ARYAN SCHOOL OF ENGINEERING & TECHNOLOGY

BARAKUDA,PANCHAGAON,BHUBANESWAR,KHORDHA-752050

LECTURE NOTE

SUBJECT NAME- POWER STATION ENGINEERING

BRANCH – MECHANICAL ENGINEERING

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Hydro electric power plant:

Introduction :- A hydro electric power plant generates electricity by using potential energy of water stored at a height, when water falls from a height. potential energy stored in water gets converted to kinetic energy.

→ This kinetic energy is converted into Mechanical energy by hydro turbine.

→ Alternators connected to turbine converts mechanical energy into electrical energy.

→ India has hydro power potential of 1,48,701 MW at 60% load factor.

→ Small hydro can contribute about another 2000 MW.

→ The present installed capacity of hydro plant in India is 45,293 MW (Apr 2018 Report).

Hydro power generation potential in India:—

SI No	River Basin	Potential at 60% load factor
1	Indus	33832 MW.
2	Ganga	20711 MW.
3	Central India	4,152 MW.
4	Rivers of Southern India [West Flowing]	9,430 MW.
5	Rivers of Southern India [East Flowing]	14,511 MW.
6.	Brambhaputra	66,065 MW
	Total	1.48,701 MW.

Region wise distribution of hydro power generation:—

Sr No	Region	Installed Capacity (MW)
1.	Northern	18909.27 MW
2.	Western	7398.00 MW.
3.	Southern	11,727.70 MW
4.	Eastern	5862 MW
5.	North-Eastern	1842.00 MW
		45298.92 MW

Selection of site for hydro power plant:—

1) Availability of large quantity of water.
2) Availability of large water storage.
3) Water at high head.
4) Quality of available water at site.
5) Silitation
6) Geological Condition of site.
7) Possibility of division of stream.
8) Availability of large area.
9) Accessibility to site.
10) Nearness to load centre.
11) Availability of large catchment area.

Terms associated with hydro power generation:—

1) Hydrology:— it deals with depletion and replenishment of water resources over and under the surface.
   - it includes all water that falls on the surface of earth.
   Ex. Rain, ice, hail, dew, sleet, frost etc.
   - it aims at transportation of water from one place to another and from one form to other.

2) Hydrological cycle:— Most of surface and underground water resources receive water from rain and snow.
   - Rainfall results from evaporation of water from rivers, lakes, ponds, oceans etc.
   - This is precipitated back as rain, snow, dew, frost, hail, sleet etc.
   - the process of evaporation and precipitation is called hydrological cycle.

Hydrograph:— It is a graph betn discharge with respect to time.
- Discharge is taken on vertical axis and time on horizental axis.
- This graph indicates flow rate of water in the steam at different time of day or year.
- This indicates minimum, average and maximum flow during the period.
- Area under the curves given total discharge upto a time. knowledge of this information helps to decide minimum and maximum firm power of plant.

(iv) Precipitation:— It is total condensation of moisture that reaches earth in all forms.
- It include rain, snow, sleet, dew, hail, frost etc.

(v) Evaporation:— It is transfere of water from liq to vapour phase from all sources of water on land, ocean, and vegetation.
- It is a portion of rainfall that does not flow in the steam and hence can not be used by power plant.

(vi) Transpiration:— It is a process of release of water by plants to atmosphere.

(vii) Run-off:- It is part of precipitation that is available as stream flow.
- out of total precipitation a part of it evaporates, a part percolates through soil. a part is absorb by vegetation and remaining flown as stream.

(viii) Stream flow:— It is the amount of water flowing in a stream.
- for determination of capacity of hydro power plant it is required to estimate the quantity of water flowing in a steam and variation on flow over a long period of time.
- Average flow gives the capacity of power plant while max flow estimation of flood level which helps in design and spillway.

(IX) Flow duration Curve:— It is a graph betn available flow duri
a period against percentage of time.
- Period of time can be a day, month, or a year.
- Either Ordinate flow duration Curve represents total quantity of run-off during the period.
- It is used for determination of min and max flow Condition
- Max flow Condition decides design of spillways for Flood Control.

(X) Mass Curve:— It is a graph betn Volm and run-off against time.
- Discharge is taken on y-axis and time [day, month, years] is taken on x-axis.
- Slope of Curve at any point indicates rate of flow at that time.
- Mass Curves are used to estimate Capacity of storage reservo

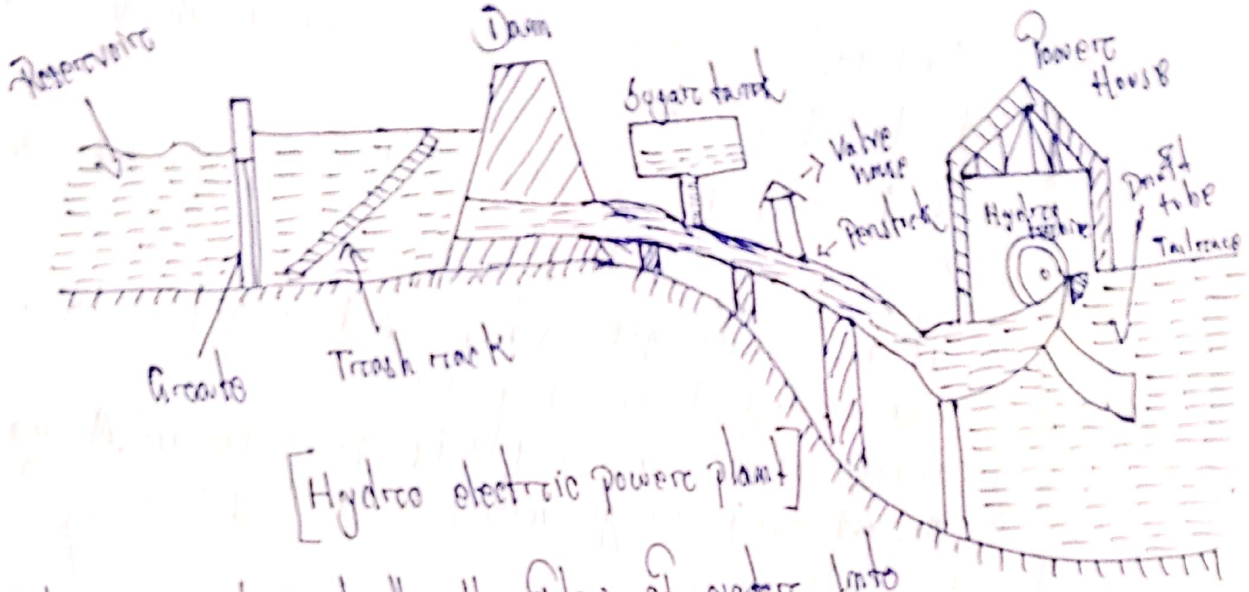
(XI) Storage:— Flow in a stream may be low or high depending upo season. hence an artificial storage of water is needed to minimise the Variation.
- This Interpret firm Capacity of hydro power plant
- The amount of storage can be ascertained from hydrograph
- If a horizontal line is drawn over average flow, portio of Curve above this line indicates amount of water storag needed in reservoir to meet demand during lean period.

(XII) Pondage:— It is a small storage near the plant which Ca meet hourly Variation in load demand.
- This is needed if the plant located away from reservoir.

Components of hydro electric power plant:—

1) Storage reservoir:— The flow of water in a stream Varie
- The flow is high during rainy season and very low during summer season.
- This affects power generation. So in order to maintain a Constant flow of water a storage reservoir is used.

- Storage reservoir takes care of variation in water flow and provides a constant flow of water.
- During high load demand, reservoir supplies the water and at other times, water is stored.
- The storage capacity of water reservoir is decided by run-off during high and lean season.



[Hydro electric power plant]

(ii) Gate: — It controls the flow of water into penstock.

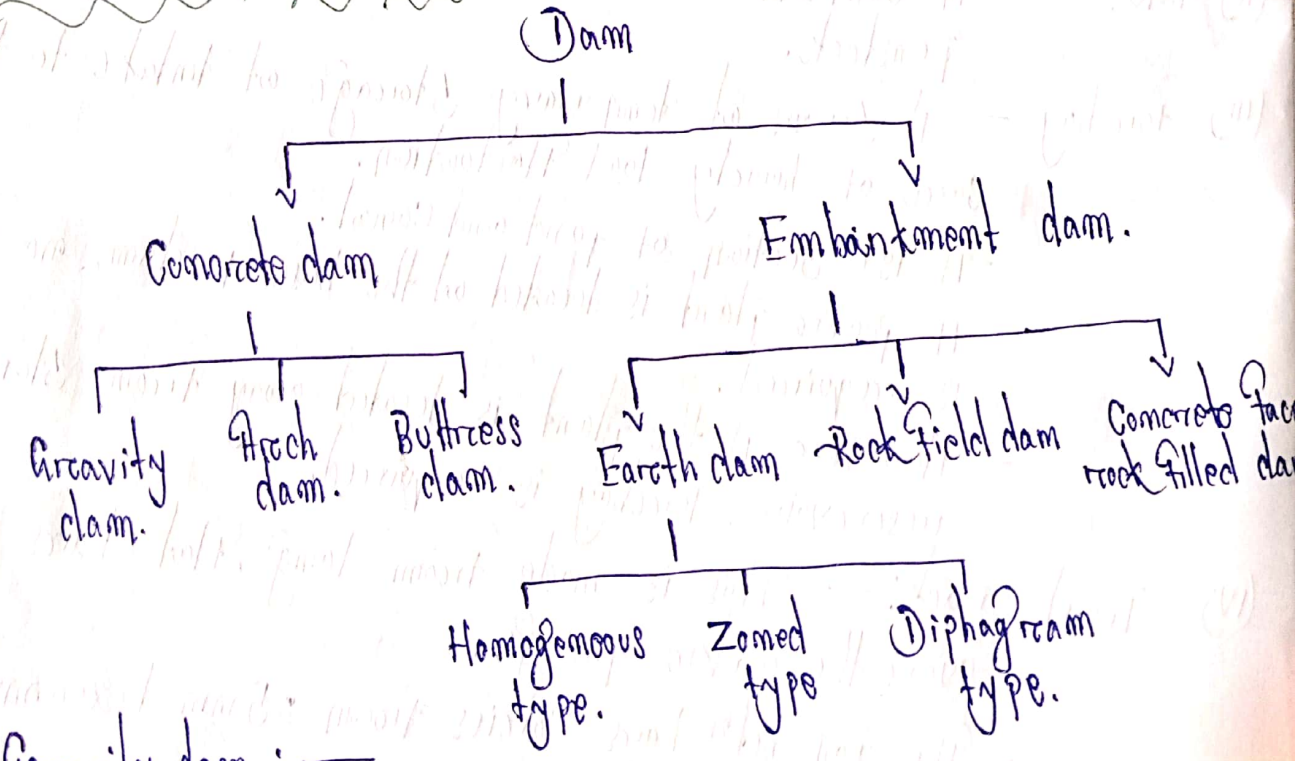
(iii) Forebay - It serves as temporary storage at intake to take care of hourly load fluctuation.
- It is a section of pond and canal.
- If power plant is located at the base of dam, no forebay is required.
- However if the plant is located away from storage reservoir, forebay is required.

(iv) Trash rack: — This is made from long, flat bars sets vertical over the water passage.
- The gap betn bars varies from 25mm to 200 mm. depending upon the size of opening.
- The purpose of the rack is to prevent entry of floating materials such as twings, piece of ice etc.

(V) Intake:- Function of Intake is to provided passage to flo of water to penstock.
- The Intake structure is provided with trash racks, screens, and brams to prevent entry of debris and Into turbine.

(VI) (1) Dam:- A dam is a barriere built across Course [Eg ri Canal, etc] to Control flow of watere ore divert water or to hold back waters.
- A barrage is a structore built across a water Course so as to regulate the flow of waters.
- it has movable gates which can be raised ore lowered t release desired amount of water.
- Purpose of dam is manifold i.e flood Control, Irregation navigation, power generation recreation etc.

Classification of Dams:-



1) Gravity dam:-
i) This type of dam is built with Concrete.
ii) The stability of this dam depends upon its weight.
iii) Height of dam depends on following damage, characteristics of sub-soil etc.

iv) Large volm Concrete is used to build the dam and requires a strong rocky foundation.
v) This dam resists hydro static pr due to its weight.

2) Arch dam:— Its Cross section is an arch (Curved) and is built on a narrow river valley.
- It is made of thin RCC [Reinforced Cement Concrete] section and is higher than gravity dam.
- The load transmitted on the dam depends on radius of Curvature.
- The water exerts hydrostatic pr horizontally to the abutments.
- The Concave side of dam is on the down stream side (tail race)
- The shape of dam helps to retain large volm of water.

3) Buttress dam:— It is a solid gravity dam but uses less Concrete and masonary.
- It has Continuous Inclined RCC slab upstream supported by a buttress or Vertical pier like walls.
- The Inclined upstream face exerts a large downward forces due to water pr.
- This forces provides stability to dam. Such a dam is suitable for earthquake prone zone.

4) Earth dam:— An earth dam has large base Compared to its height.
- The dam is built by laying Compacted soil or soil rock mix to form embankment having trapizoidal shape across the river.
- The upstream face of earth dam is protected from erosion by a surface layers of flat rock.
- This type of dam is cheapere than gravity dam.
- This type of dam is subjected to erosion, has more seepage of water and is not suitable for spillways.

⑤ Rock filled dam :- It is made a loose rocks and ~~boulders in~~ boulders instead of soil.
- It is resistant to earthquake and has steeper slope.
- Adequate spillways are needed for its safety.

⑥ Concrete faced rock filled dam :—
→ It is made with loose rocks and boulders.
→ An impervious Rcc slab is laid upstream face to reduce seepage.
→ This Rcc slab provides water tightness.

Classification of hydro electric power plants :—
Hydro electric power plants can be classified according to following —
According to availability of water :—
1) Run-off river plant without pondage.
2) Run-off river plant with pondage.
3) Storage plant.
4) pumped storage plant.

1) Run-off the river plant without pondage :—
i) Water is taken directly from river and after generation of power.
ii) It flows downstream, so no storage of water is possible.
iii) These plants use water as and when available.
iv) During lean season power generation is low, while during high flow water is wasted.
v) Water is mainly used for irrigation and navigation power generation is incidental.
vi) These plants can be built at low cost.

Nuclear power plant

Introduction:- Nuclear Fuels often an alternative to fossil fuels for power generation.

→ The quantity of nuclear fuel required is very fast and there is no environmental pollution however, operation and maintanance of nuclear power plant requires expertise which very few countries possesst.

→ There are chance of radiation lokage due to abnormal plant operation. barring few incidents in entire world nuclear power plant run safely.

→ India started nuclear power generation after indle - pendence.

→ Total contribution of nuclear energy in the installed capacity is barely 2·1. due to scarcity of Uranium in India.

→ The estimated availability of Uranium in India is 78000 tons and thorium 3,63,000 tons.

Nuclear Fuels:- Nuclear fuels used in atomic reactors are Uranium and thorium.

1. Uranium:- i) It is found in nature.
   ii) Deposite in World - USA, Czech Republic, Belgium. Congo and Canada.
   iii) In India - Jadugoda - Jharkhand.
   iv) Contains - U_{92}^{238} - 93·1. - U^{238}
   0·7·1. - U^{235}
   trace - U^{234}.

Properties:-

	Parameter	Value
1)	Density —	19·18 gm/cc.
2)	Melting point -	1133°C.
3)	Boiling point -	3900°C.
4)	Electricity resistivity -	2 to 4 $\times 10^{-4}$ micro-ohm-cm.

5) Thermal Conductivity - ~0.082 cal/cm-sec-°C
6) Thermal expansion - 25-125 X 10^{-6} per °C.
7) Allotropic transformation - Alpha to Beta at 663°C.
Beta to Gamma at 764°C.

2. Thorium:- i) Compared to Uranium, it has low strength and low resistance to Corrossion.
ii) Due to high Cost, it is not much used.
iii) Thorium Th_{90}^{233} when bombarded with neutron, Produces fissionable Isotopes which Can be used as nuclear reactors.
iv) Monazite Sand Contains thorium as ThO_2 with Small amount of Uranium Oxide U_3O_8.

physical property:-

Parameter	Value
1) Density	11.71 gm/cc.
2) Melting point	1690°C.
3) Boiling point	3000°C.
4) Electrical resistivity	18 X 10^{-6} Ω cm at 20°C.
5) Thermal Conductivity	0.09 cal/sec-cm- at 800°C.

3. plutonium:- i) plutonium oxide (PuO_2) is used as reactor fuel.
ii) It is mixed with Uranium oxide to form mixed oxide fuel (Mox). For fast breeder reactors.
iii) Properties of Mox are Similar to Uranium oxide.
iv) India has Vast reserve of thorium in India in kerela. but poor in Uranium.
v) Various agreement have been Signed for Procurement of Uranium with Countries Such as USA, Japan etc.

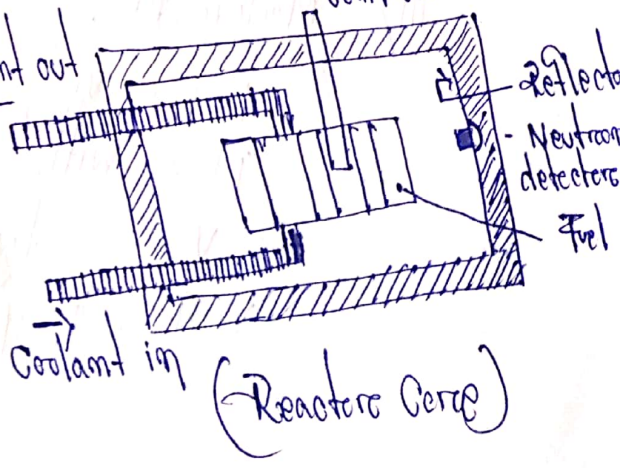
Selection of Site for a nuclear power plant:—

1) Far away from populated area.
2) Availability of large amount of water.
3) Transport facility.
4) Nearness to grid.
5) Earthquake area.
6) Site geology.
7) Geological stable area.
8) Agriculture and aquaculture.
9) Facility for nuclear waste disposal.

Nuclear reactor:— A nuclear reactor is a device where nuclear fission reaction takes place.

- The heat of nuclear fission is removed by coolant to a heat exchanger.
- It is a heavy tank like structure which can withstand high pr and radiation.
- The reactor has a central part called core which contains fuel, moderator, reflector and coolant.
- Commonly used fuel in a reactor are - Natural Uranium U235 and enriched Uranium (2 to 5%) of U235.
- A moderator is used to slow down high energy neutrons liberated in fission reaction.
- The heat of fission reaction is removed by a coolant.

1) **Core:—** Core is surrounded by neutron reflector material called shielding material. which confines escaping neutrons back to the core.



(Reactor Core)

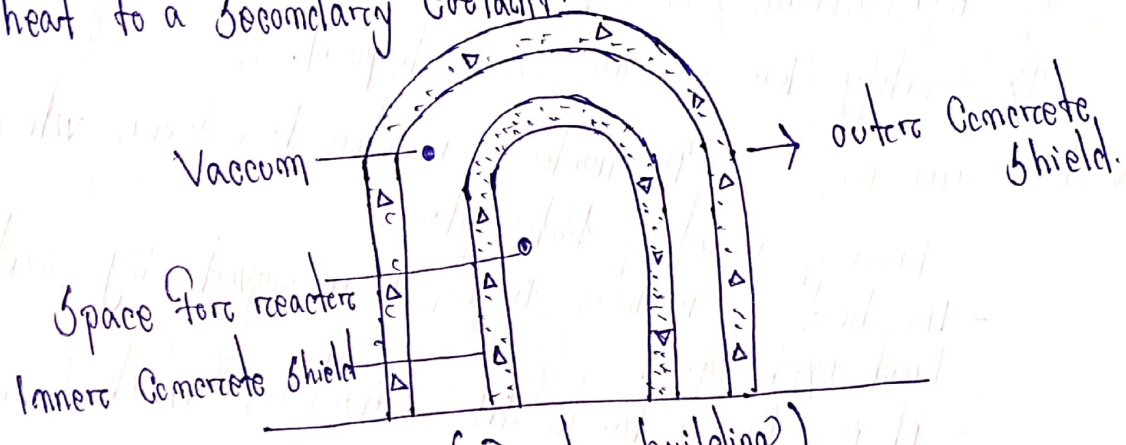
ii) Reactor Core is housed in dome shaped building with double walled Concrete Construction.

iii) The annual space betn doubled walled Concrete Construction through filtration and pump back system to ensure zero radiation leak in the worst case or an accident.

iv) Reactor Core is made of horizental cylinchrical vessel of stainless steel (SS304) Construction having Coolant channels.

v) These Coolant channels made of Zirconium - Niobium alloy Contain Fuel bundles.

vi) Coolant is Circulated around these fuel bundles to transfer heat to a secondary Coolant.



(Reactor building).

ii) Fuel:- Fuel used are Uranium-235, Uranium-233, and plutonium-239.

- Fuel is assembled in the form of rods called fuel pins. for easy insertion and removal of Calandria
- Uranium ore mines are located in Jaduguda, Bhatin, Narwa Pahad, and Turandih. [Jharkhand]

iii) Moderator:- A moderator is used to slow down fast moving neutrons so that fission reaction can take place with natural Uranium as fuel.

- Various types of moderator used are - heavy water, graphite, beryllium etc.

- Heavy water or deuterium oxide (D_2O) is made from light water or H_2O.
- 30 ltr of light water is used to produce one litre of heavy water.

iv) Control rods:— It is used to control rate of fission reaction so that chain reaction is maintained at a steady pace.
- These rods are lowered into the reactor to reduce rate of reaction and are used to shut down the reactor during emergency.
- The material of these rods absorb neutrons released during nuclear fission such as boron, cadmium, hafnium etc.
- These rods are motorised and are controlled automatically.

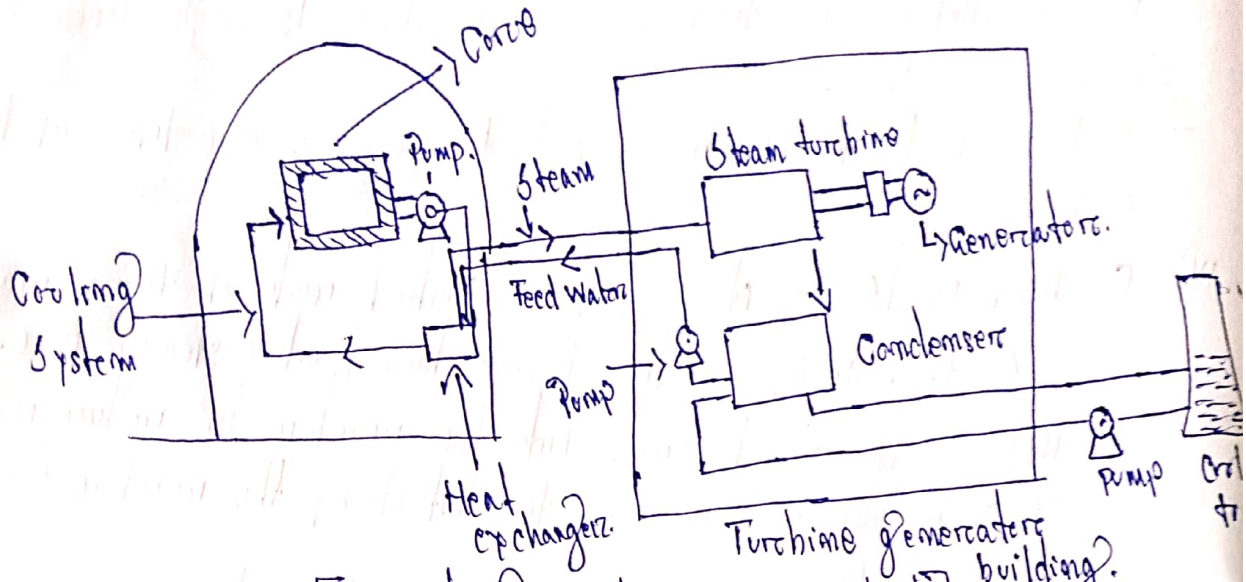
v) Coolant:— Coolant is a medium such as liq sodium, helium, Carbon dioxide, or heavy water which removes heat of chain reaction and transfers this heat to a heat exchanger or boiler.

→ This boiler produces steam for steam turbine.

vi) Reflector:— Inside surface of reactor is covered with reflector which prevents escape of neutrons from reactor core.
- This prevent radiation leak from the core to surrounding atmosphere.

vii) Shielding:— It prevents lekage of radiation to surrounding atmosphere.

viii) Containment:— It is a heavy concrete and steel structure that prevents leakage of radiation to atmosphere during malfunctioning in reactor.



[Layout of nuclear power plant]

Principle and Working of different type of reactor:—

1) Boiling Water reactor (BWR):—

→ This type of reactor is also known as pressurised heavy water reactor. (PHWR).

→ It uses natural Uranium as fuel and heavy water as moderator.

→ It has primary and secondary cooling water circuit carrying heavy water.

→ Control rods are not required as control is achived by varying moderator level in the reactor.

→ The moderator is housed in a large tank called Calendria which contains several hundred pr tubes containing Fuel.

Advantages:—

i) It uses natural Uranium.

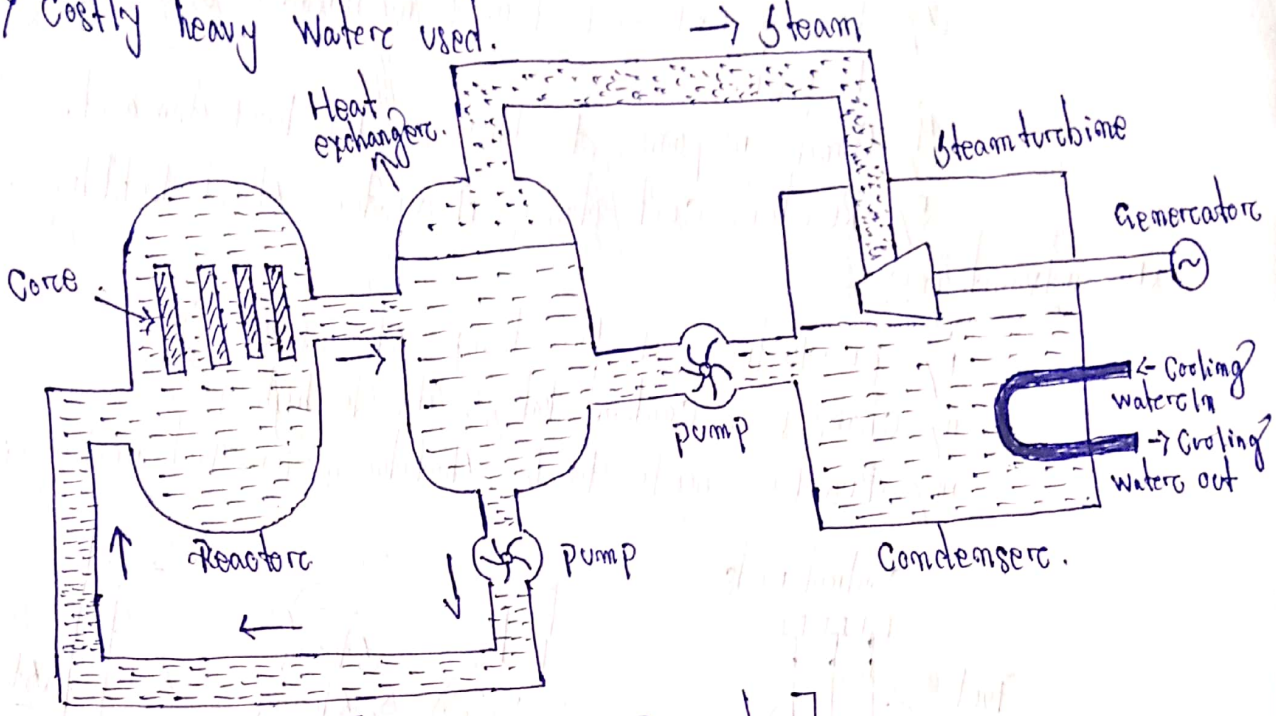
ii) Due to absence of control rods, reactor control is easy.

iii) Low fuel Consumption.

iv) Can be refuelled while a operation.

Disadvantages: —

1) Absorption of neutron in moderator i.e heavy water leads to production of tritium which is a radioactive material.
2) Costly heavy water used.



[CANDU or PHWR reactor]

Pressurised Water Reactor (PWR): —

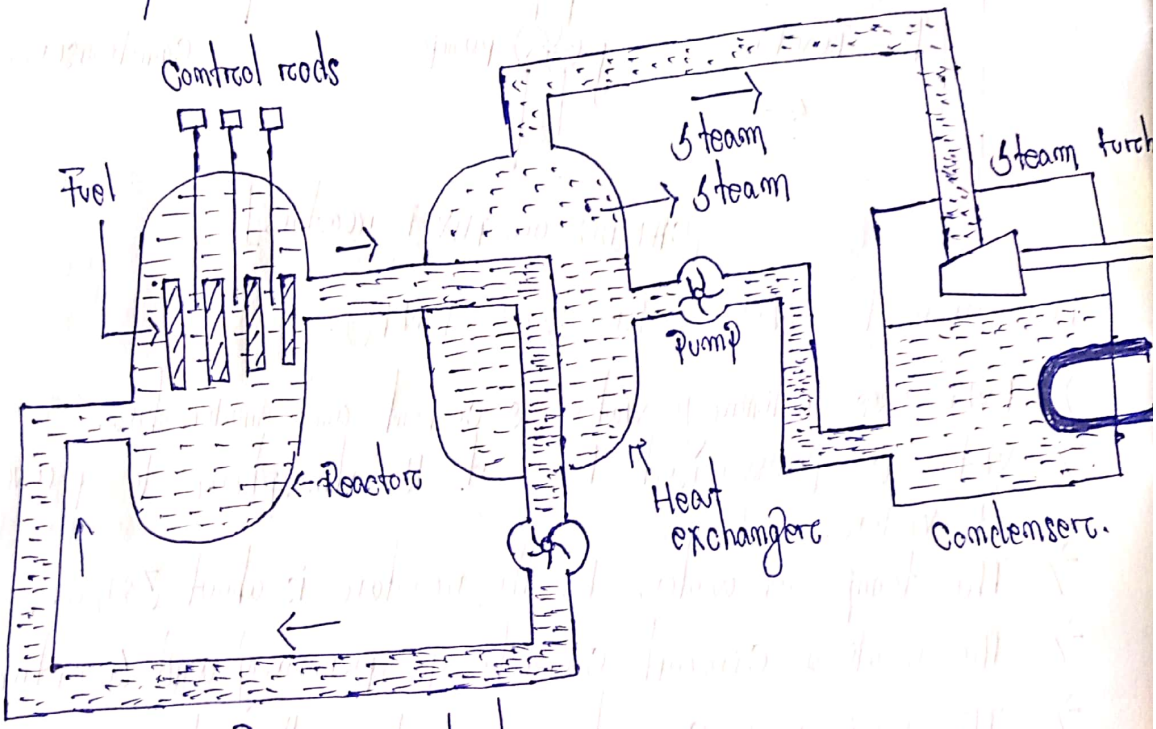
→ PWR uses ordinary water as coolant and moderator.
→ Water is pressurised to about 150 atmosphere to prevent boiling of water.
→ The temp of water in the reactor is about 325°C.
→ The Cooling Circuit Consists of primary and secondary Circuit.
→ The primary Circuit water flows through Core of reactor at high pr while secondary Circuit is used to generate steam.
→ Primary Cooling Circuit Contains a Pressuriser in the form of pr vessel with a heating coil at the bottom with water spray arrangement at the top.
→ If primary Circuit pr decreases, heating coil gets on and generates steam by boiling water.
→ This increases steam pr, if pr is high, cold water is sprayed in pressuriser to Condense the steam.

Advantages:—

1) Compact size.
2) High power density.
3) Low cost of coolant and moderator as ordinary water is used.
4) Good response to increase in load demand.
5) Reactor cools down if water start bubbling.

Dis-advantages:—

i) production of low temp steam (250°C)
ii) chances of coolant leakage due to high pr.
iii) Reactor needs to be shutdown for fuel recharging.



Pressurised water reactor (PWR).

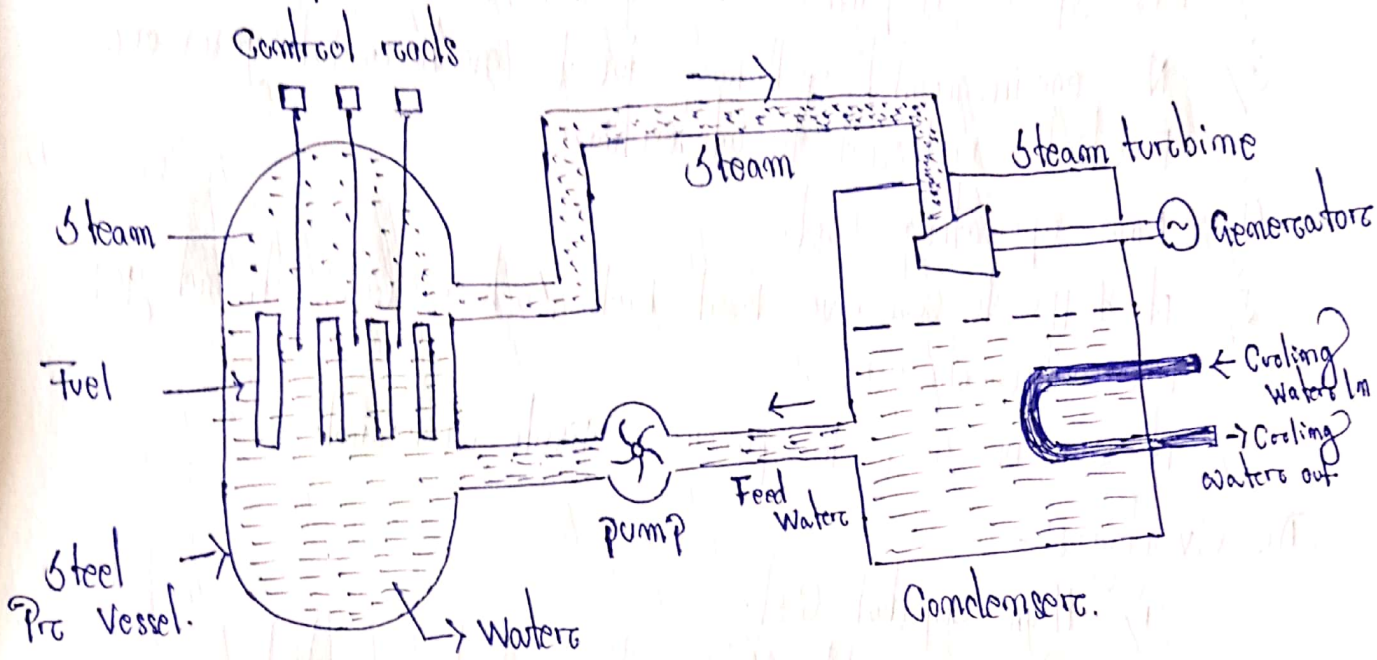
Boiling water Reactor (BWR):—

→ A boiling water reactor uses enriched Uranium oxide as fuel an ordinary water as coolant and moderator.

→ It uses single coling circuit with water at a pr of 75 atm and temp 285 °C.

→ Feed water enters the reactor at the bottom and gets evapora into steam due to heat of fission reaction.

→ This steam leaves the reactor at the top and enters steam turbine.
→ After expansion of steam in steam turbine, it gets condensed in a water cooled condenser and fed back to heat exchanger as feed water.
→ Due to radioactive contamination around the reactor core, radiological protection is provided steam turbine.



Advantages:—

1) Size of pr. vessel is small due to single cooling water circuit.
2) High thermal efficiency.
3) Temp of metal surface is lower as the boiling of water takes place inside reactor.
4) operation is more stable.

Disadvantages:—

1) Radioactive leakage chances more due to pr of single cooling circuit.
2) Size of BWR is more compared to PWR.
3) It can't cope up with sudden increase in load.

Advantages and disadvantages of nuclear power generation :—

Advantages:—

1) Required small amount of fuel and hence no problem of transportation.
2) Less space required as compared to other power plants.
3) No environmental pollution due to no harmful gases or particles released to atmosphere.
4) Low operating cost.
5) It helps to conserve fossil fuels such as coal, oil, and gas for alternate use.
6) It can be used to produce fissile material.

Dis-advantages:—

1) High capital cost.
2) large quantity of cooling water needed.
3) High skilled operators required to operate.
4) Disposal of nuclear waste is big problem as no safe method of disposal have found until date.
5) Chances of radioactive leakage during abnormal operation of plant is possible.

Diesel Power plant

Introduction: — Diesel power plant uses a diesel engine or CI engine to drive a generator.

→ Diesel engine converts chemical energy of diesel into mech energy.
→ This mech energy of engine is converted into electrical energy by the generator.
→ Capacity of diesel power plant ranges from few kw to 50 kw.
→ Fuel used in diesel power engine may be high speed diesel (HSD) commonly available in refilling stations.
→ other fuels - Light diesel oil (LDO)
- Low sulphur heavy stock oil (LSHS)
- Residual fuel oil (RFO)
- Natural gas.
- Bio-methane.

→ Engine can be run purely on 100% gas or partly gas and partly diesel.
→ Maintanance cost is high and time interval b/n two consecutive overhauls is less.
→ Diesel power plant is also used as backup in hospital, malls, hotels and other commercial establishment.

Selection of site for a diesel power plant: —

1) Site should near to the load centre as possible.
2) Larger amount of cooling water available.
3) Site should be near to the source of fuel.
4) Soil at site posses good bearing capacity to permit construction of heavy foundation.
5) transportation facility. rail, road or sea to available
6) Away from populated area. due to noise and fumes.

Classification of diesel engine :—

1) Mobility of Engines :—

i) Stationary diesel engines :— These engines are installed on a rigid foundation permanently.
- Used for power generation, these are high speed engines 3000 r.p.m or 1500 r.p.m.
Low speed engines (less than 300 r.p.m)

ii) Marine diesel engine :— These engines are used in ships for Propulsion.
- These engines are medium speed engines operating on heavy fuels such as RFO, LSHS etc.

2) Speed of engine :—

i) Low speed engines :—
Speed – Less than 300 r.p.m – low speed engine
Used – In ships for Marine application.
operate – Heavy fuels.
– quietly bulky.

ii) Medium speed engine :—
Speed – (300 to 1000) r.p.m
used – power generation process.
operating – On heavy fuels.

iii) High Speed engine :—
Speed – More than 1000 r.p.m.
Used – Emergency power generation Purpose.
operating – High speed diesel oil (HSD)
– Light diesel oil (LDO)
Compact due to high speed operation but require more maintanance.

3) Cylinders Orientation of engine: —

1) Horizental engines: — Axis of the cylinders are horizental.
Capacity - low capacity engines.
Used - providing motive power.

2) Vertical engines - Axis - Vertical.
Capacity - large capacity or multi cylinders engine.
Used - Power generation.

3) Inclined engines: — Axis - Inclined
Capacity - Medium. multi cylinders engines.

4) Number of cylinders: —

1) Single to 4 cylinders engine: —
Used - For small capacity pumps such as for agricultural application.

2) Six to eight cylinders -
Used - Commonly for power generation process.

5) Type of fuel used: —

1) Liquid fuel engines: — These engines operate on liq fuels such as HSD, LDO, LSHS, RFO etc.

2) Gas engine: - These engines operate fully on natural or bio methane.

3) Dual fuel engine - These engines operate partly on gas and partly on diesel.

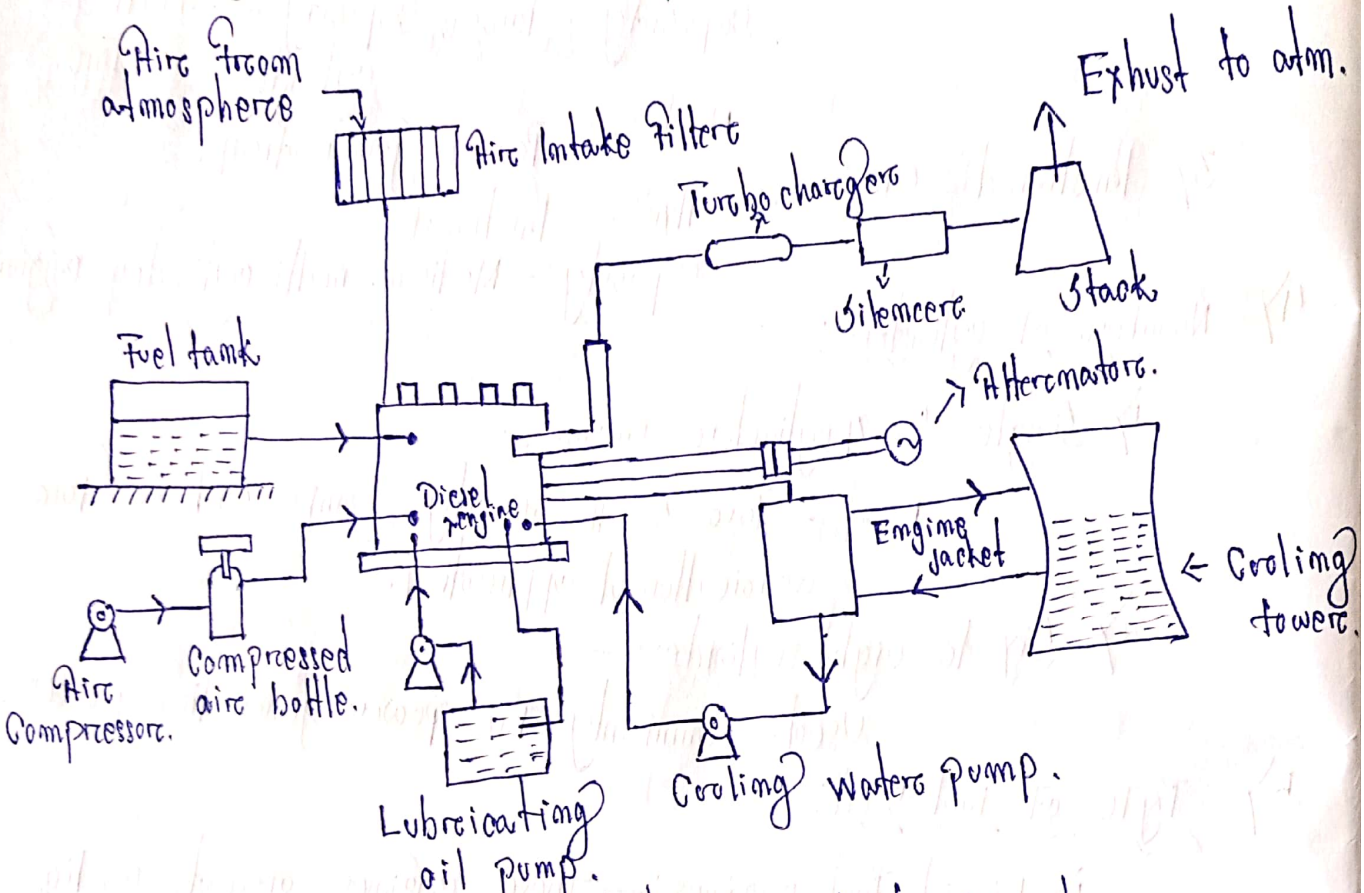
6) Type of aspiration: —

1) Naturally aspirated engines: — These engines suck air from atmosphere due to downward movement of piston in the cylinders.

ii) - No artificial method are employed to increase suction air volume, such engines are used for small capacity generaters set or pump.

11) Turbo charged engines:— These engines employ turbo chargers wh increased suction air volume into the cylinders.
- Such engines are suitable for high capacity generator sets.

Working of diesel power plant:—



→ A diesel engine is cranked by a starting system comprising either battery and self starter. or air compressor and compressed air storage bottle.
→ Once the engine starts after cranking, air is sucked through air filter to engine cylinders.
→ Fuel is injected into engine cylinders by injector and FP pump.
→ Injector atomises the fuel in the air in the engine cylinders.
→ The high temp & pr of air fuel mixture causes ignition leading to expansion of piston producing a power stroke.
→ The flue gases are produced due to combustion and exhusted to atmosphere through exhust valve.

→ The engine governors keeps the speed of the engine constant irrespective of variation in load on the engine.
→ Automatic voltage regulators keeps output voltage of alternators constant.

Components of diesel power plant:—

A diesel power plant consists of a diesel engine coupled to a generators, cooling towers, diesel storage tank, electrical panels etc.

1. (I) Diesel engine:—

(i) Engine start system:—

i) It is used to crank the engine to start.
ii) The system uses either battery with a starters motors ore compressed air with a compressors to crank the engine.
iii) Battery system is used for high speed engine while low and medium speed engines use compressed air for starting the engine.
iv) When start impulse is given to the engine, suction valve opens and admits air into the engine cylinders.
v) This is followed by compression, fuel injection, expansion and exhust stroke once the engine starts, starting system is disengaged.

(ii) Air intake system:—

i) Air intake system supplies clean filtered air to engine for combustion.
ii) When piston inside a cylinders moves downwards. it creates partial vaccum.
iii) Air then enters engine through air filter and passes through oil bath.
iv) Air suction system are of two types.
i) Naturally aspirated system ii) turbo charged system.
v) Air enters engine cylinders due to downward motion of piston in a cylinders.

→ Such system is used for small capacity.
→ As the size of the engine increases, the vol^m of air required also increases.
→ So a turbo charger is used to allow higher vol^m of air required also increases into engine cylinders.
→ A turbo charger consist of no of blades attached to a disc.
→ The other end of this disc is connected to another similar disc through a shaft.
→ The exhust gases from engine passes through the exhust manifold where the disc is connected.
→ The exhust gases cause the disc to rotate, this rotation is transferred to the other disc which sucks air from atmosphere and forces into the engine cylinders.
→ This increses the rate of flow of air into the cylinders.

(III) Fuel Injection System:—

i) Fuel is stored either in underground tanks or overr ground tanks in tank farm area away from power house due to fire hazard.
ii) Fuel from these tanks is pumped into a day tank, located near the engine which meets day's requirement of fuel.
iii) The fuel injection system in engine consist of fuel filter, fuel measuring unit [pr timing pump or PT pump] injectors.
iv) A small capacity of fuel is measured by PT pump and injected into cylinders through injectors.
v) Injectors atomise the fuel for better combustion.
vi) The fuel injected into engine cylinders at a high pr.
vii) Normally 3 types of fuel injection systems are used —
  i) Common rail injection system.
  ii) Individual pump injection system.
  iii) Distributor system.

(IV) Cooling System:—

i) Cooling system removes heat from engine and cools lubricating oil.
ii) It consists of a cooling water pump, cooling towers and a heat exchanger
iii) Heat generated due to combustion inside engine cylinders is transmitted to engine jacket water system.

iv) This head from engine jacket water is conveyed to atmosphere through cooling towers.
v) The cooling of lubrication oil is also carried out by this system.

Lubrication system:

i) Lubrication system feeds lubrication oil to piston and cylinders bearings.
ii) Lubrication oil reduces friction bet" moving parts such as piston and cylinders. removes heat from cylinders and bearings and provided sealing bet" piston rings and cylinders.
iii) The lubrication oil is drawn from an oil sump through a pump and an oil filters to various parts in a system such as pinion and cylinders years, bearings, cam shaft, connecting rod, etc.
iv) The lubrication oil becomes hot and is cooled through a heat exchanger and sent back to oil sump.

Exhust System:—

i) Exhust system discharges products of combustion to atmosphere.
ii) It consist of exhust system manifold, turcho charger, silencers and stack.
iii) The stack is at sufficient height to disperse hot exhust gases over a wide area.
iv) Turcho charger is a centrifugal bleeper which is rotn by escaping exhust gases at one end of exhust manifold.
v) At other end, there is another blowers which draws air from the atmosphere and feeds air intake system. this is known as supere charging.
vi) Supere charging increses volm of air compared to a naturally aspirated engine.

Advantages of supere charging:—

1) Increasing in engine power output.
2) Better fuel economy.
3) Higher Mechanical efficiency.
4) Decreased fuel smoking.
5) Higher Volumetric efficiency.

Alternators :—

→ A alternators is mechanically coupled to the diesel engine.
→ Alternators has stators and rotors.
→ Stators has 3 phase ac winding while rotors carries dc excitation system.
→ The excitation system consists of an exciter coupled to engine shaft.
→ Exciter feed rotors winding. The magnitude of generated voltage is regulated by an automatic voltage regulators (AVR).
→ Purpose of AVR is the maintain constant output voltage irrespective of variation in speed or load.
→ The powers generated from alternators is fed to electrical distribution system.
→ The voltage of exciters is 115 V DC or 220 V DC.
→ The generated voltage is 415 V, 50 HZ to 11000 V, 50 HZ.

Electrical Instumentation System :—

→ It consists of measuring instruments, synchonising system and safety trips and interlocks for engine and alternators.
→ Electrical measuring system has ammeters, voltmeters, wattmeters, energy meters, and frequency meter.
→ These instruments are mounted on generators panel.
→ Synchonising system is used to parallel two alternators consisting of a synchonising panel with necessary instruments and relays.
→ Safety trips for engine comprises alarm and trip sensors for high lubricating oil temp, low cooling water pr of low lubricating oil pr.
→ The alternators safety trips and alarm include high winding temp. over current, earth fault, over voltage etc.
→ In the event of abnormal parameters, alarm is sounded on the control panel and if the parameters exceed a certain value, system is tripped or shutdown.

Advantages and dis-advantages of diesel engine power plant:—

Advantages:—

1) Low cost of installation.
2) Time required for installation of plant is less.
3) High efficiency compared to thermal power plant.
4) Less amount of cooling water required.
5) Layout of plant is simple and require less space.
6) Engine use liquid fuels as well as gaseous fuels.
7) Req few operating Personnels as compared to other plants
8) No stand by losses.

Dis-advantages:—

1) Required high maintanance.
2) Plant can't take over load.
3) Plant has low life about 10 years.
4) Unit cost of electricity produced is very high.
5) Production capacity is less as compared to other power plants.