

① The factors based on which energy efficient motors are selected. Unit-4 (38)

* Energy efficient motors are selected based on the following factors.

1. The comparison of saving of electric power & life-cycle expenses with standard motors
2. Improved capability to operate under dangerous situations like abnormal voltage.
3. Minimum operating temperatures (or) lower heat output.
4. vibration (or) noise level.
5. Capability to accelerate loads of higher-inertia than the standard motors.
6. Maximum operating efficiencies at all points of load.

The advantages & disadvantages of energy efficient motors.

Advantages:-

1. Less operating cost
2. operate more adequately under abnormal voltage.
3. Electric power is saved.
4. Less operating temperature.
5. Low noise level
6. Higher speed than standard motors
7. Less maintenance cost & improved operation in industry
8. Increasing the production.

Disadvantages:-

1. portability
2. High initial cost
3. speed control.

* A short note on Luminaire:-

A luminaire is a device that delivers, filters (or) converts the discharged light given by one or more lamps. It is also known as light fitting.

It consists of all the components needed for fixing or holding the lamp in appropriate position and for protecting the lamps.

Light fittings are classified into different types as given below.

1. Direct lighting

2. Semi-direct lighting

3. Diffused lighting

4. Indirect lighting

5. Semi-indirect lighting

Advantages of variable frequency drives:

The following are the advantages of variable frequency drives

1. The speed of an induction motor can be controlled from zero value to zero value to value above the base value.

2. The performance of the induction motor under transient and steady state conditions will be good.

3. The speed regulation is small.

4. The power factor is quite high, due to which the copper losses are reduced.

5. Efficiency is high due to low losses.

6. The current drawn will be comparatively less.

7. These drives are more reliable and are preferred over D.C drives.

The demerits of variable frequency control of induction motors:-

1. This method will give efficient results for speeds up to rated speed. For speeds greater than the rated speed, the torque capability decreases.

2. The performance of the motor will be efficient if the operation is restricted to the linear & stable region of the speed torque characteristic.

3. The cost of variable frequency fed induction drives will be high.

Ventilation:-

It is defined as the process of either removing or supplying air to and from a particular room, space or unit of a structure with the help of natural means. It is considered as an important factor in building planning and every structure should have provision of ventilation in it. As a result the room gets contaminated due to the respiratory

②

action, bacteria present and bad odours. sufficient ventilation. If provided removes such contaminated air and also helps to regulate the temperature difference inside the building. In case, if the ventilation provided is not adequate, it may result in increase in temperature as well as humidity inside the room which causes several discomforts to the people living in the room like headache, nausea, sweating, sleepiness, lethargy etc.

DSM planning framework:

Demand side management consists of five elements. They are as follows

1. Setting of objectives
2. Identifying alternatives
3. Evaluation and selection of programs
4. Implementation of programs
5. Monitoring the programs

Implement DSM programmes:

The following are the points that are considered for successful implementation of demand side management

1. For research and experimental work, funds should be organised
2. Making awareness and motivating the consumer is the important factor
3. Non-conventional energy adopted by the users should be provided by utilities
4. Efficient safety plans should be given the government to the consumers for purchasing energy efficient appliances
5. Beneficial policies and decisions taken by government plays a vital role in the promotion of DSM programmes

Advantages of DSM

1. Generation cost of electricity is minimum
2. Innovation in technology of DSM results in new jobs
3. Consumer is benefited from the reduction in their energy bill
4. Green house effect due to harmful gases is mitigated
5. Shutdown of power plants for maintenance is minimised

Types of fuels:-

1. Hydrogen

2. Hydrocarbon fuels

3. Natural gas

4. Alcohol fuel

5. Hydrogen fuel

properties to be considered in selection of fuel cells:-

1. The energy conversion efficiency should be high

2. It should not cause chemical pollution

3. It must possess flexibility to work with any fuel

4. It should be highly responsive to loads and operation of fuel cell:-

Fuel cell is an electrochemical device in which electrical energy is generated by chemical reaction. When cell operates, the fuel oxidizes and chemical reaction provides the energy which can be converted into electricity. The major problem associated with the operation of a fuel cell is to obtain sufficient fuel-electrolyte reaction in a given volume. Therefore, the composition of electrolyte should not change as the cell operates.

The fuel cells convert hydrocarbon fuel into a hydrogen rich gas that is compatible with the cell. The major problem in fuel cells development is finding a way to convert low grade fuel into H_2 rich gas that has minimum impurities. Another problem is that, sulphur material adversely affects the fuel processor. presently, the research is directed to find a cell electrolyte that is more tolerant of fuel impurities.

classification of A/C compressors:-

They two types. They are

1. Reciprocating compressors

1) According to process of compression

a) single stage - pressure range upto 10 bar

b) multi stage - pressure range above 10 bar

2) According to air compression process in the cylinder

a) single acting

b) double acting

2. Rotary compressors

a) positive displacement rotary compressor

b) dynamic type rotary compressor

Functions of air compressors

1. They have more applications in automobile industry
2. It is a vital component for refrigeration system
3. These are used for operating pneumatic hand tools
4. To operate air brakes in automobile, tram rfts and in pneumatic conveyors,
5. To supercharge IC engines
6. For transmitting power in machines
7. For starting diesel engines
8. These are also used for mining applications

Difference between Reciprocating & Rotary compressors:-

Reciprocating compressor	Rotary compressor
1. They have maximum delivery pressure of about 100 bar	1. They have maximum delivery pressure of about 10 bar only
2. Suitable for high pressure & low discharge air	2. Suitable for low pressure & high discharge of air
3. Air-compressor speed is low	3. Air compressor speed is high
4. They possess intermittent air supply	4. They possess continuous air supply
5. Air-compressor size is large for given discharge	5. Air-compressor size is low for given discharge
6. They have complicated lubricating system	6. They have simple lubricating system
7. Less clean air is supplied due to contact with lubricating oil	7. More clean air is supplied as it does not come in contact with lubricating oil
8. In these compressors balancing is major problem	8. No balancing problem in it

Classification of pumps:-

A pump is a machine or device which converts mechanical energy into pressure energy (i.e. adding energy to water)

pumps classification —
 → positive displacement pumps
 → rotary pumps

1) positive displacement pumps:-

It has a piston & cylinder arrangement in which fluid is alternately flooded and expelled. Discharge depends on crank speed. These pumps are used for high discharge & large pressure rise. Ex: Reciprocating pump

2) Rotodynamic pumps:-

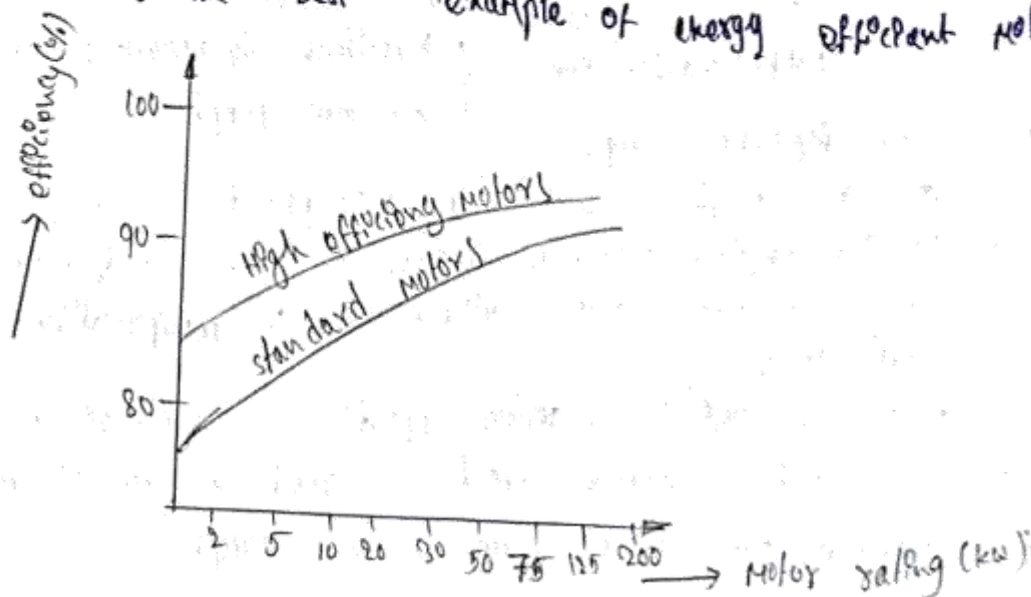
It has an impeller & action depends on change of angular momentum of rotating element. Discharge depends on speed & size of impeller
 Ex: centrifugal pump, screw pump & vane pumps

Need of energy efficient motors

1. when purchasing a motor for a new installation
2. when major changes are made to existing provisions or procedures
3. for old new purchases of apparatus collection containing electric motors like compressors, air conditioners & filtration systems
4. when buying spares for exchanging damaged motor
5. As a substitute for replacing old standard efficiency motors
6. To exchange under loaded & grossly oversized motors
7. As a part of preventive maintenance program (or) an energy management
8. protecting other devices
9. Improve efficiency
10. when an energy study reveals enough saving for an application
11. when utility preservation programs, rebate (or) incentives are proposed that causes the retrofit of energy efficient motor cost-effective

Energy efficient motor (EEM):-

A motor which delivers the same shaft output power by consuming the less amount of input power than a standard efficiency motor is known as energy efficient motor. It is also known as "efficiency premium motor" (or) energy saving motor "or" high efficiency motor". Unlike the standard motor, energy efficient motor competes on efficiency instead of price. This motor can operate continuously at (or) heat rated load. If the motor operates more, the cost saving will be more. For example the run of a ventilating fan for 24 hrs per day for all the seven days in the week is the best example of energy efficient motor.



(4)

The manufacturing materials and electrical and mechanical design of Motors gives us final efficiency. In order to achieve higher efficiency these motor are employed with high quality & optimized design. The rotor losses in energy efficient motors can be reduced by employing stator with large diameter copper wire & rotor with more aluminium.

Constructive description:

The energy efficient motors (ECM) are constructed by altering the same frame T-frame motor, but have the following differences:

1. stator with higher quality and thinner steel laminations
2. winding with more copper
3. Better air gap between the rotor & stator
4. DPMPSher fan losses
5. Neardy matching tolerances
6. Greater length
7. Rotor frame with high quality aluminium

Energy efficient lighting control

Lighting control is one of the most advanced areas of lighting technology whose primary objective is to increase a comfort lighting quality & conserve energy. The energy can be conserved by decreasing the light levels, by dimming or switching off lamps along with energy conservation when varying levels are required, a modern method of control.

The lighting control system is based on:

1. Time scheduling
 2. Monitoring the presence of human
 3. Dimming control based on intensity of daylight.
 4. Constant lighting level control and other things
- Factors considered for selection of luminaire

Selection of luminaire is one of the important elements to be considered in estimating the energy efficiency of overall system in the design of lighting scheme. The selection of luminaire mainly depends on following factors:

- i) Type of lamp
- ii) Nature of reflector

9) Type of lamp:-

The type of lamp is selected based on the area of work surface. For smaller area, tubular fluorescent lamps (or) tungsten filament lamps are used, while Mercury discharge lamps (or) sodium lamps are recommended for larger areas such as industrial lighting.

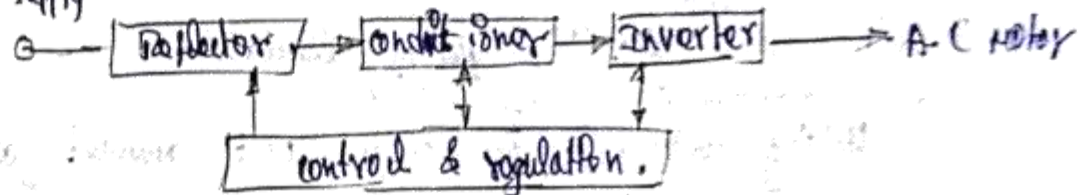
10) Nature of Reflector:-

Depending on the illumination required, the type of reflector is selected:

1. standard reflectors,
2. Diffused lighting
3. concentrating reflector,
4. Angle variable frequency drives

Variable frequency drive is also known as an adjustable frequency drive (or) variable speed drive. It is a device which converts an AC supply voltage into DC voltage & vice versa.

3- ϕ supply



As shown in figure, a variable frequency drive comprises of four important components such as rectifier, conditioner, inverter & controller.

Advantages:-

It is very commonly used for:

Ventilation:-

1. preventing the undue concentration, due to the following reasons
2. To carry away the heat produced either by any electrical (or) mechanical equipment (or) the heat produced by the human body
3. To stop the unwanted congregation of dust, smoke, fume & bad odour
4. for creating the healthy living conditions inside the building by obstructing the accumulation of unwanted carbon dioxide & moisture

Air conditioning:-

Air conditioning is defined as the process of conditioning (or) controlling air with respect to temperature, humidity, purity & distribution to meet the physiological requirement industrial process.

- 5) Necessity of Air conditioning (or) necessity of Refrigeration:- (12)
- For maintaining is an important process employed for the following reasons
- 1) For maintaining the temperature in storage space as per the requirement
 - 2) with the aid of refrigeration better controlling of temperature can be achieved
 - 3) Fresh fruits, vegetables meat etc. can be prevented from dehydration
 - 4) Ice can be manufactured easily through refrigeration

HVAC controller

HVAC (Heating, ventilation and air conditioning) system are used to deliver the air (heated or cooled) to various parts of the surface area. They help to add or remove unwanted air conditions, heat, noise from the area to maintain the desired environmental condition. HVAC device need to be controlled properly, otherwise, heat leaks into the room and make the device to take extra load. Different types of control systems used to control HVAC are as follows

i) Self-powered control system

Self-powered control systems are the type of system in which no external power is required to control the equipment they work on the principle of expansion and contraction of bellows. The bellows are filled with the wax which has high coefficient of expansion. As the temperature increases the wax in the bellows expands and results in radiation values. Ceiling and diffusers are the examples of self-powered controlled

ii) Electronic control system

As the name indicates the electronic control system electronic control classified system

(a) On/off electrical control system

(b) Modulating electrical control system

(iii) Electronic control system

Electronic control systems are also known as electrical system. They control the devices by varying the voltage and current

- (a) Time for Pressure to build up at electrode
- (b) Time for metal to cool
- (c) Time interval between consecutive welding operation.

Demand side management (DSM):

Demand-side management is the term to describe the various implementations and monitoring of electricity used by the consumer to assist the desire in the utility load curve.

Explanation:

Demand-side management is a strategy adopted by electric utility to control of electricity and period of its usage. This is carried out so as to make an effective use of the insufficient energy increase of demand or change between peak periods for irregular, tough demand.

This DSM aims at reducing high energy periods, increase dependency on system, decrease the emergency as black out, transmission, protecting the environment.

Thus, DSM is low in cost, fast and tidy technique to overcome problem in power system operation and control.

DSM planning elements:-

1. Setting of objectives:-

DSM initially sets up a set of objectives which are to be fulfilled. Some of these objectives are to reduce energy needs, reduce depends on foreign imports, improve cash flow, supply relation.

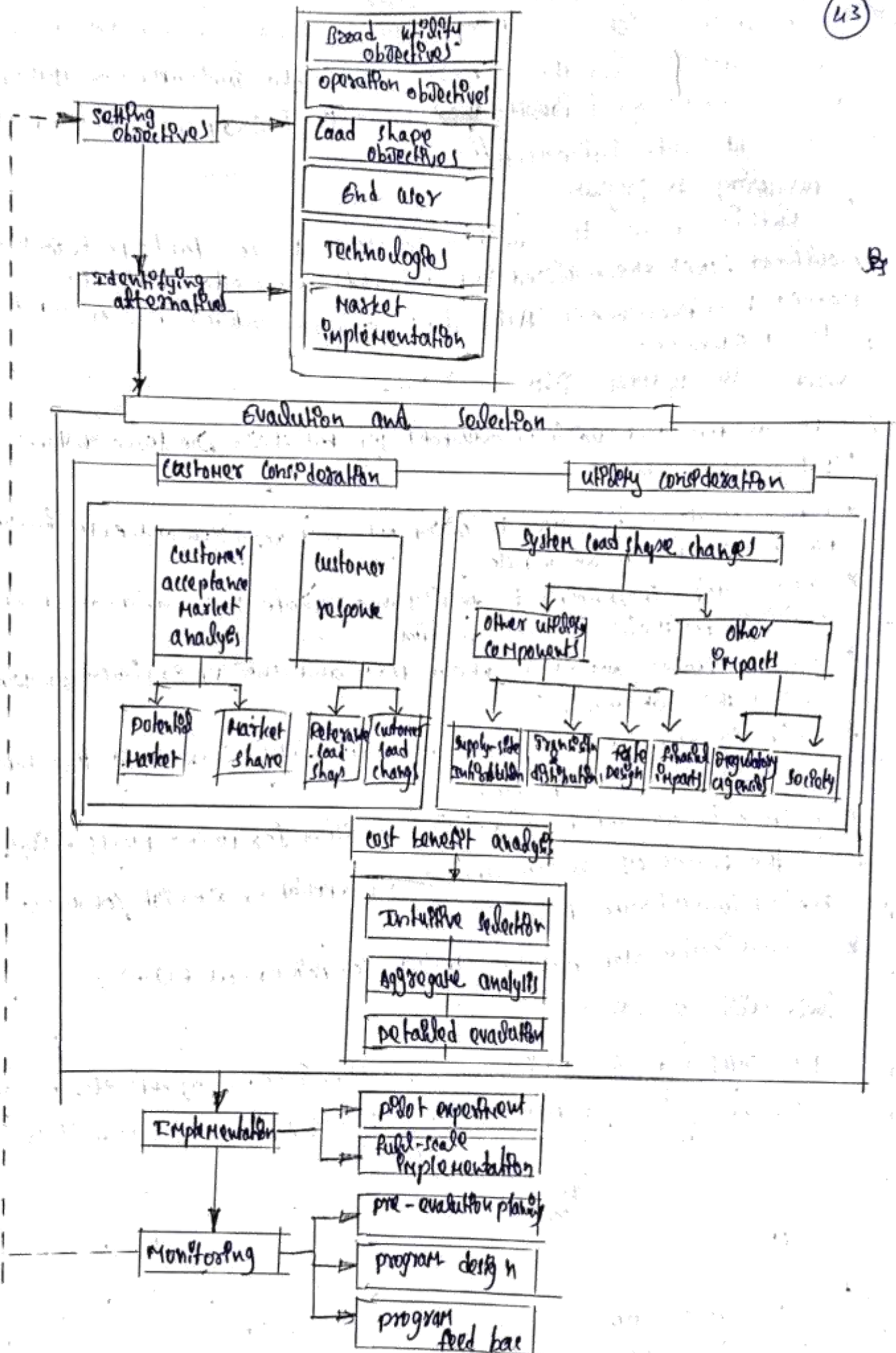
There are many load shape changing possibilities available: peak clipping, valley filling, load shifting, strategic conservation, strategic load growth, flexible load shape etc. which can be used in combinations.

2. Identifying Alternatives:-

In this the various Alternative Available are determined. Here initially load curve objectives which has been set up in the previous stage is matched to Peak energy consumption curves of the various end users (commercial, industrial) Thus the end user load curves with the load pattern changes are selected.

(6)

43



4. Implementation of program
 In this stage a high level DSM Project team is formed with persons from Team is responsible for the entire control and implementation of the process. The implementers must provide the team with. It is suggested that a pilot is brought into implementation.

5. Monitoring the program

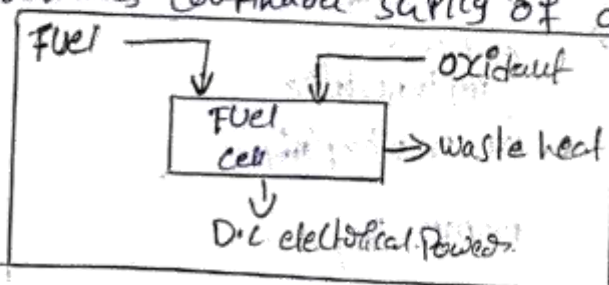
In this stage the variation between the resultant performance is monitored. Then the required improvements are made both present and planned DSM programmes. This stage possesses evolution and examination of DSM programme.

Obstacles to Implement DSM programmes

Though DSM has various advantages but there are some obstacles faced by it for the implement.

- * Finance is the main source to carry out any research and experimental work which becomes an obstacle
 - * Utility companies inefficiently in collecting an accurate information about energy adding for their current operation
 - * Lack of proper awareness about DSM and energy efficiency programming among the consumers
 - * Illiteracy and less knowledge about the advertisement in the technology among the consumer/people.
 - * Political involvement in the pricing decision for power plays a vital role.
 - * As the prices of energy efficiency appliances are high consumer is showing low interest to buy it
 - * Communication gap between utility companies and users
- #### Fuel cell & classification

Fuel cell is a device which converts chemical energy into electrical energy. It requires continuous supply of a fuel and oxidant and shown in figure

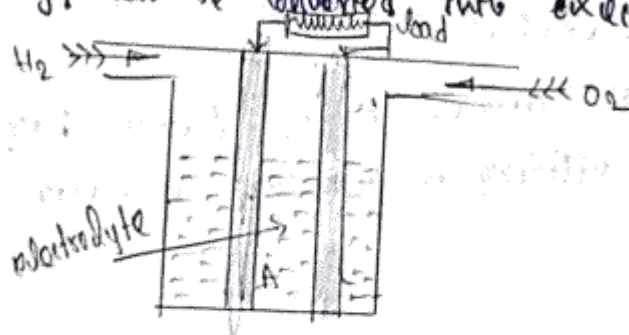


- According to the type of fuel and oxidant used,
- (i) H_2 - O_2 fuel cell
 - (ii) H_2 - air fuel cell

- Advantages of fuel cells
1. Conversion efficiency is very high
 2. Transmission of power is not required because they can be installed near the usage
 3. No noise pollution (or) poisonous effects
 4. Space requirement is less
 5. No cooling water is required on large scale
 6. They can start in less time
 7. There are no moving parts, therefore maintenance cost is less
 8. Its weight & volume are considerably low compared to other energy sources
 9. A wide variety of fuels can be used with the fuel cell
 10. part-load efficiency remains constant

Working of fuel cell

"Fuel cell" is an electrochemical device which generates electricity by chemical reaction. The basic difference between storage battery (or) primary cell & fuel cell is that the electrode and the electrolyte are permanent. When cell operates, fuel is oxidized and chemical reaction provides the energy can be converted into electricity.

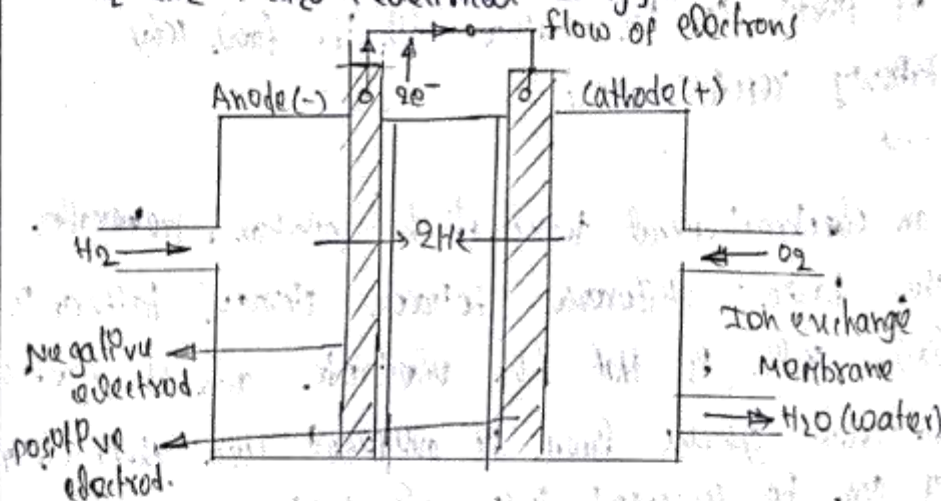
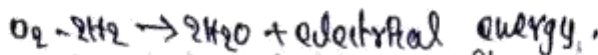
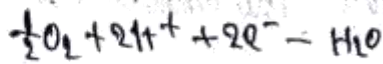
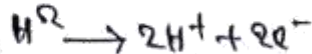


Working

Fuel is supplied to anode where it is oxidized thereby releasing electrons, which flow in the circuit, and the hydrogen ions which pass through the electrolyte to the cathode combine with oxygen and electrons to form water. Electrodes for this type of cell are usually porous impregnated with a catalyst. In liquid electrolyte, a diaphragm is added must be considered.

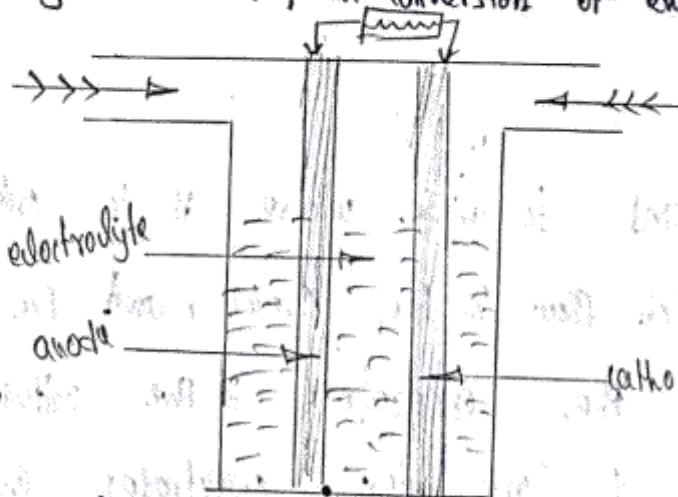
Ion exchange membrane fuel cell

It is also called as polymer electrolyte fuel cell. This type of fuel cell consists of an electrolyte which is in the form of solid polymer membrane, two electrodes, inlet and outlet sections for fuel, oxidiser and water. The electrolyte membrane comprises of an organic material i.e., polystyrene sulphonic acid. This membrane is not conductive to electrons, while it is permeable for hydrogen.



Proton exchange membrane fuel cell

Fuel cell converts chemical energy directly into electrical energy. It possesses higher efficiency in conversion of energy.



An external electrical load, connected to anode and cathode through which electrons are separated from fuel, hydrogen

⑧ windows at the anode flow, which constitutes the electron current. These electrons are returned to the cell at cathode where they are absorbed by the H_2O_2 ions to form water (H_2O). The electrolyte is necessary to conduct the positively charged hydrogen ions from the anode electrode to the cathode electrode to complete the circuit. The electrodes must be good highly resistant to corrosive environment.

operating efficiency of fuel cells

It is defined as the efficiency to convert the chemical energy of fuel into electrical energy. The overall efficiency of fuel cells is always below 100%.

$$\therefore \eta_{\text{overall}} = \eta_{\text{thermo}} \cdot \eta_{\text{volt}} \cdot \eta_{\text{fuel}} \cdot \eta_{\text{design}}$$

1) Thermodynamic efficiency (η_{therm})

It is expressed as

$$\eta_{\text{therm}} = \frac{Q_{\text{out}} - Q_{\text{lat}}}{Q_{\text{out}}}$$

And $Q_{\text{out}} = W_e + Q_{\text{lat}}$

where

Q_{out} - reaction enthalpy

Q_{lat} - latent heat in reaction

W_e - Energy of current flowing

2) Voltage efficiency (η_{volt})

It is expressed as

$$\eta_{\text{volt}} = \frac{U_p}{E^0}$$

where

U_p - operating voltage at current density i_p

E^0 - E.M.F value of a fuel cell

In case of hydrogen-oxygen fuel cells, the value of E^0 at 25°C is 1.229 V

3) Coulombic efficiency (η_{coul})

It is generally known as faradaic efficiency. All the reactants in a fuel cell may not be used for producing electrical

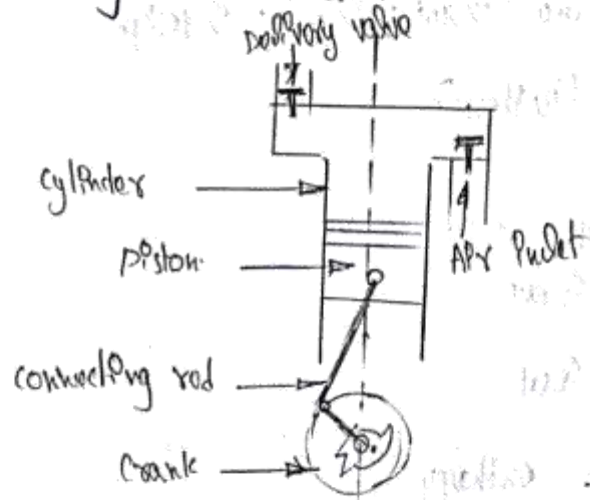
W) overall efficiency ($\eta_{overall}$):

The fuel used to generate the electrical energy, a part of which is also used for operating equipment like pumps and control devices.

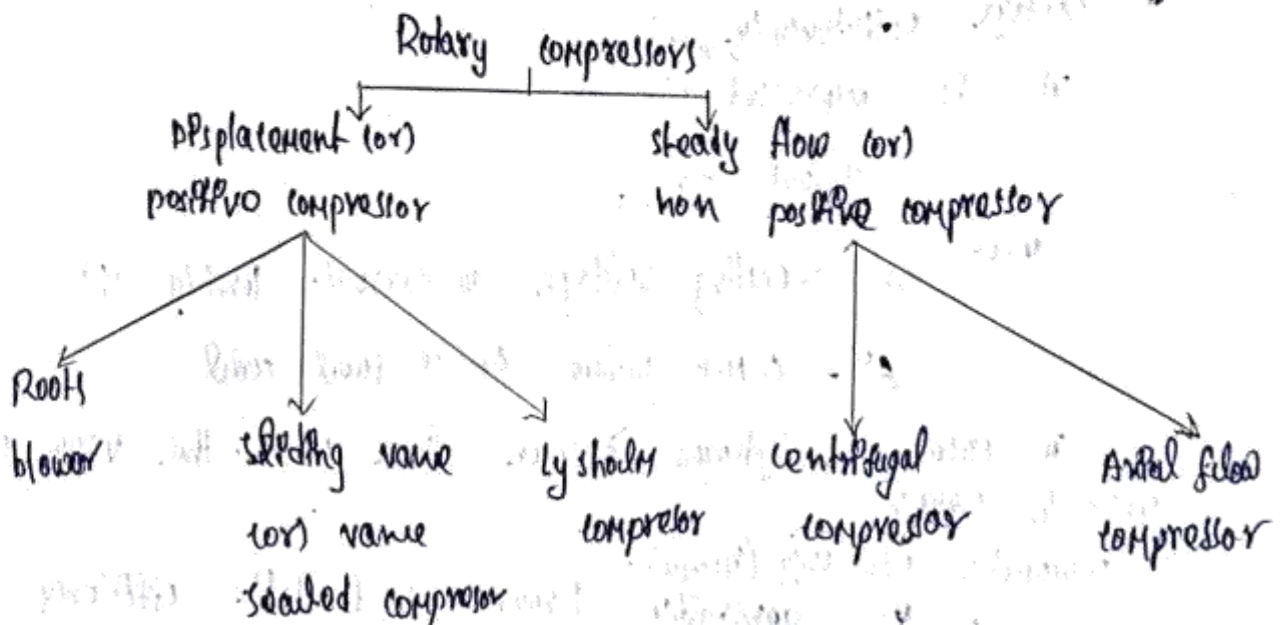
Thus, the overall efficiency is the product of all the above efficiencies and is an important factor that influences the power generation.

Single cylinder reciprocating A/C compressor

A single acting single cylinder reciprocating A/C compressor is simplest in construction among all the types of compressor. It consists of a cylinder, piston, connecting rod, a crank and valves.



classifications of rotary compressors:-

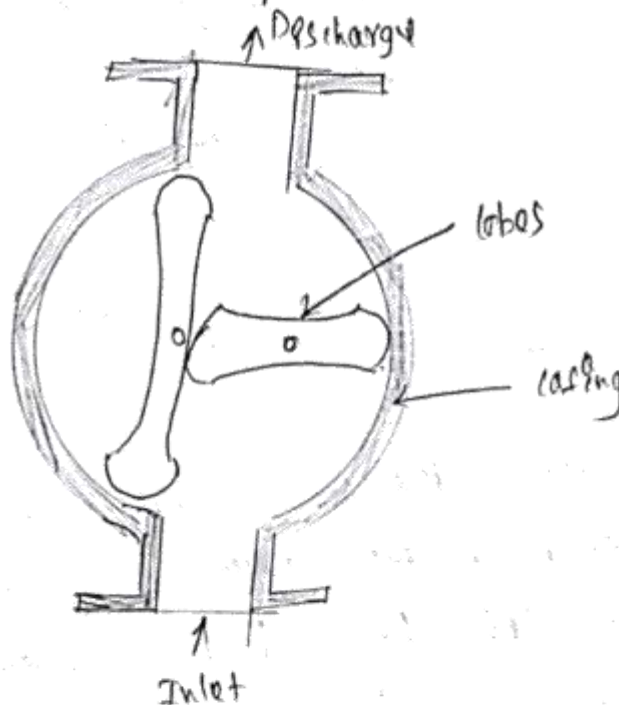


Q

working roots blower:-

46

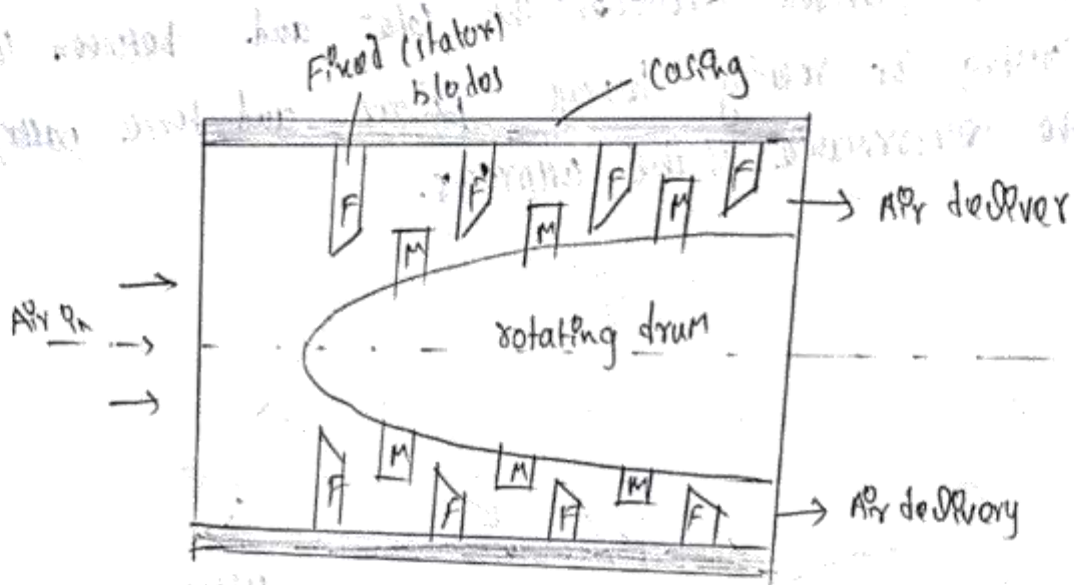
The roots blower compressor consists of two (or) lobes on two separate axes as shown in figure. One of the rotor is directly connected to a drive and the other is driven by gear connected to the first. These rotors rotate in opposite direction to each other. The rotor (or) lobes are of cycloidal (or) involute profile and are connected in such a way as to seal the delivery side from the suction (or) inlet side. A small clearance is to be provided between the lobes and between lobe and the casing for reducing leakage passage and hence passage & affects the performance of the compressor.



from the intake Port The air enters into the casing and the air trapped the rotors or lobes moves along the Port and then discharges through the discharge Port to the receiver. But when the outlet Port is open, the gas from the receiver flow back as it is high pressure and causes an irreversible pressure rise or back compression up to the delivery pressure and it is shown in P-V diagram by dotted lines.

Axial flow compressors

An axial flow compressor consists of adjacent rows of fixed and moving blades. A set of fixed and moving blades is called as a stage of compressor. In this type of compressor the flow air is fixed to the rotating drum as shown. In figure the blades are so arranged that the space between them forms diffuser passage. In order to keep the flow velocity constant, the annular area is reduced from the inlet to the outlet of compressor.



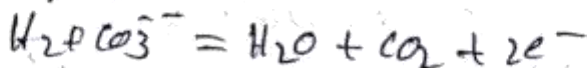
During its work the work input is provided to the rotating shaft which transfers to the acceleration of air to the moving of rotor blades. This leads to the acceleration of air.

Generally there are two types of rotors used. They are:

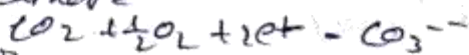
1. Drum type (used for static industrial applications)
2. Disk type (" " ")

Thus the CO_3 ions formed are directed towards anode and cathode. Continuous reaction at anode and cathode.

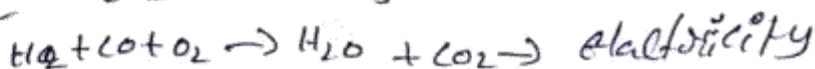
at Anode.



At Cathode

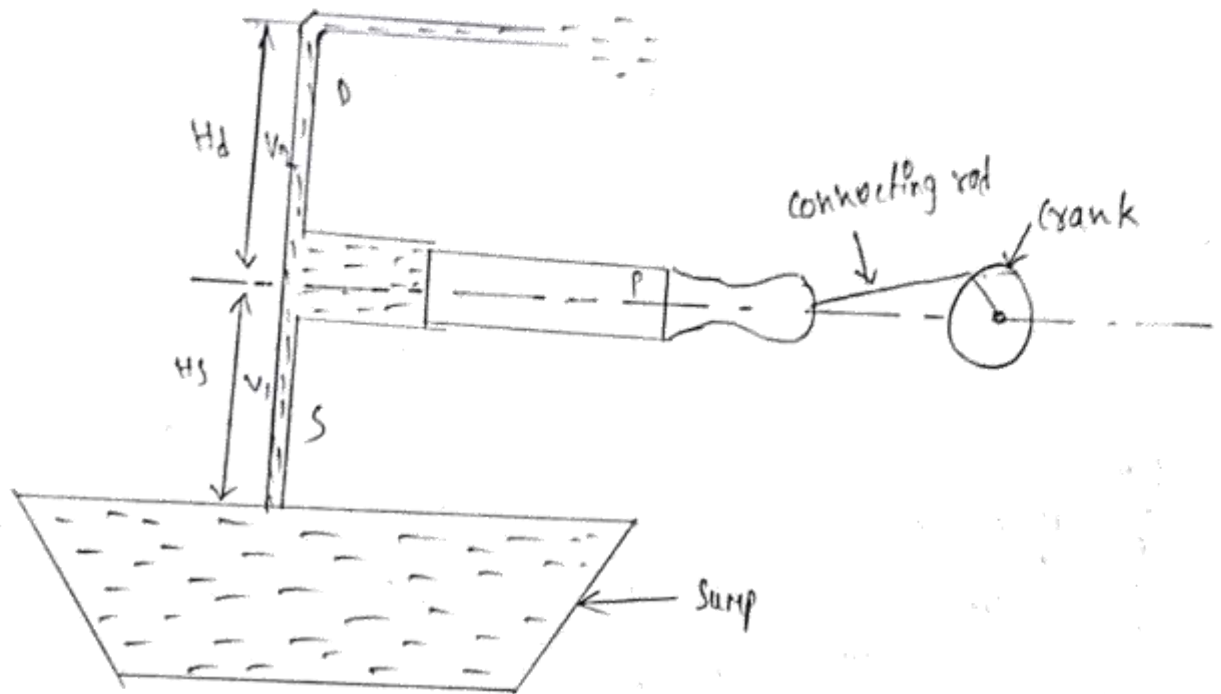


Overall



Reciprocating pumps:

Reciprocating Pump is a positive displacement pump in this pump the liquid is first sucked into a cylinder and then displaced or pushed by the back of piston or plunger. The pump consists of a cylinder and piston. The cylinder is incorporated with suction and delivery pipes. The piston is moved by external source through crank and connecting rod.



The movement of piston produces alternately negative pressure if the liquid acts on only one side of the piston. It is called as single acting if the liquid acts on both sides it is called as double acting pump.

The rotation of the crank brings about an about the piston in cylinder.

For one revolution of the crank the quantity of water raised up in the delivery pipe is equal to stroke volume in the total height of water.

$$H_t = H_s + H_d$$

H_s - suction head or weight of axis of the cylinder

H_d - Delivery head above the cylinder axis

The Advantage of the Pump.

$$Q = \frac{A \cdot L \cdot \omega}{60} \text{ m}^3/\text{sec}$$

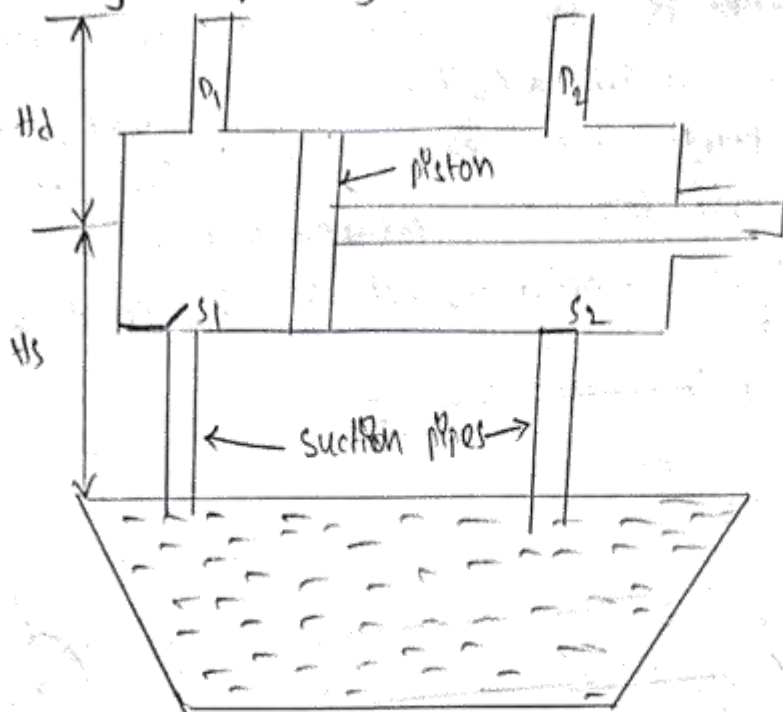
where

A = Area of the piston

L = Stroke length

ω = number of strokes/min

Double-Acting Reciprocating Pump



Where

- D_1 = Delivery valve (closed)
- D_2 = Delivery valve (being open)
- S_1 = Suction valve (being open)
- S_2 = Suction valve (closed)

Advantages of centrifugal pumps over reciprocating pumps

The Advantages of centrifugal pumps over reciprocating pumps are:

1. Initial cost for installation of centrifugal pumps is low.
2. Installation and maintenance of centrifugal pump is easier and mechanical has small number of components.
3. It is very compact and requires less space.
4. It is a high speed pump and can be directly coupled to oil engine.
5. Discharging capacity of centrifugal pump is high than reciprocating pump.
6. Discharge through the centrifugal pump is uniform.
7. Torque is uniform for centrifugal pump.
8. The efficiency of lifting high viscous fluids like oil is better.
9. There is no danger of separation and cavitation of liquid in the pump.
10. For same capacity and energy transferred the gross weight of centrifugal pump is less than the reciprocating pump.