
	WLG = Water level gauge

Experiment No. 3

Objective: To study about 2 stroke engine.

Introduction

Heat Engines: Any type of engine or machine which derives heat energy from the combustion of fuel or any other source and converts this energy into mechanical work is termed as a heat engine.

Classification of Heat Engines

- External Combustion Engines
- Internal Combustion Engines

External Combustion Engines: In this case, combustion of fuel takes place outside the cylinder as in case of steam engines where the heat of combustion is employed to generate steam which is used to move a piston in a cylinder. Other examples of external combustion engines are hot air engines, steam turbine and closed cycle gas turbine. These engines are generally used for driving locomotives, ships, generation of electric power etc.

Internal Combustion Engines (I.C. Engines): In this case, combustion of the fuel with oxygen of the air occurs within the cylinder of the engine. The internal combustion engines group includes engines employing mixtures of combustible gases and air, known as gas engines, those using lighter liquid fuel or spirit known as petrol engines and those using heavier liquid fuels, known as oil compression ignition or diesel engines.

Classification of I.C. Engines:

Internal combustion engines may be classified as given below:

1. According to cycle of operation:
   - Two-stroke cycle engines
   - Four-stroke cycle engines
2. According to cycle of combustion:
   - Otto cycle engine
   - Diesel cycle engine
   - Dual-combustion
3. According to the fuel employed and the method of fuel supply to the engine cylinder:
   - Petrol engine
   - Diesel engine
   - Oil, Gas engine
4. According to method of ignition:
   - Spark ignition (S.L) engine
   - Compression ignition (C.I.) engine
5. According to method of cooling the cylinder:
   - Air-cooled engine
   - Water-cooled engine
6. According to number of cylinders:
   - Single cylinder engine
   - Multi-cylinder engine

Different Parts of I.C. Engines (Parts Common to both Petrol and Diesel Engine):

1. Cylinder
2. Cylinder head
3. Piston
4. Piston rings
5. Gudgeon pin
6. Connecting rod
7. Crankshaft
8. Crank
9. Engine bearing
10. Crank case
11. Flywheel
12. Governor
13. Valves and valve operating mechanism

Parts for Petrol Engines Only:

1. Spark plugs 2. Carburetor 3. Fuel pump

Parts for Diesel Engine Only:

1. Fuel pump 2. Injector

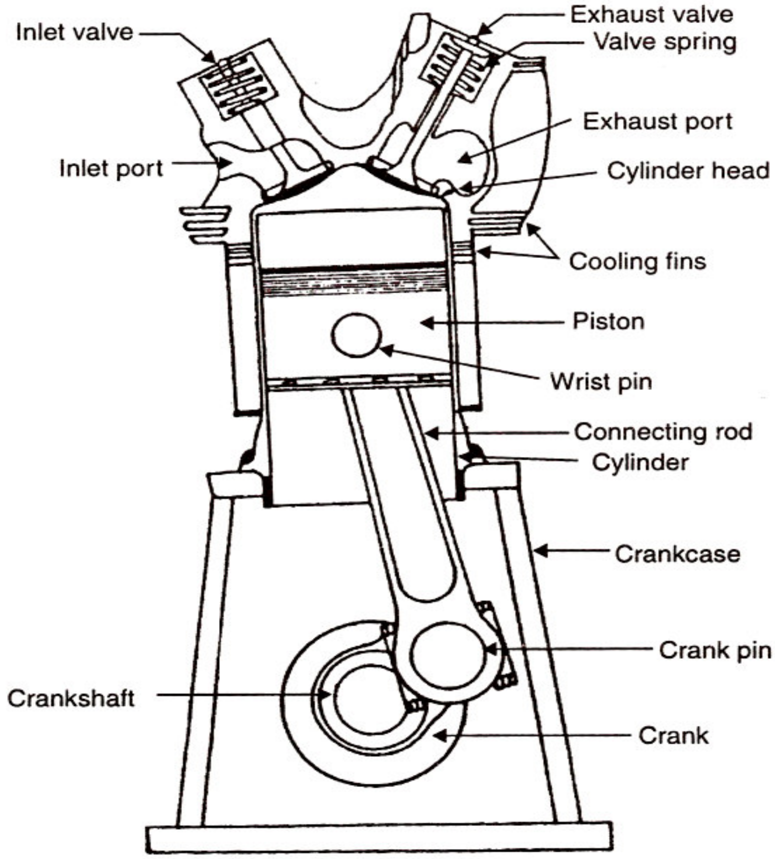


Fig. Air Cooled I.C Engine

TWO-STROKE CYCLE ENGINES

- Two Stroke Petrol engine
- Two Stroke Diesel engine

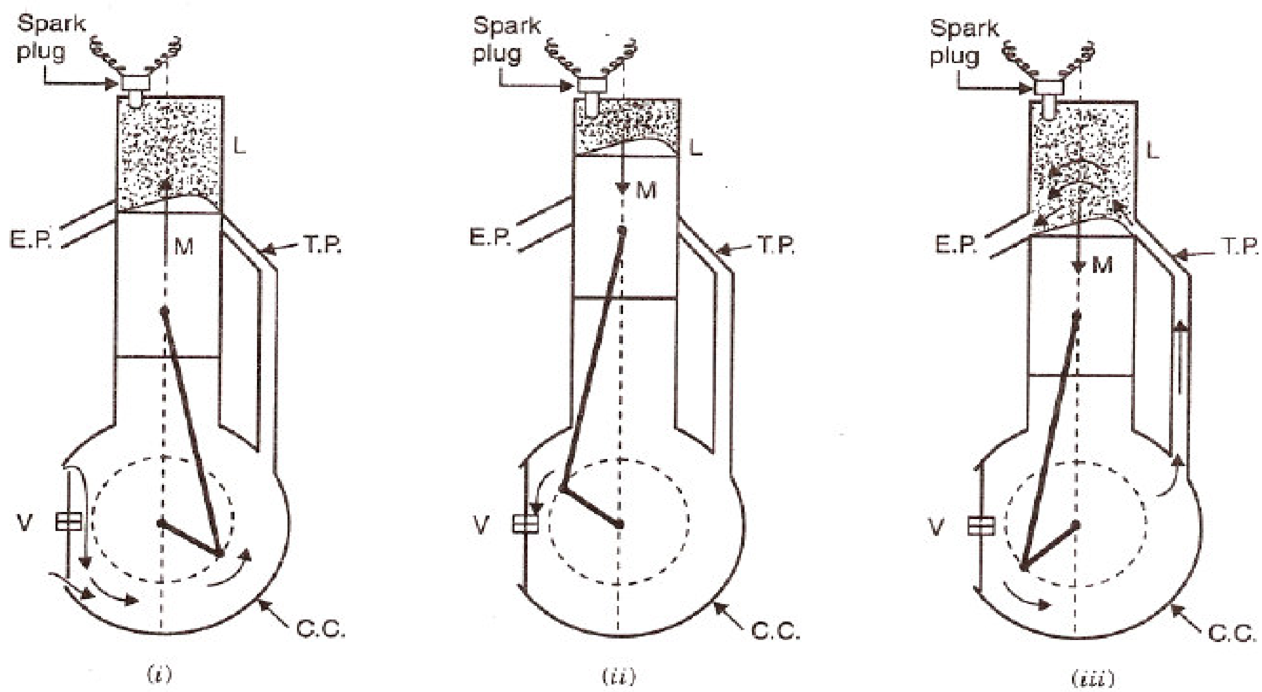
TWO STROKE ENGINES

In 1878, a British engineer introduced a cycle which could be completed in two strokes of piston rather than four strokes as is the case with the four-stroke cycle engines.

In this engine suction and exhaust strokes are eliminated. Here instead of valves, ports are used. The exhaust gases are driven out from engine cylinder by the fresh charge of fuel entering the cylinder nearly at the end of the working stroke.

A two-stroke petrol engine (used in scooters, motor cycles etc.).

The cylinder L is connected to a closed crank chamber C.C. During the upward stroke of the piston M, the gases in L are compressed and at the same time fresh air and fuel (petrol) mixture enters the crank chamber through the valve V.



L = Cylinder E.P. = Exhaust port T.P. = Transfer port V = valve, C.C = Crank chamber

When the piston moves downwards, V closes and the mixture in the crank chamber is compressed the piston is moving upwards and is compressing an explosive change which has previously been supplied to L. Ignition takes place at the end of the stroke. The piston then travels downwards due to expansion of the gases and near the end of this stroke the piston uncovers the exhaust port (E.P.) and the burnt exhaust gases escape through this port.

The transfer port (T.P.) then is uncovered immediately, and the compressed charge from the crank chamber flows into the cylinder and is deflected upwards by the hump provided on the head of the piston.

It may be noted that the incoming air-petrol mixture helps the removal of gases from the engine-cylinder; if, in case these exhaust gases do not leave the cylinder, the fresh charge gets diluted and efficiency of the engine will decrease.

The piston then again starts moving from B.D.C. to T.D.C. and the charge gets compressed when E.P. (exhaust port) and T.P. are covered by the piston; thus the cycle is repeated.

Experiment No. 4

Objective: To study about 4 stroke diesel and 4 stroke petrol engine.

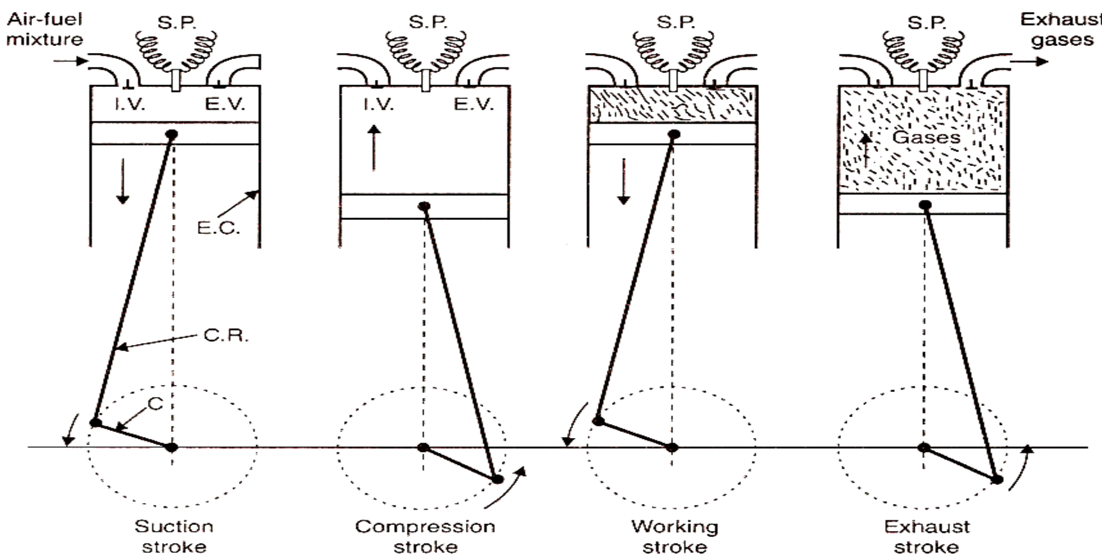
Introduction

FOUR-STROKE CYCLE ENGINES

- Four Stroke Petrol engine
- Four Stroke Diesel engine

FOUR STROKE PETROL ENGINE

The four stroke-cycles refers to its use in petrol engines, gas engines, light, oil engine and heavy oil engines in which the mixture of air fuel are drawn in the engine cylinder. Since ignition in these engines is due to a spark, therefore they are also called spark ignition engines.



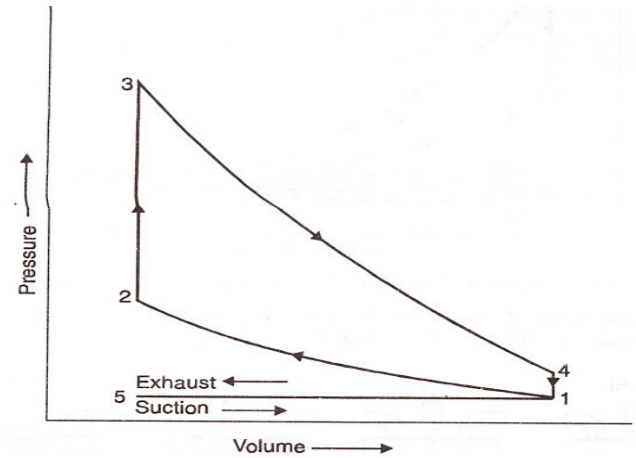
I.V = Intel valve, E.V. = Exhaust valve, E.C. = Engine cylinder, C.R. = Connecting rod
C = Crank, S.P. = Spark plug.

SUCTION STROKE: In this Stroke the inlet valve opens and proportionate fuel-air mixture is sucked in the engine cylinder. Thus the piston moves from top dead centre (T.D.C.) to bottom dead centre (B.D.C.). The exhaust valve remains closed through out the stroke.

COMPRESSION STROKE: In this stroke both the inlet and exhaust valves remain closed during the stroke. The piston moves towards (T.D.C.) and compresses the enclosed fuel-air mixture drawn. Just before the end of this stroke the operating plug initiates a spark which ignites the mixture and combustion takes place at constant pressure.

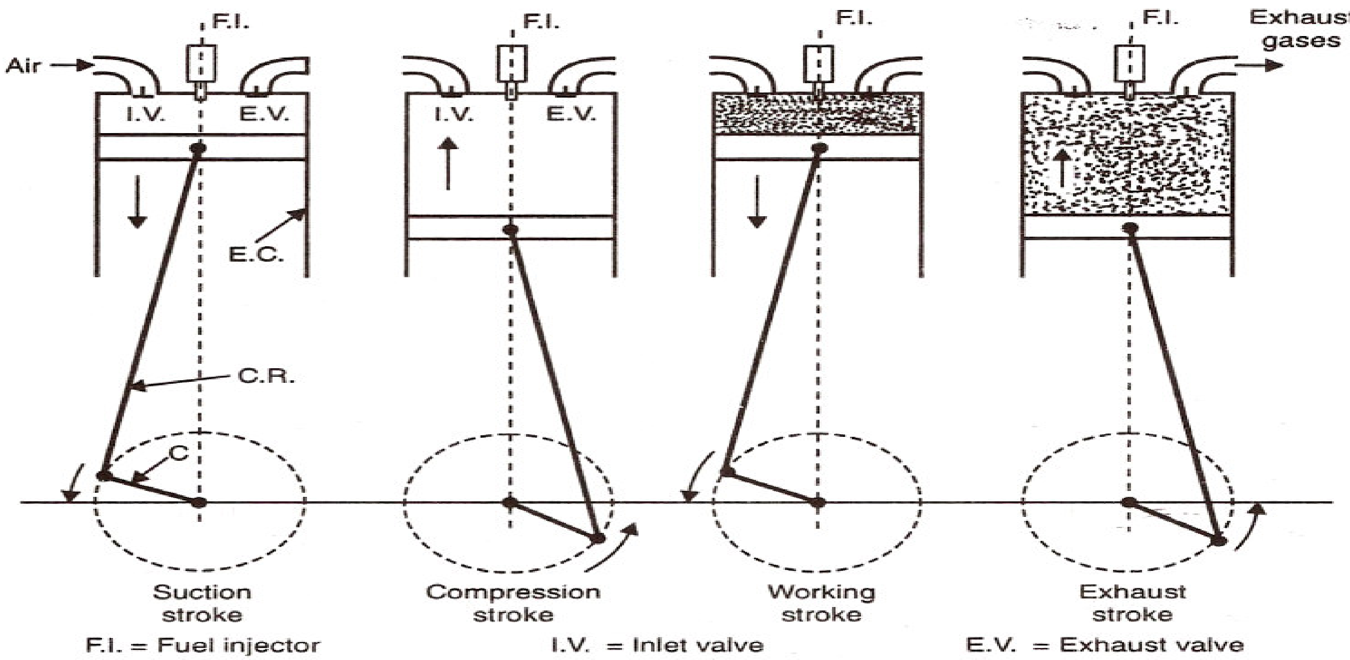
POWER STROKE OR EXPANSION STROKE: In this stroke both the valves remain closed during the start of this stroke but when the piston just reaches the B.D.C. the exhaust valve opens. When the mixture is ignited by the spark plug the hot gases are produced which drive or throw the piston from T.D.C. to B.D.C. and thus the work is obtained in this stroke.

EXHAUST STROKE: This is the last stroke of the cycle. Here the gases from which the work has been collected become useless after the completion of the expansion stroke and are made to escape through exhaust valve to the atmosphere. This removal of gas is accomplished during this stroke. The piston moves from B.D.C. to T.D.C. and the exhaust gases are driven out of the engine cylinder; this is also called SCAVENGING.



Theoretical P-V diagram of a four-stroke engine

FOUR STROKE DIESEL ENGINE



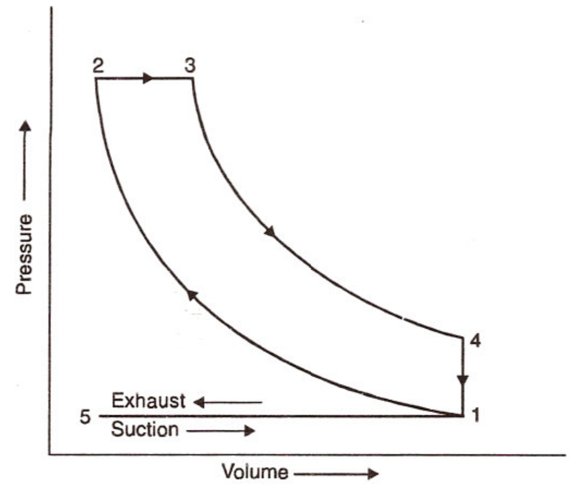
SUCTION STROKE: With the movement of the piston from T.D.C. to B.D.C. during this stroke, the inlet valve opens and the air at atmospheric pressure is drawn inside the engine cylinder; the exhaust valve however remains closed. This operation is represented by the line 5-1

COMPRESSION STROKE: The air drawn at atmospheric pressure during the suction stroke is compressed to high pressure and temperature as the piston moves from B.D.C. to T.D.C. Both the inlet and exhaust valves do not open during any part of this stroke. This operation is represented by 1-2

POWER STROKE OR EXPANSION STROKE: As the piston starts moving from T.D.C to B.D.C, the quantity of fuel is injected into the hot compressed air in fine sprays by the fuel injector and it (fuel) starts burning at constant pressure shown by the line 2-3.

At the point 3 fuel supply is cut off. The fuel is injected at the end of compression stroke but in actual practice the ignition of the fuel starts before the end of the compression stroke. The hot gases of the cylinder expand adiabatically to point 4. Thus doing work on the piston.

EXHAUST STROKE: The piston moves from the B.D.C. to T.D.C. and the exhaust gases escape to the atmosphere through the exhaust valve. When the piston reaches the T.D.C. the exhaust valve closes and the cycle is completed. This stroke is represented by the line 1-5.



Theoretical p- *V* diagram of a four-stroke Diesel Engine

Experiment No. 5

Objective: To Calculate the efficiency of simple screw jack.

Introduction

Machine: It is a device which is use for doing a particular work from receives energy in some available form.

Lifting Machine: It is a device which is use to overcome a force or load (W) applied at one point by mean of another force called effort (P).

Types of Machine:

1. Simple machine
2. Compound machine
   - Simple Machine: Have only one point for the application of effort and one point for load.eg: Lever, screw jack etc.
   - Compound Machine: has more than one point for the application of effort and for load. eg: Printing machine, milling machine, planer, shaper etc

IMPORTANT TERMS

- Mechanical advantage of a machine (M.A.): It is the ratio of the weight lifted (W) to the effort applied (P).
  - M.A. = W/P
- Velocity ratio (V.R.): It is the ratio of the distance (y) moved by the effort to the distance (x) moved by the load.
  - V.R = y/x
- Input of a machine: It is the work done on the machine. In a lifting machine, it is measured by the product of effort and the distance through which it has moved (i.e., P.y).
- Output of a machine: It is the actual work done by the machine. In a lifting machine it is measured by the product of the weight lifted and the distance through which it has been lifted i.e., (W.x).
- Efficiency of a machine (η): It is the ratio of output to the input of a machine.
  - η = Output/Input
- Ideal machine: A machine is said to be ideal if its efficiency is 100%. In this case, output is equal to input.

Whereas:

W= Load lifted by the machine;
P = Effort required to lift the load;
y = Distance moved by the effort, in lifting the load;
x = Distance moved by the load;
η = Efficiency of the machine.

SIMPLE SCREW JACK

It is a device employed for lifting heavy loads which are usually centrally loaded upon it. Horizontal power is applied with the lever (or handle).

Formula Used

Let L = Length of lever (or power arm)
P = The effort applied
W= The load lifted
p = Pitch of the screw

Suppose, screw has taken one full revolution,

Distance moved by the load = p
Distance moved by the effort = $2\pi L$
V.R. = (Distance moved by P) / (Distance moved by W) = $2\pi L / p$

If the screw is double threaded then for one revolution of power arm the load will be lifted up through twice the pitch.

Hence, V.R. for double threaded screw, V.R = $2\pi L / 2p = \pi L / p$

M.A = W / P
η = M.A / V.R

Procedure:

1. Firstly stabilize the simple screw jack machine and wrap the cord around the load drum and pass it over the pulley.
2. Put some weight on the load drum. And add the some effort to the effort hanger on the pulleys.
3. Hit the machine with some material, thus you will see some kind of movement in the load drum.
4. Write down the initial reading in the observation table.
5. After taking the initial reading we put the some load on the load drum.
6. After this just increase the effort on the effort pulleys (either to the left or to the right)
7. Again hit the machine with some material, thus you will see another movement in the load drum.
8. Write down the second reading in the observation table.
9. After this apply the above procedure, four to five times with gradually increasing the Load as well as Effort to the load drum and effort pulley respectively.
10. Write down the all reading in the given observation table.
11. Measure the radius of the load drum and pitch of screw.
12. Calculate the MA, VR and η of machine.

Observation table:

S.No.	Load (W) in gram.	Effort (P) in gram.		
		P_A	P_B	$P = P_A + P_B$
1.				
2.				
3.				
4.				
5.				

Diagram:

Precautions:

1. Lubricate the screw before starting the experiment.
2. Trapping should be done after adding the weight in the effort hanger.
3. Overlapping of string should not be there.

Source of error:

1. Frictions in the pulley.
2. Effort being pulled suddenly.

Result: The efficiency of the simple screw jack is……………………………..

Experiment No. 6

Objective: To calculate the efficiency of following:

i. Single Start Worm and Worm Wheel
ii. Double Start Worm and Worm Wheel
iii. Triple Start Worm and Worm Wheel

SINGLE START WORM AND WORM WHEEL

Introduction

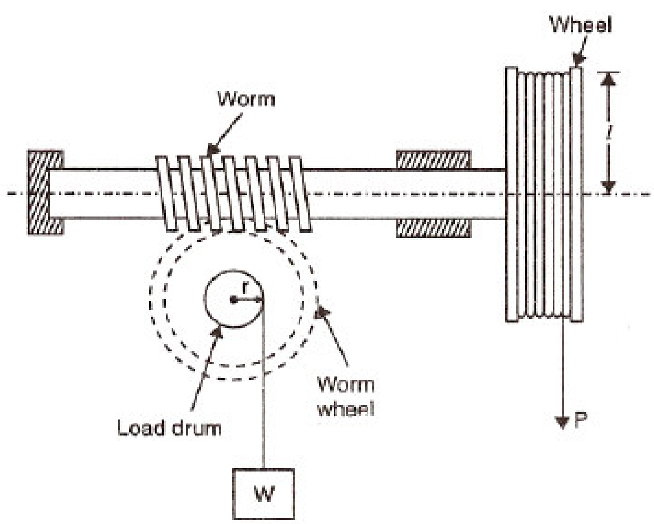
Worm and worm wheel consists of a square threaded screw (known as worm) and a toothed wheel (known as worm wheel) geared with each other. A wheel is attached to the worm, over which passes a rope a load is securely mounted on the worm wheel.

Formula Used

Let L = Radius of the wheel
r = Radius of the load drum
W = Load lifted
P = Effort applied to lift the load
T = Number of teeth on the worm wheel

If the worm is single threaded (i.e., for one revolution of the wheel, the worm pushes the worm wheel through one tooth) then for one revolution of the wheel the distance moved by the effort = $2\pi L$

The load drum will move through = $1/T$ revolution
Distance, through which the load will move = $2\pi r / T$



V.R = (Distance moved by P) / (Distance moved by W) = $(2\pi L / (2\pi r / T)) = LT / r$

In general, if the worm is *n* threaded then, V.R = LT / nr
M.A = W / P
η = M.A / V.R

Procedure:

1. Firstly stabilize the Single Start Worm and Worm Wheel machine and wrap the cord around the load drum and the effort wheel.
2. Put some weight on the load drum. And add the some effort to the effort wheel via hanger.
3. Hit the machine with some material, thus you will see some kind of movement in the load drum as well as in effort wheel.
4. Write down the reading in the observation table
5. After this apply the above procedure, four to five times with gradually increasing the Load as well as Effort to the load drum and effort pulley respectively.
6. Write down the all reading in the given observation table.
7. Measure the radius of the load drum and the radius of the effort wheel.
8. Calculate the MA, VR and η of machine.

Observation table:

S.No.	Load (W) in gram.	Effort (P) in gram.
1.		
2.		
3.		
4.		
5.		

Precautions:

1. Lubricate the screw before starting the experiment.
2. Trapping should be done after adding the weight in the effort hanger.
3. Overlapping of string should not be there.

Source of error:

1. Frictions in the pulley.
2. Effort being pulled suddenly.

Result: The efficiency of the single start worm and worm wheel is………………………..

DOUBLE START WORM AND WORM WHEEL

Formula Used

If the worm is double threaded (i.e., for one revolution of the wheel pushes the worm wheel through half teeth then

V.R = LT / 2r

M.A = W / P

η = M.A / V.R

Procedure:

1. Firstly stabilize the double Start Worm and Worm Wheel machine and wrap the cord around the load drum and the effort wheel.
2. Put some weight on the load drum. And add the some effort to the effort wheel via hanger.
3. Hit the machine with some material, thus you will see some kind of movement in the load drum as well as in effort wheel.
4. Write down the reading in the observation table
5. After this apply the above procedure, four to five times with gradually increasing the Load as well as Effort to the load drum and effort pulley respectively.
6. Write down the all reading in the given observation table.
7. Measure the radius of the load drum and the radius of the effort wheel.
8. Calculate the MA, VR and η of machine.

Observation table:

S.No.	Load (W) in gram.	Effort (P) in gram.
1.		
2.		
3.		
4.		
5.		

Precautions:

1. Lubricate the screw before starting the experiment.
2. Trapping should be done after adding the weight in the effort hanger.
3. Overlapping of string should not be there.

Source of error:

1. Frictions in the pulley.
2. Effort being pulled suddenly.

Result: The efficiency of the double start worm and worm wheel is………………………..

TRIPLE START WORM AND WORM WHEEL

Formula Used

If the worm is double threaded (i.e., for one revolution of the wheel pushes the worm wheel through half teeth then

V.R = LT / 3r

M.A = W / P

η = M.A / V.R

Procedure:

1. Firstly stabilize the triple Start Worm and Worm Wheel machine and wrap the cord around the load drum and the effort wheel.
2. Put some weight on the load drum. And add the some effort to the effort wheel via hanger.
3. Hit the machine with some material, thus you will see some kind of movement in the load drum as well as in effort wheel.
4. Write down the reading in the observation table
5. After this apply the above procedure, four to five times with gradually increasing the Load as well as Effort to the load drum and effort pulley respectively.
6. Write down the all reading in the given observation table.
7. Measure the radius of the load drum and the radius of the effort wheel.
8. Calculate the MA, VR and η of machine.

Observation table:

S.No.	Load (W) in gram.	Effort (P) in gram.
1.		
2.		
3.		
4.		
5.		

Precautions:

1. Lubricate the screw before starting the experiment.
2. Trapping should be done after adding the weight in the effort hanger.
3. Overlapping of string should not be there.

Source of error:

1. Frictions in the pulley.
2. Effort being pulled suddenly.

Result: The efficiency of the triple start worm and worm wheel is………………………..

Experiment No. 7

Objective: To calculate the efficiency of following:

i. Single Purchase Winch Crab
ii. Double Purchase Winch Crab

SINGLE PURCHASE CRAB WINCH

Introduction:

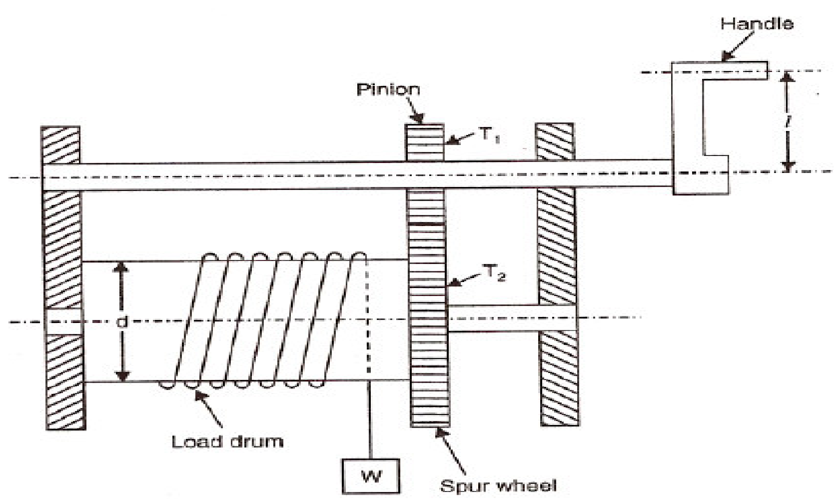
In a single purchase crab winch, a rope is fixed to the drum and is wound a few turns round it. The free end of the rope carries the load W. A large toothed wheel known as spur wheel is rigidly mounted on the load drum. Another small toothed wheel, called pinion, is geared with the spur wheel.

Formula Used

Let, T_1 = Number of teeth on the pinion
T_2 = Number of teeth on the spur wheel
L = Length of the handle
d = Diameter of the drum

Consider one revolution of the handle. Then, distance moved by the effort = $2\pi L$

Number of revolutions made by the pinion = 1 and number of revolutions made by the spur wheel = T_1 / T_2



Distance moved by the load = $\pi d / (T_1 / T_2)$

V.R = (Distance moved by P) / (Distance moved by W)
= $2\pi L / \pi d / (T_1 / T_2)$
= $(2L / d) / (T_2 / T_1)$
M.A = W / P
η = M.A / V.R

Procedure:

1. Firstly stabilize the single purchase crab machine and wrap the cord around the load drum and the effort wheel.
2. Put some weight on the load drum. And add the some effort to the effort wheel via hanger.
3. Hit the machine with some material, thus you will see some kind of movement in the load drum as well as in effort wheel.
4. Write down the reading in the observation table
5. After this apply the above procedure, four to five times with gradually increasing the Load as well as Effort to the load drum and effort pulley respectively.
6. Write down the all reading in the given observation table.
7. Measure the radius of the load drum and the radius of the effort wheel.
8. Calculate the MA, VR and η of machine.

Observation table:

S.No.	Load (W) in gram.	Effort (P) in gram.
1.		
2.		
3.		
4.		
5.		

Precautions:

1. Lubricate the screw before starting the experiment.
2. Trapping should be done after adding the weight in the effort hanger.
3. Overlapping of string should not be there.

Source of error:

1. Frictions in the pulley.
2. Effort being pulled suddenly.

Result: The efficiency of the single purchase winch crab is………………………..

DOUBLE PURCHASE CRAB WINCH

Introduction:

In a double purchase crab winch the velocity ratio is obtained in two stages. In this lifting machine there are two spur wheels of teeth T_2 and T_4 and two pinions of teeth T_1 and T_3.

The arrangement of spur wheels and pinions is such that the pinion with teeth T_1gears with the spur wheel of teeth T_2.

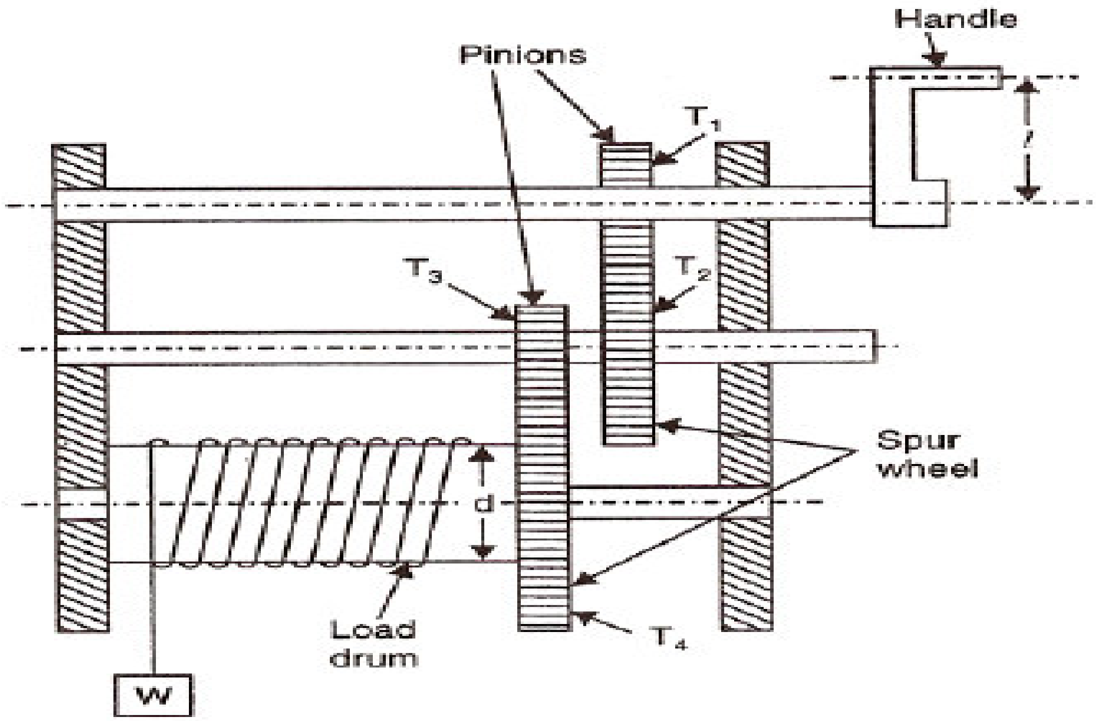
Similarly, the pinion with teeth T3 gears with spur wheel of teeth T4. The effort is applied at the handle.

Formula Used

Consider one revolution of the handle.

Then, distance moved by the effort = $2\pi L$
No. of revolutions made by the pinion 1 = T_1
No. of revolutions made by the spur wheel 2 = T_2
No. of revolutions made by the spur wheel 3 = T_1 / T_2
No. of revolutions made by the spur wheel 4 = $(T_1 / T_2).(T_3 / T_4)$

Distance moved by the load = $\pi d.(T_1 / T_2).(T_3 / T_4)$



V.R = (Distance moved by the effort) / (Distance moved by the load)
= $2\pi L / [\pi d.(T_1 / T_2).(T_3 / T_4)]$
= $(2L / d).(T_1 / T_2).(T_3 / T_4)$
M.A = W / P
η = M.A / V.R

Procedure:

1. Firstly stabilize the double purchase crab machine and wrap the cord around the load drum and the effort wheel.
2. Put some weight on the load drum. And add the some effort to the effort wheel via hanger.
3. Hit the machine with some material, thus you will see some kind of movement in the load drum as well as in effort wheel.
4. Write down the reading in the observation table
5. After this apply the above procedure, four to five times with gradually increasing the Load as well as Effort to the load drum and effort pulley respectively.
6. Write down the all reading in the given observation table.
7. Measure the radius of the load drum and the radius of the effort wheel.
8. Calculate the MA, VR and η of machine.

Observation table:

S.No.	Load (W) in gram.	Effort (P) in gram.
1.		
2.		
3.		
4.		
5.		

Precautions:

1. Lubricate the screw before starting the experiment.
2. Trapping should be done after adding the weight in the effort hanger.
3. Overlapping of string should not be there.

Source of error:

1. Frictions in the pulley.
2. Effort being pulled suddenly.

Result: The efficiency of the double purchase winch crab is………………………..

Experiment No. 8

Objective: To study about various types Water Turbine as follows:

i. Pelton Turbine
ii. Francis Turbine
iii. Kaplan Turbine

WATER TURBINES:

Introduction:

Hydraulic turbines are uses the potential and kinetic energy of water and converted it into usable mechanical energy as efficiently as possible. The mechanical energy made available at the turbine shaft is used to run an electric motor for generate the electricity.

Classification of Water Turbines:

Impulse Turbine: Are those turbines in which the available fluid energy is converted into kinetic energy by a nozzle.

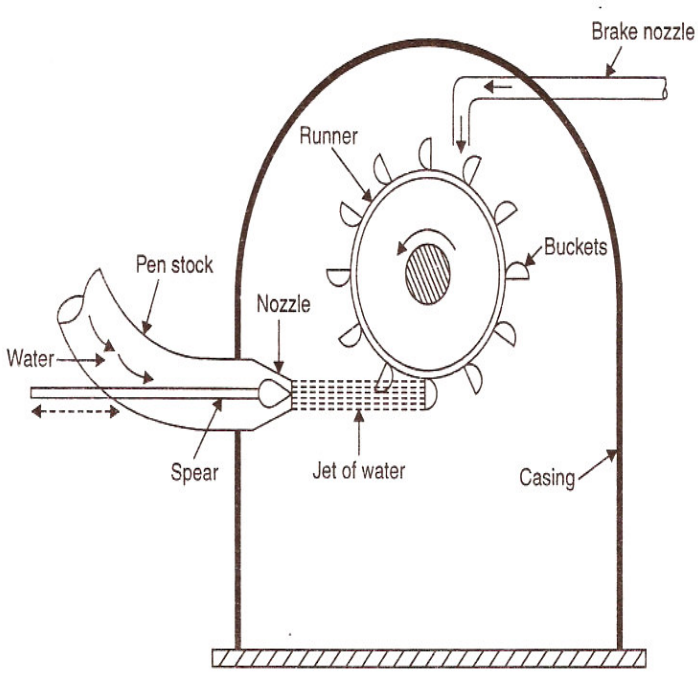
Reaction Turbine: Are those turbines in which the energy of the fluid is partly transformed into kinetic energy before it enters the runner of the turbine.

WATER TURBINE			
S.No	BASIS	IMPLUSE TURBINE	REACTION TURBINE
1.	According to water flow through runner	Tangential Flow (example:- Pelton Turbine)	a) Axial or Parallel Flow (eg. Kaplan Turbine). b) Mixed Flow i.e. Radial and Axial (eg. Modern Francis Turbine). c) Outward Radial Flow (eg. Fourneyron Turbine) d) Inward Radial Flow (eg. Old Francis Turbine)
2.	According to head	High Head (above 250m) :- Pelton Turbine	Low (upto 30 m):- Propeller and Kaplan Turbine. Medium Head (60-250 m):- Modern Francis Turbine.
3.	According to discharge	Small rate of flow: - Pelton Turbine.	Medium rate of flow: - Modern Francis Turbine. Very High: - Propeller and Kaplan Turbine.
4.	According to specific speed (in r.p.m)	For Pelton Turbine:- 9-17 for a slow runner 17-25 for a normal runner 25-30for a fast runner 40for a double jet	For Francis Turbine:- 50–100 for a slow runner 100-150 for a normal runner 150-250 for a slow runner For Kaplan Turbine:- 250-850 r.p.m
5.	According to disposition of shaft	Horizontal shaft and Vertical runner arrangement	Either horizontal or vertical shaft

PELTON TURBINE

INTRODUCTION: The Pelton wheel turbine is a tangential flow impulse turbine. The water strikes the bucket along the tangent of the runner. The energy available at the turbine is only kinetic energy. This turbine is used for high head and is named after the American engineer Lester Pelton.

DIAGRAM



CONSTRUCTION DETAILS OF PELTON TURBINE: Components of the Pelton turbine:-

- Nozzle: - the amount of water striking the vanes (buckets) of the runner is controlled by providing a spear (flow regulating arrangement) in the nozzle.

- Spear: - the spear is a conical needle which is operated either by a hand wheel or automatically in an axial direction depending upon the size of the unit.

- Runner with bucket: - runner of Pelton wheel consists of a circular disc on the periphery of which a number of buckets evenly spaced are fixed.

- Casing: - casing is to prevent the splashing of the water and to discharge water to tail race. It is made up of cast iron or steel plate.

- Breaking jet: - when the nozzle is completely closed by moving the spear in the forward direction the amount of water striking the runner reduce to zero.

  But the runner due to inertia goes on revolving for a long time. To stop the runner in a short time, a small nozzle is providing which directs the jet of water on the back of vanes. This jet of water is called breaking jet.

- Governing mechanism: - speed of turbine runner is required to be maintained constant so that electric generator coupled directly to turbine.

WORKING OF PELTON TURBINE

The amount of water striking the vanes (buckets) of the runner is controlled by providing a spear (flow regulating arrangement) in the nozzle.

Then the efficient nozzle that converts the hydraulic energy into a high speed jet. The turbine rotor is called runner.

The impact jet of water is striking on the runner and runner revolves at constant with the help of governing mechanism.

The runner shaft is connected with the generator; thus the electricity is produce with the help of generator.

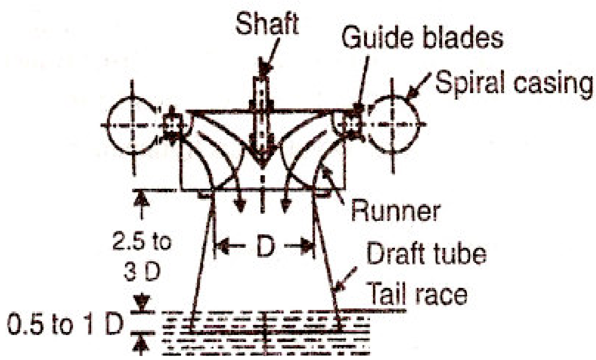
EFFICIENCIES OF PELTON TURBINE

- Mechanical efficiencies: - It is ratio of the shaft power to the water power.
- Hydraulic efficiencies: - It is ratio of the power developed at the turbine runner to the power supplied by the water jet at entrance to the turbine.
- Volumetric efficiencies: - It is ratio of the theoretical to the actual discharge.
- Overall efficiencies: - It is ratio of the shaft power to the water power.

FRANCIS TURBINE

INTRODUCTION: The Francis turbine is an inward flow reaction turbine which was designed and developed by the American engineer James B. Francis. Francis turbine has a purely radial flow runner; the flow passing through the runner had velocity component only in a plane of the normal to the axis of the runner. Reaction hydraulic turbines of relatively medium speed with radial flow of water in the component of turbine are runner.

DIAGRAM:



CONSTRUCTION DETAILS OF FRANCIS TURBINE: Components of the Francis turbine:-

- Pen stoke: - It is a large sized shaped; where the water is provided to the turbine runner from the dam.
- Scroll casing: - Penstocks connected to and feeds water directly into an annular channel surrounding the turbine runner. The channel is spiral in its layout.
- Guide vanes: - A series of airfoil shaped vanes called the guide vanes are arranged inside the casing to form a number of flow passages between the casing and the runner blades. Guide vanes are fixed in position (they do not rotate with rotating runner).
- Guide wheel and governing mechanism: - It changes the position of guide blades to affect variation in the water flow rate in the wake of changing load conditions on the turbine. When the load changes, the governing mechanism rotates all the guide blades about their axis through the same angle so that the water flow rate to the runner.
- Runner and runner blades: - Runner of the Francis turbine is a rotor which has passages formed between the drat tube and scroll casing.
- Draft tube: - After passing through the runner, the water is discharged to the tail race through a gradually expanding tube.

WORKING OF FRANCIS TURBINE: The amount of water falls on the vanes (buckets) of the runner. The turbine rotor is called runner. Runner revolves at constant with the help of governing mechanism. The runner shaft is connected with the generator; thus the electricity is produce with the help of generator. And the water is discharge from the tail race.

THEORY OF OPERATION: The Francis turbine is a reaction turbine, which means that the working fluid changes pressure as it moves through the turbine, giving up its energy. A casement is needed to contain the water flow. The turbine is located between the high pressure water source and the low pressure water exit, usually at the base of a dam.

The inlet is spiral shaped. Guide vanes direct the water tangentially to the runner. This radial flow acts on the runner vanes, causing the runner to spin. The guide vanes (or wicket gate) may be adjustable to allow efficient turbine operation for a range of water flow conditions.

As the water moves through the runner its spinning radius decreases, further acting on the runner. Imagine swinging a ball on a string around in a circle. If the string is pulled short, the ball spins faster. This property, in addition to the water's pressure, helps inward flow turbines harness water energy.

At the exit, water acts on cup shaped runner features, leaving with no swirl and very little kinetic or potential energy. The turbine's exit tube is specially shaped to help decelerate the water flow and recover kinetic energy.

APPLICATION: Francis Inlet Scroll, Grand Coulee Dam Large Francis turbines are individually designed for each site to operate at the highest possible efficiency, typically over 90%. They are best suited for sites with high flows and low to medium head. Francis Turbines are very expensive to design, manufacture and install, but operate for decades.

In addition to electrical production, they may also be used for pumped storage; where a reservoir is filled by the turbine (acting as a pump) during low power demand, and then reversed and used to generate power during peak demand.

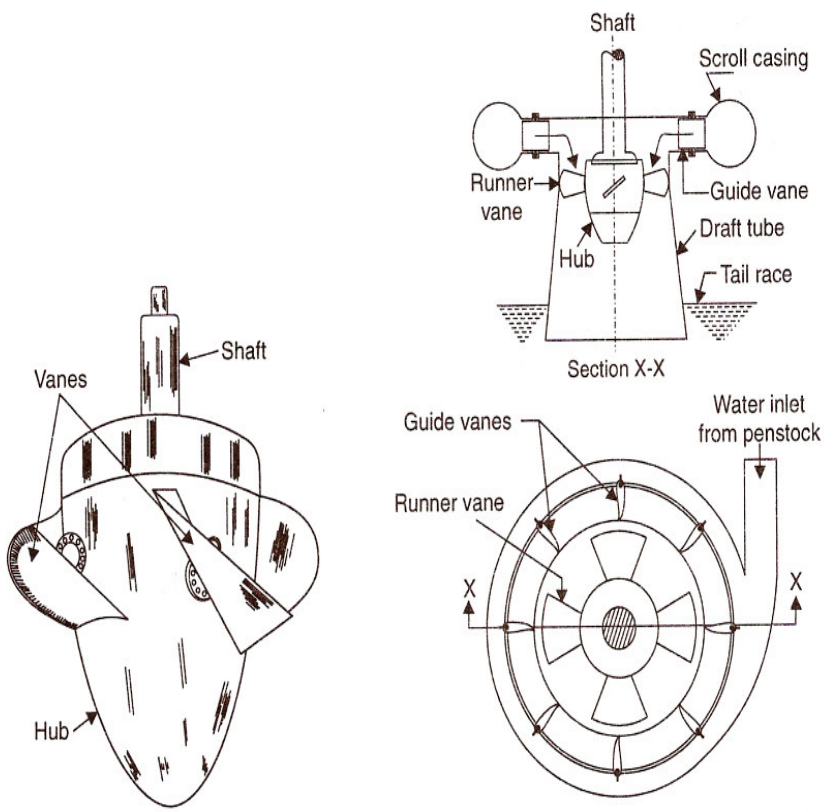
Francis turbines may be designed for a wide range of heads and flows. This, along with their high efficiency, has made them the most widely used turbine in the world.

KAPLAN TURBINE

INTRODUCTION: Kaplan-type hydraulic turbine in which the positions of the runner blades and the wicket gates are adjustable for load change with sustained efficiency, it is a purely axial flow turbine with a vertical shaft disposition. Which was designed and developed by the Australian engineer Viktor Kaplan? Kaplan turbine has adjustable runner blades with less number of blades (i.e. 3 to 8 blades). Kaplan turbines are now widely used throughout the world in high-flow, low-head power production.

Victor Kaplan obtained his first patent for an adjustable blade propeller turbine in 1912. But the development of a commercially successful machine would take another decade. Kaplan struggled with cavitations problems, and in 1922 abandoned his research for health reasons.

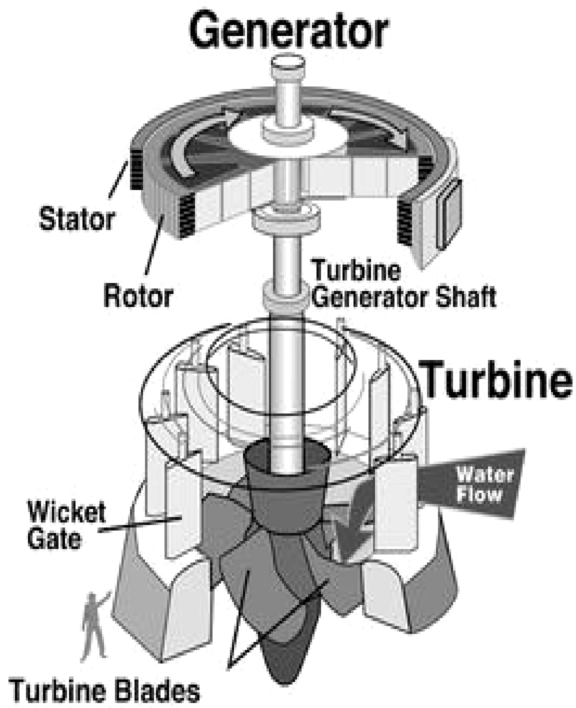
DIAGRAM



CONSTRUCTION DETAILS OF KAPLAN TURBINE: Components of the Kaplan turbine:-

- Scroll casing: - It is the cashing in which we pass the water to the runner in the turbine.
- Guide vanes: - It is the blade in which guides the water and control the water passage (i.e. how much the water flow goes in the turbine).
- Draft tube: - After passing through the runner, the water is discharged to the tail race through a gradually expanding tube.
- Runner: - It is an important part of the turbine which is connected to the shaft of the generator and consist movable vanes and hub (boss).
- Hub (Boss):- It is the part of the runner in which blades are mounted.

WORKING OF KAPLAN TURBINE: The Kaplan turbine is an inward flow reaction turbine, which means that the working fluid changes pressure as it moves through the turbine and gives up its energy. The design combines radial and axial features.



The inlet is a scroll-shaped tube that wraps around the turbine's wicket gate. Water is directed tangentially, through the wicket gate, and spirals on to a propeller shaped runner, causing it to spin.

The outlet is a specially shaped draft tube that helps decelerate the water and recover kinetic energy.

The turbine does not need to be at the lowest point of water flow, as long as the draft tube remains full of water. A higher turbine location, however, increases the suction that is imparted on the turbine blades by the draft tube. The resulting pressure drop may lead to capitation.

Variable geometry of the wicket gate and turbine blades allows efficient operation for a range of flow conditions. Kaplan turbine efficiencies are typically over 90%, but may be lower in very low head applications.

APPLICATIONS: Kaplan turbines are widely used throughout the world for electrical power production. They cover the lowest head hydro sites and are especially suited for high flow conditions.

Inexpensive micro turbines are manufactured for individual power production with as little as two feet of head.

Large Kaplan turbines are individually designed for each site to operate at the highest possible efficiency, typically over 90%. They are very expensive to design, manufacture and install, but operate for decades.

VARIATIONS: The Kaplan turbine is the most widely used of the propeller-type turbines, but several other variations exist:

Propeller turbines have non-adjustable propeller vanes. They are used in low cost, small installations. Commercial products exist for producing several hundred watts from only a few feet of head.

Experiment No. 9

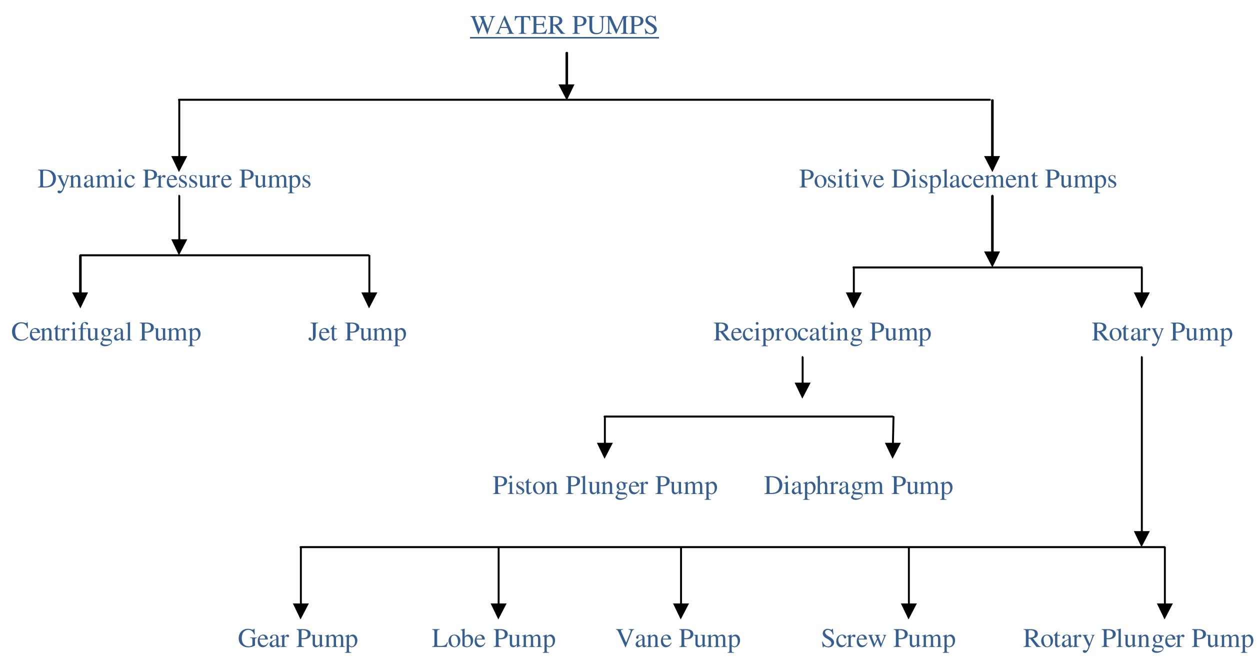
Objective: To study about various types Pumps as follows:

i. Centrifugal Pump
ii. Reciprocating Pump

WATER PUMPS

Introduction: There are many types of hydraulic machinery. The most popular ones used in civil engineering are called turbo machines (i.e. a rotating element through which the fluid passes). The rotor is called runner in a turbine and impeller in a water pump. Turbo machines are classified as axial-flow, radial-flow and mixed-flow machines depending on the predominant direction of the fluid motion relative to the rotor's axis as the fluid passed the blades.

CLASSIFICATION OF WATER PUMPS

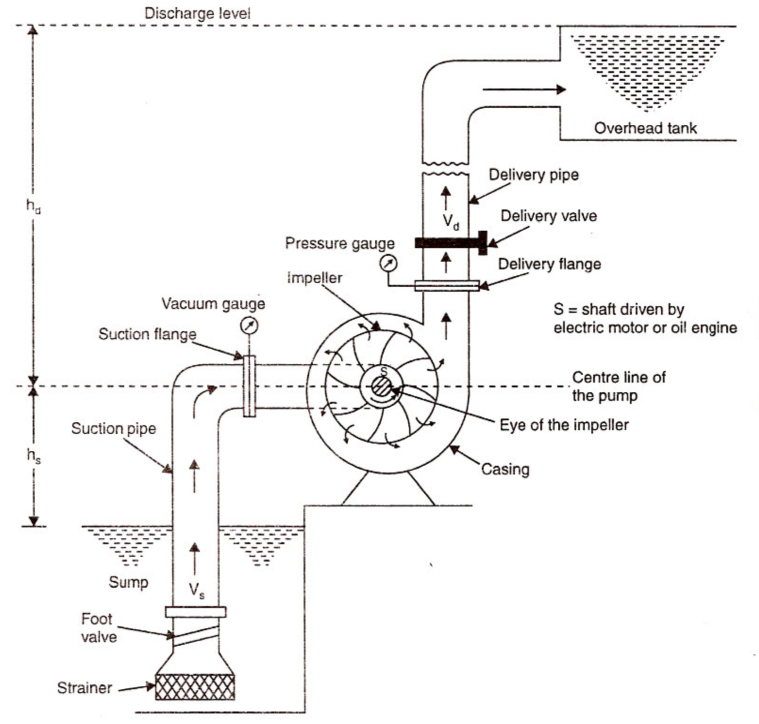


CENTRIFUGAL PUMP

Introduction: Centrifugal pumps are the most widely used of all the turbo machine (or rotodynamic) pumps. This type of pumps uses the centrifugal force created by an impeller which spins at high speed inside the pump casing.

Principle: Its principle work on Centrifugal force.

Diagram



CONTRUCTION DETAILS OF A CENTRIFUGAL PUMP: Centrifugal pump is classified as the following:-

1. Stationary components
2. Rotating components

1. Stationary components of the centrifugal pump are the following:

   a) Casing: - It is an air tight passage surrounding the impeller. It is designed in such a way that the kinetic energy of the water discharged at the outlet of the impeller is converted into pressure energy before the water leaves the casing and enters the delivery pipe. Types of casing:-

      - Volute casing: - It is spiral type of casing in which area of flow increase gradually. The increase in area of flow decreases the velocity of flow and increases the pressure of water.
      - Vortex casing: - if a circular chamber is introduced between casing and the impeller, the casing is known as vortex casing.
      - Casing with guide blades: - the impeller is surrounded by a series of guide blades mounted on a ring know as diffuser.

   b) Suction pipe: - a pipe whose one ends is connected to the inlet of the pump and other end dip into water in a sump.
   c) Delivery pipe: - a pipe whose one end is connected to the outlet of the pump and other end is involved in delivering the water at a required height.

2. Rotating component of the centrifugal pump is Impeller.

Impeller: - It is the main rotating part that provides the centrifugal acceleration to the fluid. Classification of impeller:

   a) Based on direction of flow:

      - Axial-flow: - the fluid maintains significant axial-flow direction components from the inlet to outlet of the rotor.
      - Radial-flow: - the flow across the blades involves a substantial radial-flow component at the rotor inlet, outlet and both.
      - Mixed-flow: - there may be significant axial and radial flow velocity components for the flow through the rotor row.

b) Based on suction type:

- Single suction: - liquid inlet on one side.
- Double suction: - liquid inlet to the impeller symmetrically from both sides.

c) Based on mechanical construction:

- Closed: - shrouds or sidewall is enclosing the vanes.
- Open: - no shrouds or wall to enclose the vanes.
- Semi-open or vortex type.

Working: Water is drawn into the pump from the source of supply through a short length of pipe (suction pipe). Impeller rotates; it spins the liquid sitting in the cavities between the vanes outwards and provides centrifugal acceleration with the kinetic energy.

This kinetic energy of a liquid coming out an impeller is harnessed by creating a resistance to flow. The first resistance is created by the pump volute (casing) that catches the liquid and shows it down.

In the discharge nozzle, the liquid further decelerates and its velocity is converted to pressure according to BERNOULLI'S PRINCIPAL.

SPECIFIC SPEED: - speed of an imaginary pump geometrically similar in every respect to the actual pump and capable of delivering unit quantity against a unit head. It is denoted by N_S:-

$$N_S = \frac{N (Q)^{1/2}}{(H)^{3/4}}$$

Where: - N: - pump speed in r.p.m
Q: - discharge in m^3/sec
H: - head per stage in mete

Tabulated form of specific speed in a centrifugal pump:

Pump	Speed	Specific speed (in r.p.m)
Radial flow	Slow Medium High	10-30 30-35 50-80
Mixed flow		80-160
Axial flow		100-450

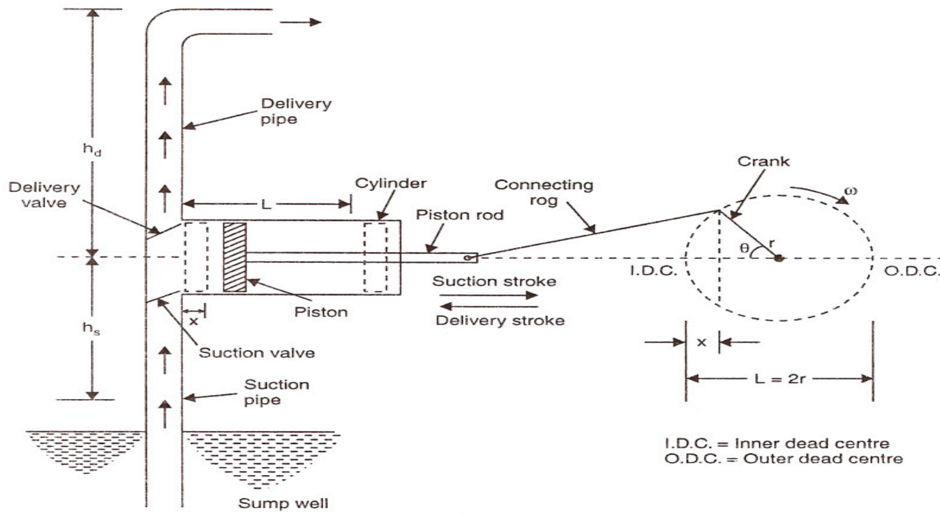
EFFICIENCIES OF CENTRIFUGAL PUMPS:-

Mechanical efficiencies: - It is ratio of the impeller power to the shaft power.
Hydraulic efficiencies: - It is ratio of the manometric head to the Euler head.
Volumetric efficiencies:- It is ratio of the actual to the theoretical discharge.
Overall efficiencies: - It is ratio of the water power to the shaft power.

Reciprocating Pump

PRINCIPLE: Reciprocating pump operates on the principle of pushing of liquid by a piston that executes a reciprocating motion in a closed fitting cylinder.

DIAGRAM:



CONTRUCTION DETAILS OF A RECIPROCATIN PUMP: Components of reciprocating pumps:-

a) Piston or plunger: - a piston or plunger that reciprocates in a closely fitted cylinder.

b) Crank and Connecting rod: - crank and connecting rod mechanism operated by a power source. Power source gives rotary motion to crank. With the help of connecting rod we translate reciprocating motion to piston in the cylinder.

c) Suction pipe: - one end of suction pipe remains dip in the liquid and other end attached to the inlet of the cylinder.

d) Delivery pipe: - one end of delivery pipe attached with delivery part and other end at discharge point.

e) Suction and Delivery value: - suction and delivery values are provided at the suction end and delivery end respectively. These values are non-return values.

WORKING OF RECIPROCATING PUMP

Operation of reciprocating motion is done by the power source (i.e. electric motor or i.c engine, etc). Power source gives rotary motion to crank; with the help of connecting rod we translate reciprocating motion to piston in the cylinder (i.e. intermediate link between connecting rod and piston). When crank moves from inner dead centre to outer dead centre vacuum will create in the cylinder. When piston moves outer dead centre to inner dead centre and piston force the water at outlet or delivery value.

EXPRESSION FOR DISCHARGE OF THE PUMP:-

$$Q = \frac{A\,L\,N}{60}$$

Where: - Q: - discharge in m^3/sec
A: - cross-section of piston or cylinder in m^2
L: - length of stroke in meter
N: - speed of crank in r.p.m

Experiment No. 10

Objective: To study about various types Hydraulic Devices as follows:

i. Hydraulic Lift

ii. Hydraulic Jack or Hydraulic Press

HYDRAULIC DEVICES

Introduction: There are many types of hydraulic devices in which force and energy are transmitted through an incompressible fluid, oil etc. These devices based on the principles of hydro-static and hydro-kinetics.

Classification of Hydraulic Devices

a) Hydraulic lift
b) Hydraulic jack
c) Hydraulic accumulator
d) Hydraulic crane
e) Hydraulic ram
f) Hydraulic intensifier

HYDRAULIC LIFT

Introduction: The hydraulic lift is a device used to lift or bring down passengers and loads from one floor to another in multi-storeyed buildings.

CLASSIFICATION OF HYDRAULIC LIFT

HYDRAULIC LIFT

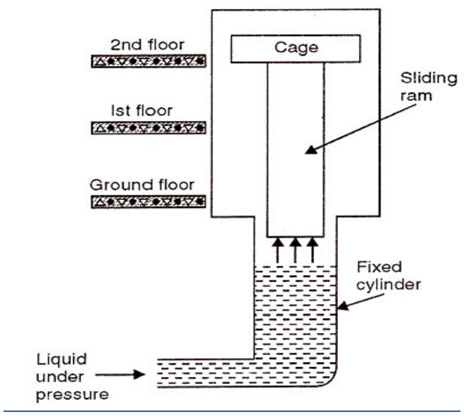
- Direct Acting Hydraulic Lift
- Suspended Hydraulic Lift

Direct Acting Hydraulic Lift

CONSTRUCTION DETAILS: Components of direct acting hydraulic lift:

- Fixed cylinder: It is fixed with the wall of the floor, where the sliding ram reciprocate when we apply the pressure.
- Cage: It is fitted on the top of the sliding ram where the load is placed (i.e. lifted load).
- Sliding ram: It is fitted in the fixed cylinder which is reciprocate (upward or downward direction) when we applied the pressure (i.e. reaches the floor wise.)

Diagram



WORKING OF DIRECT ACTING HYDRAULIC LIFT:

When fluid under pressure is forced into the cylinder, the ram gets a push upward. The platform carries loads or passengers and moves between the guides. At required height, it can be made to stay in level with each floor so that the good or passengers can be transferred.

In direct acting hydraulic lift, stroke of the ram is equal to the lift of the cage.

SUSPENDED HYDRAULIC LIFT

CONSTRUCTION DETAILS:

Cage: It is fitted on the top of the sliding ram where the load is placed (i.e. lifted load).

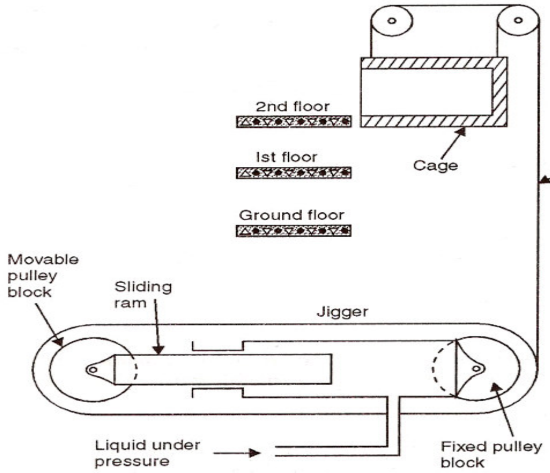
Wire rope: It connects the cage to pulley.

Sliding ram: It is fitted in the fixed cylinder which is reciprocate (upward or downward direction) when we applied the pressure (i.e. reaches the floor wise)

Pulleys: pulleys are connected to the sliding ram and fixed cylinder; where one pulley is fixed and other pulley is movable.

Hydraulic jigger: It consists of a moving ram which slides inside a fixed hydraulic cylinder.

Fixed cylinder-: It is fixed with the wall of the floor, where the sliding ram reciprocate when we apply the pressure.



WORKING OF SUSPENDED HYDRAULIC LIFT

When fluid under pressure is forced into the cylinder, the ram gets reciprocate to the movable pulleys. With the help of arrangement of hydraulic jigger; pulley can rotates; with the help of wire rope the cage is maintain there pressure force with there floor. At required height, it can be made to stay in level with each floor so that the good or passengers can be transferred.

Working period of the lift is ratio of the height of lift to the velocity of lift.

Idle period of lift is the difference of the total time for one operation and the working period of the lift.

HYDRAULIC JACK or HYDRAULIC PRESS

The hydraulic jack is a device used for lifting heavy loads by the application of much smaller force. It is based on Pascal's law, which states that intensity of pressure is transmitted equally in all directions through a mass of fluid at rest.

WORKING PRINCIPLE: The working principle of a hydraulic jack may be explained with the help of Fig. 23. Consider a ram and plunger, operating in two cylinders of different diameters, which are interconnected at the bottom, through a chamber, which is filled with some liquid.

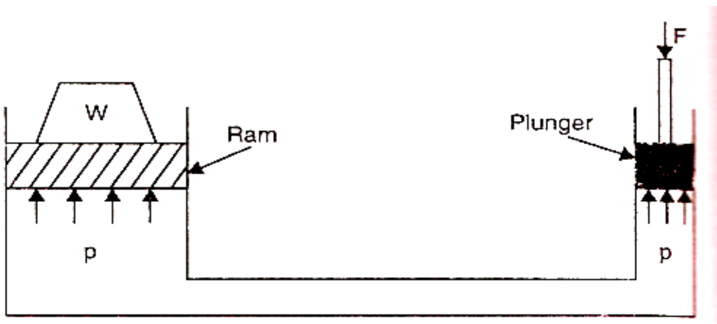


Fig. Hydraulic jack

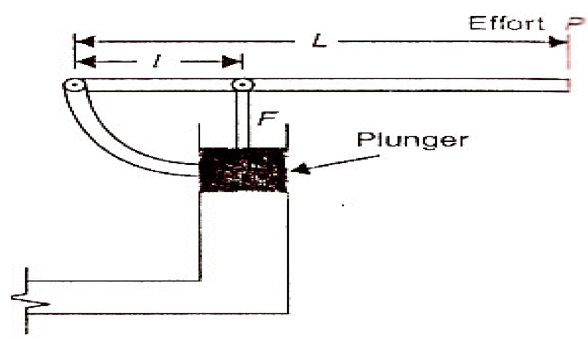


Fig. Plunger

Let
W= Weight to be lifted,
F = Force applied on the plunger,
A = Area of ram, and
a = Area of plunger.

Pressure intensity produced by the force F, p = F/Area of plunger = F/a
As per Pascal's law, the above intensity p will be equally transmitted in all directions.
Therefore, The pressure intensity on ram = p = F/a = W/A or W= F(A/a)
Above Equation indicates that by applying a small force F on the plunger, a large force W may be developed by the ram.
Mechanical advantage of press = A/a
If the force in the plunger is applied by a lever which has a mechanical advantage (L/l) then total mechanical advantage of machine = (L/l)(A/a)
The ratio (L/l) is known as leverage of press.

Hydraulic jack may be employed for the following jobs:

- Metal press work (to press sheet metal to any required shape).
- Drawing and pushing rods.
- Bending and straightening any metal piece .
- Packing press.
- Cotton press.
- To prepare moulds and casting of bakelite (Bakelite press).
- Forgoing press.
- Plate press.

Experiment No. 11

Objective: To study about various types of Steam Condensers.

Introduction:

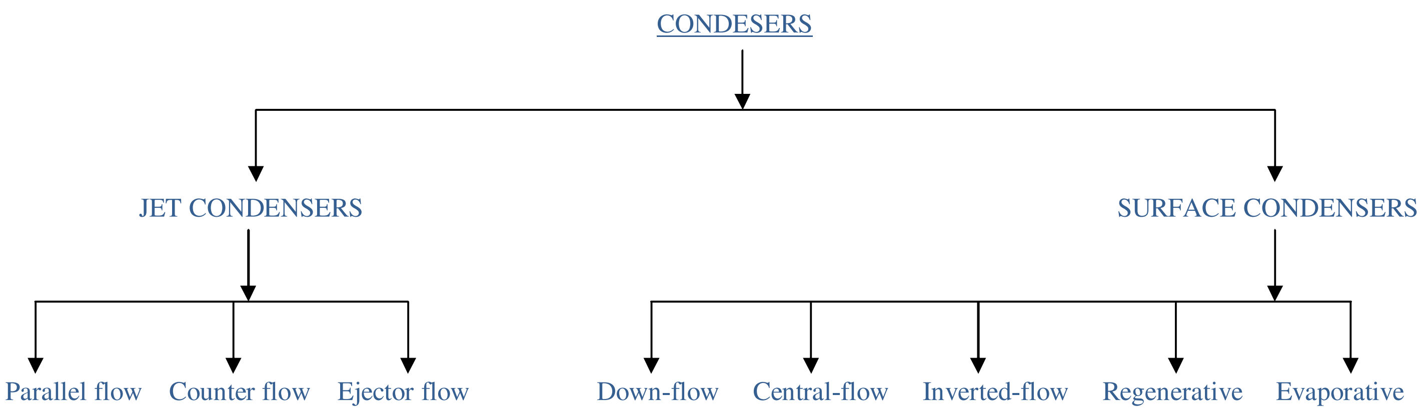
Steam Condenser: It is a device or an appliance in which steam condenses and heat released by steam is absorbed by water.

Classification of Condensers

1. Jet condensers
2. Surface condenser

Jet Condensers: The exhaust steam and water come in direct contact with each other and temperature of the condensate is the same as that of cooling water leaving the condenser. The cooling water is usually sprayed into the exhaust steam to cause, rapid condensation.

Surface Condensers: The exhaust steam and water do not come into direct contact. The steam passes over the outer surface of tubes through which a supply of cooling water is maintained.



PARALLEL-FIOW TYPE OF JET CONDENSER:

The exhaust steam and cooling water find their entry at the top of the condenser and then flow downwards and condensate and water are finally collected at the bottom.

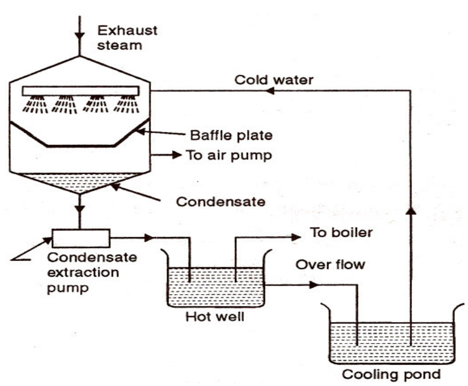


Fig. Parallel flow type condenser

COUNTER-FLOW TYPEJET CONDENSER:

The steam and cooling water enter the condenser from opposite directions. Generally, the exhaust steam travels in upward direction and meets the cooling water which flows downwards.

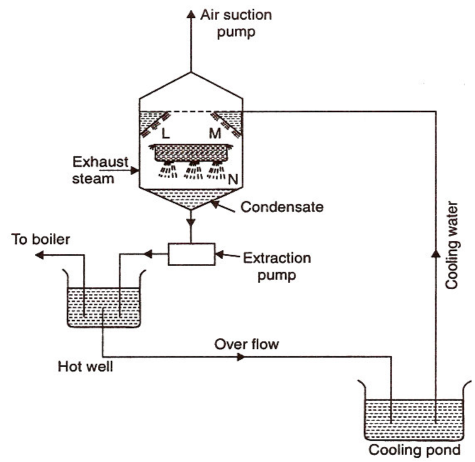


Fig. Low level counter flow type condenser

LOW LEVEL JET CONDENSER (COUNTER-FLOW TYPE JET CONDENSER)

Figure Shows, L, M and N are the perforated trays which break up water into jets. The steam moving upwards comes in contact with water and gets condensed. The condensate and water mixture is sent to the hot well by means of an extraction pump and the air is removed by an air suction pump provided at the top of the condenser.

HIGH LEVEL JET CONDENSER (COUNTER-FLOW TYPE JET CONDENSER)

It is also called barometric condenser. In this type the shell is placed at a height about 10.363 meters above hot well and thus the necessity of providing an extraction pump can be obviated. However provision of own injection pump has to be made if water under pressure is not available.

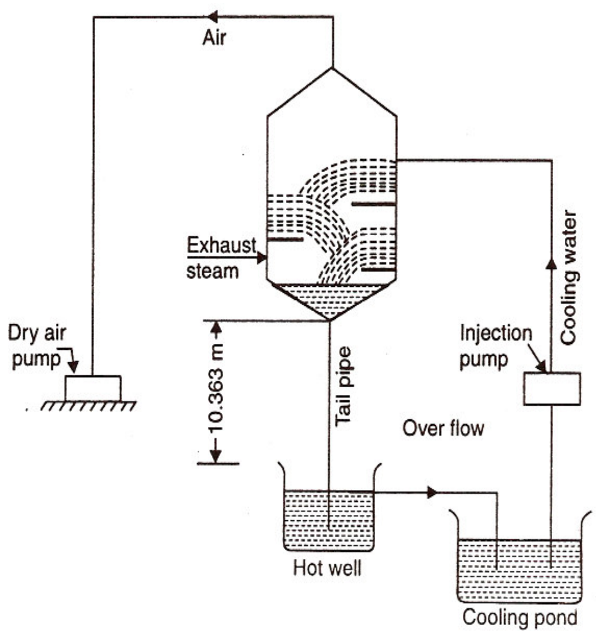


Fig. High level counter flow type condenser

EJECTOR CONDENSER FLOW TYPE JET CONDENSER

Here the exhaust steam and cooling water mix in hollow truncated cones. Due to this decreased pressure exhaust steam along with associated air is drawn through the truncated cones and finally lead to diverging cone. In the diverging cone, a portion of kinetic energy gets converted into pressure energy which is more than the atmospheric so that condensate consisting of condensed steam, cooling water and air is discharged into the hot well. The exhaust steam inlet is provided with a non-return valve which does not allow the water from hot well to rush back to the engine in case a failure of cooling water supply to condenser.

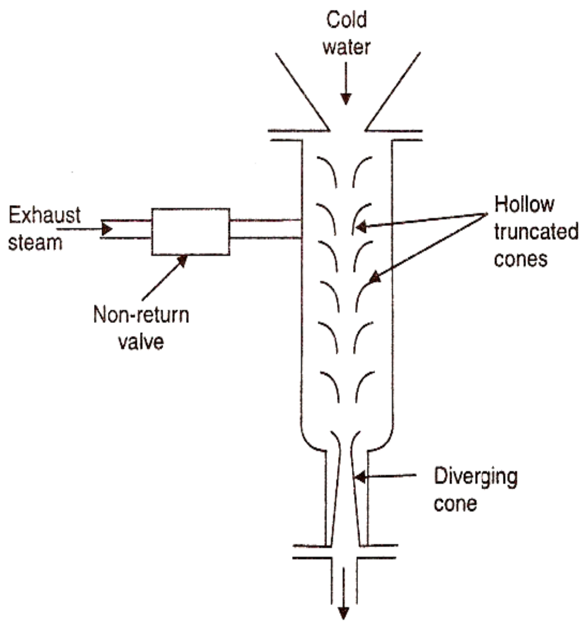
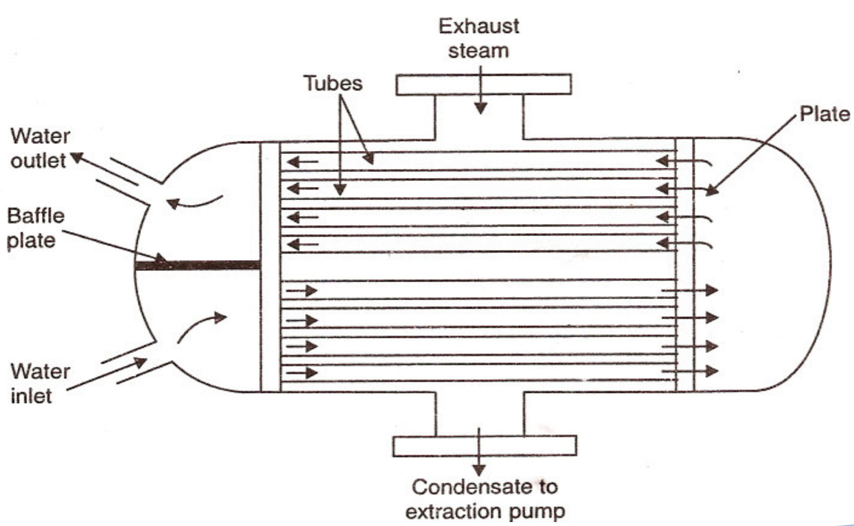


Fig. Ejector flow type condenser

SURFACE CONDENSERS

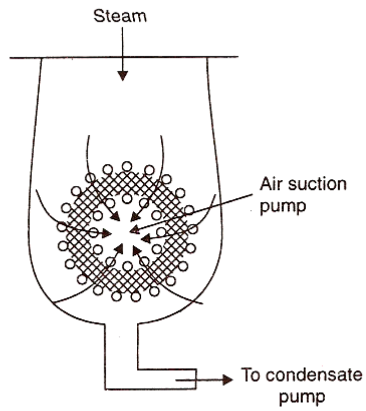
DOWN-FLOW TYPE:

The cooling water enters the shell at the lower half section and after traveling through the upper half section comes out through the outlet. The exhaust steam entering shell from the top flows down over the tubes and gets condensed and is finally removed by an extraction pump. Due to the fact that steam flows in a direction right angle to the direction of flow of water, it is also called cross-surface condenser.



CENTRAL FLOW TYPE:

In this type of condenser, the suction pipe of the air extraction pump is located in the centre of the tubes which results in radial flow of the steam. The better contact between the outer surface of the tubes and steam is ensured, due to large passages the pressure drop of steam is reduced.



INVERTED FLOW TYPE:

This type of condenser has the air suction at the top, the steam after entering at the bottom rises up and then again flows down to the bottom of the condenser, by following a path near the outer surface of the condenser. The condensate extraction pump is at the bottom.

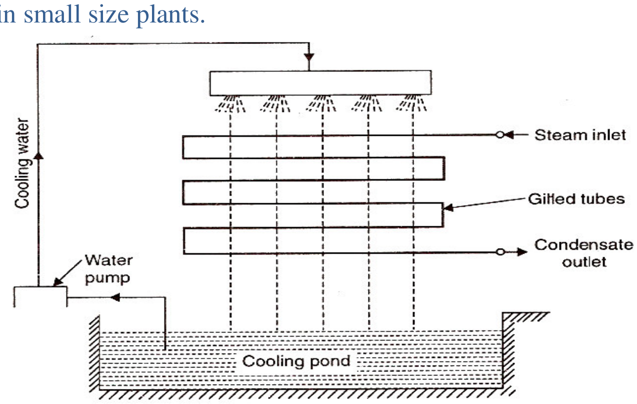
REGENERATIVE TYPE:

This type is applied to condensers adopting a regenerative method of heating of the condensate. After leaving the tube nest, the condensate is passed through the entering exhaust steam from the steam engine or turbine thus raising the temperature of the condensate, for use as feed water for the boiler.

EVAPORATIVE TYPE:

The principle of this condenser is that when a limited quantity of water is available, its quantity needed to condense the steam can be reduced by causing the circulating water to evaporate under a small partial pressure.

The exhaust steam enters at the top through gilled pipes. The water pump sprays water on the pipes and descending water condenses the steam. The water which is not evaporated falls into the open tank (cooling pond) under the condenser from which it can be drawn by circulating water pump and used over again. The evaporative condenser is placed in open air and finds its application in small size plants.



Experiment No. 12

OBJECTIVE: To calculate the S.F and B.M of simple supported beam with graphical diagram.

Introduction:

Shearing Force (S.F): The shearing force at a section along a loaded beam is the algebraic sun of all the vertical forces acting to one side of the section.

Bending Moment (B.M): The bending moment at any section along a loaded beam is the algebraic sum of the moments as all the vertical forces acting to one side of the section about the any point

Sign Conversions:

1. For S.F

   - If the force is upward the shearing force is positive.
   - If the force is downward the shearing force is negative.

2. For B.M

   - If the moment is clockwise the bending moment is negative.
   - If the moment is anti-clockwise the bending moment is positive.

Instrument Used: A wooden block with scale over the whole length of the block. And two supports with internally spring-it attachment with the base at both the ends in the instrument.

Diagram:

Calculation of S.F:

Calculation of B.M:

Graphical Diagram: