GOVERNMENT POLYTECHNIC, DHENKANAL

LECTURE NOTES

ON

Génération Transmission&Distribution

SEMESTER-4th

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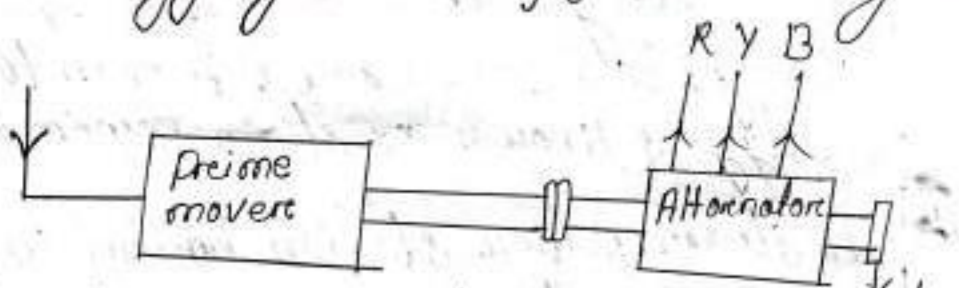
GENERATION OF ELECTRICAL ENERGY ÷

I. The conversion of energy conversion of energy is avaleble in different forms in nature in to electrical energy is known as generation of electrical energy.

II. Energy is avaleble in various form different natural sources such as pressure head of water, chemical energy of fuels and neuclear energy of radio active substances.

All these form of energy can be converted into electrical energy by the use of suitable arrangement



An alternator is coupled to prime mover the prime mover is driven by the energy optend from various sucess. such as combusting of fuel, pressure of watter, porces of wind etc------

Generating station ÷

I. The bulk electric power is produced in power plant or electric power generating stations. An generating stations essentialy employes a prime mover coupled to an alternator from production of electric power

II. The prime mover may be steam turbine, water turbine converts energy from some other from into mechanical energy the alternat converse mechanical energy of prime mover in to electrical energy.

III. The electrical energy produced by a generating station is transmitted and distributed with the help of conductors to various consumers.

IV. Depending upon the form of energy converted into electrical energy generating stations are classified these are (1) steam power station
(2) Hydroelectric power "
(3) Neuclear power "
(4) Disel electric power station.

STEAM POWER STATION :-

I. A generating station which converts pick energy form coal combustion in to electrical energy is known as steam power station.

II. A steam power station basical works on the rankine cycle.

III. Steam is prodeeed in the boiler by utilising the heat of coal combution.

IV. The steam is then exponded in the prime mover (steam turbine) then the steam is condense in condensere to freem water and is fet in to the boiler again.

V. This steam turbine triples the alternator which converts mechanical energy of the turbine into electrical energy. This type of power station is suitable where coal and water aree available plently and large amount of electric power is generated.

SCHEMETIC ARRENGEMENT OF STEAM POWER STATION :-

The hole arrengement of steam power station can be devided in to the following stages can be devided in to the following stages for simplicity ① Coal and Ash handling arrengement

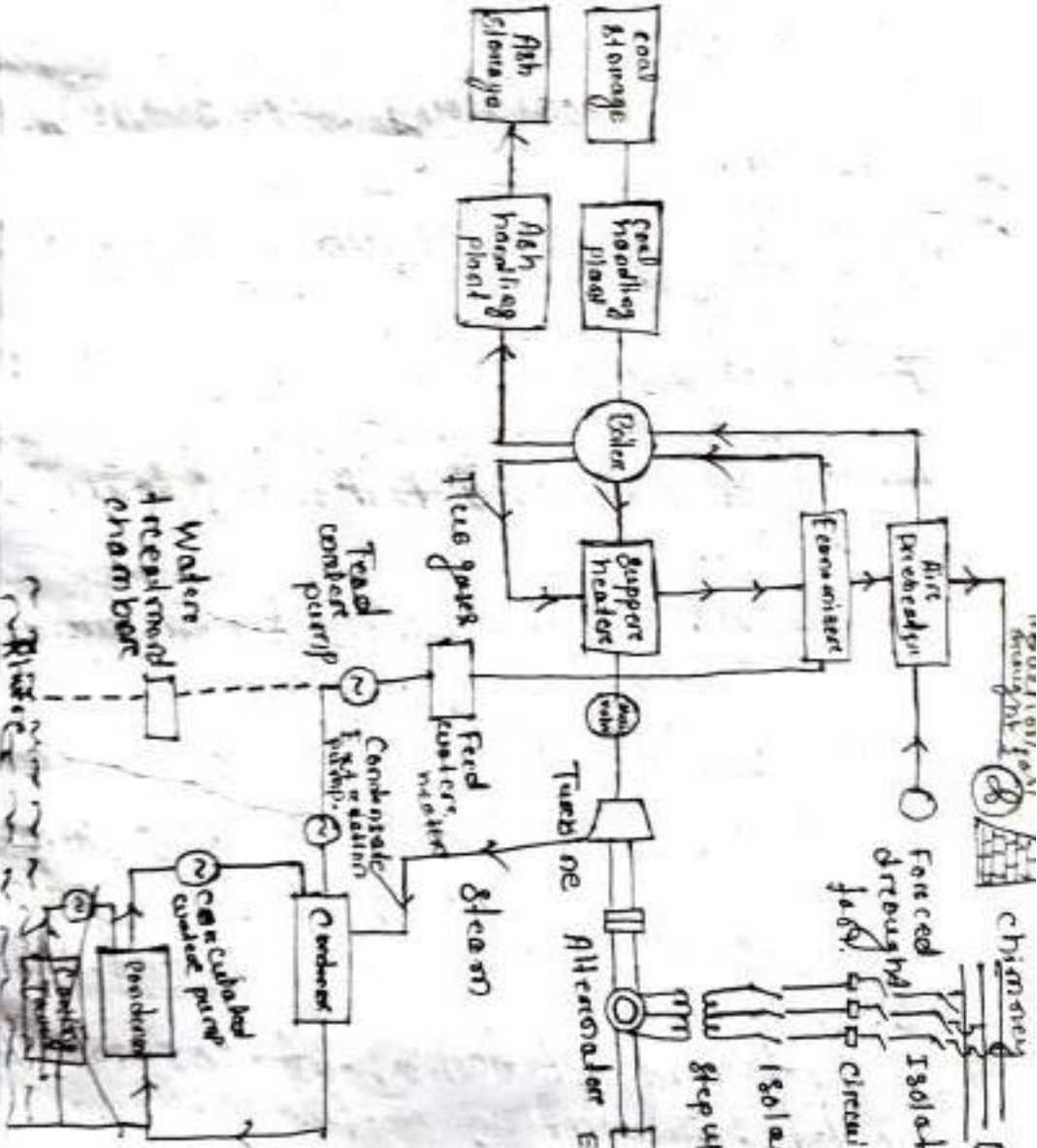
② Steam generating plant

③ Steam turbine.

④ Alternator.

⑤ Feed water.

⑥ Colling arrengement.



COAL AND ASH HANDLING PLANT :-

I. The coal is transported to the power station by a road and rail and it stored in the pole storage plant in the pole storage plant pole is protected and store for a future use when poles strikes, fellier of transpotation and generation of pole shortage occcures

II. From the coal storage plant coal is delivered to the coal handling plant here it is pulverised (crushed in small pices) in order to increase its surface exposer it increases the rate of conversion the rate of combution without using large quantity of excess air.

The pulverised coal is feed to the boiler by conveyer belt.

III. The coal is burnt in the boilere and ash is produced after complet combution of coal. The ash is removed to the ash storage plant for dispose.

IV. The removal of ash from the boiler furnesh is the necessary for proper burning of ash.

V. A 100 mega watt power station operating at 60% load factore may burn about 20,000 tonns of coal per month and ash produced may be 10% to 15% of coal burnt. that is 2000 to 3000 tonns.

In the thermal station about 50% to 60% of the total operating cost is fuel purchesing and its handeling.

STEAM GENERATING PLANT :-

The steam generating plant consist of boiler for the production of steam and other auxilary equipment for utilization of flue gas.

1. BOILER :-

I. The coal is burnt in the furnace to heat the water in the boiler. The heat of combution of coal is utilised to convert water into steam at high temperature and pressure.

II. The flue gases from the furnace of boiler goes to supper heater, economiser, air preheater and are finaly exented to atmosphere through the cheminey.

2. SUPERHEATER :-

I. The steam produced in the boiler in the coal and its past through a supper heater. Where it is dried and super heated.

II. When the steam is super heated the temprature if steam is increased above than the boiling point of water by the help of flue gases.

III. By supere heating the steam we get two advanteges ① Overall eficency is increased
② Too much condenstion in the last stage of turbine is avoided.
So corrosion of blead is avoided.

IV. The supere heated steam from the superheter is feat to steam turbine through the main valve

3. ECONOMISER :-

I. An economiser is essentialy a feed water heater an derives heat from the flue gases from these perpose.

II. The feed water is fead to the economiser before supply to the boiler.

III. The economiser extract a part of heat of flue gases to increase the tempreature of feed water.

4. AIR PREHEATER :-

I. An air preheater increases the tempreature of air supplied for coal burning by deriving heat from the flue gases air is drawn from the atmosphere by a forced draught and its past through air preheater before suppling to the boiler furnace.

II. The air preheater extracts heat from flue gases and increses the tempreature of air used for coal combustion.

III. The main advanteges of preheating of air are
① It increeses the thermal efficency.
② It increases the steam capacity per square meter of boiler surface.

3. STEAM TURBINE :-

1. The dry and supper heated steam from supper-heater is fed to the steam turbine through main valve.

II. The heat energy of steam when passing over the blads of turbine is converted into mechanical energy. Then this mechanical energy rotates the turbine.

iii. After going to the turbine the suppere heated steam is exerted to the condensere.

iv. In the condensere the exerted steam condence by steam cooled circumtension.

4. ALTERNATOR :-

1. The steam turebined is coupled to an alternatore the alternator converts the mechanical energy of turebine in to electrical energy.

ii. The electrical output of alternatore is delivered to the bus bais through transformer circuit breakers and Isolaters.

5. FEED WATER :-

1. The condensed from the condensere is used as feed watere to the boiler some watere may be lost in the cycle which is sutebly mad up from the external source (river)

ii. The feed watere on its way to the boiler is heated by watere heatere and economisere,

iii. This helps in Increasing the overall eficency of plant.

6. COOLING ARRANGEMENT :-

1. In ordere to improve the eficency of ploant the exerted steam is condensed by a condensere.

ii. Watere is drawn from a natural source of supplied such as rivere kenal or lake and is circuleted through the condensere.

iii. The circuleted watere takes of ~~watere~~ the heat of ~~of~~ the exisiting steam and it self becomc hot.

IV. The hot water from the condenser is past at a suitable location down to the river.

V. Where there is no availability of water source the hot water to the condenser is past through the colling towers.

VI. The cooled water of cooling towers is reused in the condenser.

ADVANTAGES :-

I. The fuel (coal) used is quit cheaf

II. It has less initial cost as compaired to other generating stations.

III. It can be instal at any place irrespective of the existence of coal. The coal can be transported to the site of the plant by rail or road.

IV. It required less space as compaired to hydroelectric power station.

V. The cost of generation is less than that of the disel power station.

DISADVANTAGES :-

I. It polutes the atmosphere due to the production of large amount of smoke and fumes.

II. It is costlier in running cost as compair to hydroelectric power station

CHOICE OF SITE OF STEAM POWER STATION ÷

1. In ordere to achive overe all efficency the following point should be considere while selecting a site ore a steam powere station.

① Supply of fuel ÷

The steam powere station should be located neare the coal mines so that the treansportatio of fuel will be minimum.

If ~~pete~~ coal is not available neare the plant adequate facilities should be provided fore the treansporetation of coal.

② Availability of watere ÷

As huge amount of watere is required fore the condenser there fore shuch plant near the reivere ore kenal.

③ Treanspotation facilities ÷

A steam powere station always requires the treanspotation of material and mechinaries there fore adequate treansporetation facilities must exist it means that the plant should be well connected through othere poret of cuntrey by rail, road etc—.

④ Cost and type of land ÷

The steam powere station should be located at the chief where the land will chief and the forthere extension can be possible in necessrey. Again bearing capacity of the ground should be addiquate so that heavy equipment can be installed.

(5) Nearness to load centre :-

In order to reduce the transmission cost the plant should be located near the load centre this is important if D.C supply system is adopted. Because if A.C supply system is adopted this is less important as a.c power is transmited at high voltage with reduce transmission cost. Therefore it is possible to instant the plant away from the load centre provided other conditions are favorable.

(6) Distance from populated area :-

A huge amount of ~~pole~~ coal is burnt in a steam power station. Therefore smoke and fumes polute the surrounding areas. so plant should be located at a considerable distance from the populated areas.

Conclusion

It is clear that all the above factor are not favorable at one place.

Therefore practicaly a side should be selected which is near by the river side where sufficent water is available, no polution of atmosphere occures and fuel can be transmeted economical.

HYDRO ELECTRIC POWER STATION :-

* A generating station which utilisation the potential energy of water of high level from the generation of electrical energy is known as hydroelectric power station.

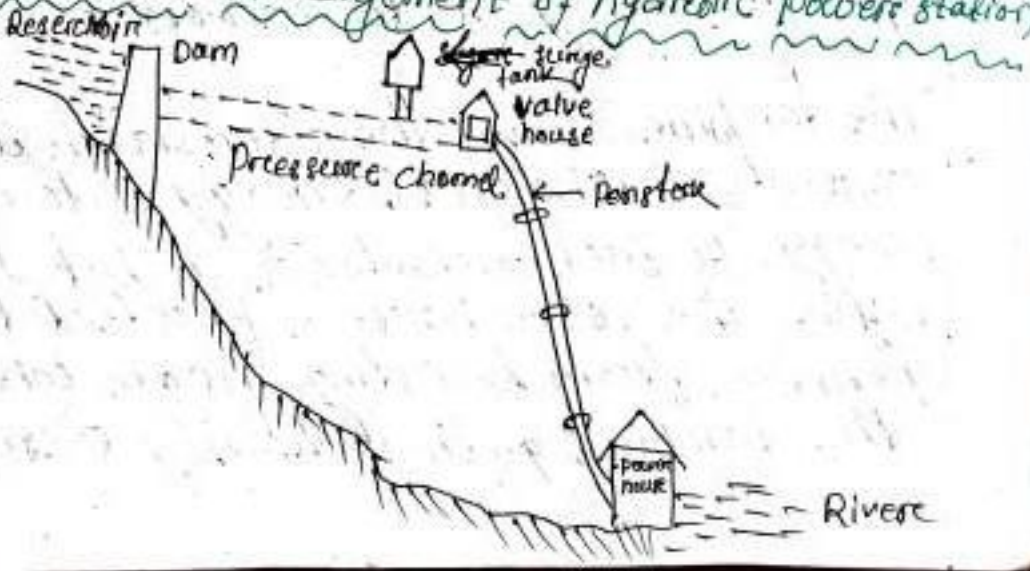
* It is generally located in hilly areas where dams can be build conveniently and large amount of water can be store.

This store is known as water reservoir.

* In hydroelectric power station water head is created by constructing a dam across a river or lake.

From the dam water is led to the water turbine. The water turbine captures the energy of the falling water and converts it into mechanical energy and turbine shaft. The turbine drives the alternator which converts mechanical energy into electrical energy.

Schematic Arrangement of hydrolic power station



* The dam is constructed across river ore ~~that~~ lake. Water from the catchment area collects at the back of the dam to form reservoir.

* A pressure channel is taken to the valve house from the reservoir and water is brought to the valve house at this start of penstock.

* The valve house contain main sluice valve and accelomatic isolating valve...

* The main sluice valve controels the water flow to the power house and isolating valve cutoff the seppply of wattter when the penstock ~~brust~~ brust.

* From valve house water is taken to water turbine through a large steam pipe. This pipe is known as penstock.

Penstock may be also made of reinforced cement concrit. The water turbine convers hyadraolic energy in to mechanical energy.

The turbine drives the alternator which converts mechanical energy in to electrical energy. A ~~such~~ substance is bit just before the valve house & proetect the penstock from bursting incase when the turbine gate suddenly closed.

* When the gate closed their is a sudden stop of water and lower end of penstock. The surge tank absorve the pressure by increase its level of water.

Constituent of Hydro electric power plant

1. Hydro electric structure includes dam, spillways, Head works, surge tank, penstock and accessories works.

DAM :-

* A dam is a barrier which stores water and create water head.
* Dams are built of concreet and ston masonary, earth or rock fill
* The type of arrangement depends upon the topography of site.
* A mechnaary dam may be built in a narrow river or lake or space.
* earth dam may be built in a width ver.
* The type of dam also depends upon the foundation conditions, Local materials and transportation avilable, occurance of earthquake and other hazards
* In one site more than one type of dam is suitable and the wall which is most economical should be chosen.

SPILLWAYS :-

* Sometime rivers flow exceed the storage capcity of the reservoir.

such a situation arcrwise during heavy rain fall in the catchment area.

* In order to discharge the sorplus water from the storage riserever into the ~~riserever~~ river on the down stream site of the dam. spillways can be use.
* Spillways are constructed of concrete piers on the top of dam.
* Gates are provided between these piers and surplus water is discharge by opening these gates.

HEADWORKS :-

The head works consist of diversion structure at the head of intech. They generaly include booms and racks fore digabidg floting depres.

* They also includes ~~~~ slowieses for bipasing depres and sediments and valves for controling flow of water to turbine.
* The flow of water into and through head works should be smooth.
* For these purpose it is necessary avoid in the share f corneres.

SURGE TANK :-

* A surge tank is a small riserwoier or tank in which water levle rises or fall to reduce in the pressure in the ~~pi~~ penstock or condeite.

Surge tank is located near the begoing the penstock when the turbine is located running at a steady load.

* There are no surges in the flow of water through the penstock

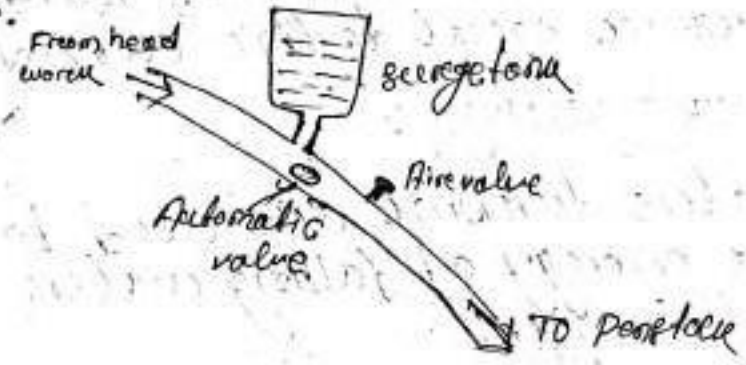
The quantity of water flowing in the penstock is ~~just~~ just sufficient to meet.

When the lode on the turbine decreases the governore closes the gets of turbine reducing water supply to the turbine.

* The excess water at the lower end of penstock or reaches back to the surge and increases its water level. Thus the penstock is prevented from bursting.

When the load of the turbine increases addition water is drawn from the surge tank to meet the increase load requirement.

* Hence a surge tank overcomes the abnormal pressure in the penstock, when load on the turbine decreases as on the riverbed when load on the turbine increases.



PENSTOCK :-

* Penstocks are open and closed conduits which carry water to the turbine. These generaly made of Reinforced cement concrete or steel.
* Concreet penstock are suitable for low heads (Less than 30 metere) Because greater pressure may cause damage to the concreet the steel penstock are degine for any head
* The thickness of penstock increases with the head or working pressure.
* Various devices such as automatic butter fly valve, Air valve and surge tank are provided for the protection of penstock.
* Automatic butter fly valve shuts off water flow through the penstock if it ruptures. ~~etc~~.
* Air valve maintains the air pressure inside the penstock which is equal to outside atmospheric pressure when water runs out of a penstock faster than it enters a vacume is created which may colaps to the penstock under such situation air valve opens and admit valve in to the penstock this maintains inside air pressure equal to the outside air pressure

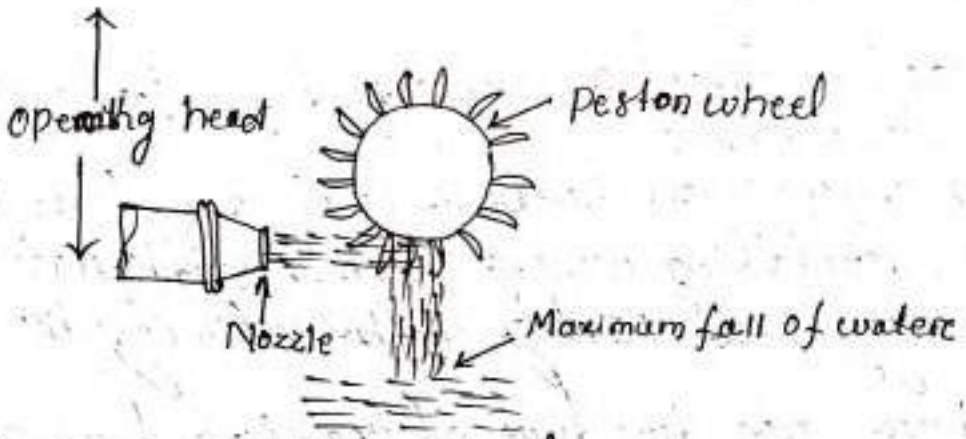
WATER TURBINE :-

* Water turbine are used to convert the energy of falling water in to mechanical energy.

* There are two type of turbine use these are :- ① Impulse Turbine.
② Reaction Turbine.

Impulse Turbine :-

* Theas turbines are used high heads.
* In an Impulse turbine the entire pressure of water is converted in to Kinetic energy nozzle.
* The velocity of the water drives the wheel of turbine.



Pelton wheel.

* The example of thease type of turebine is pelton wheel which is shown in the figure
* It consist of a wheel fitted with electrical bucket along its periphery
* The force of water jet striking in the bucket on the wheel drives the turbine.
* The quantity of water jet falling on the turbine is controlled by means of riddle or spear placed in the tip of nossol.

The moment of niddle is controled by the governer.

* If The load of the turbine decreases the governere process the niddle in to the nosale which reduces the quantity of water striking buckets.
* If the load on the turbine increases the governere pulls out the ~~nosot~~ niddle from the nosol which increases the flow of water striking in the bucket.

REACTION TURBINE :-

* Reaction turbine are used for low and medium aids.
* In a reaction turbine water enteres in the reotating runner pathly with rotere energy and pathly with velocity heads.
* There are two type of reaction turbine
  - (I) Francis turbine
  - (II) Kaplan turbine.

FRANCIS TURBINE

* A francis turbine are used for low to medium heads. It consist of an outer reain of stationare guid plates fixed to the turbine casing and inner reing of reotating bleads which fore the runner.
* The guid blads control the flow of

water to the turbine.

* Water flows radially in wards and changes to down ward direction while passing through the runner. As the water passes over the rotating blades of runner both pressure of velocity of water are reduced this causes a reaction force to drive the turbine.

KAPLAN TURBINE

Kaplane turebine is used for low heads and large quantity of water. It is similar to Francis turbine but here the runner risives water axialy and water flows radialy inwards through regulating ~~gate~~ gates all around the sides. This changes the direction of force in the runner to axial flow.

This causes a reaction force which drives the turebine.

Advantages

* It requires no fuel as water is used for generation of electric city.
* It is quite neat & clean as no smoke and ash is produced.
* It requires a very small running charges because water is the source of energy which is available free of cost.

* It is comparatively simple in construction and requires less maintenance.
* It does not require long static time like a steam power station.
* It has longer life.
* Such plants serve many purposes: In addition of generating of electrical energy they also help in irrigation and controling flots.
* For operation of hydropower plant a few experience are necessary

DISADVANTAGES :-

* It involves high capital cost due to construction of dam.
* The production of power depends upon the availability of enough amount of water.
* Skill and expense person are required the build the plant.
* It requires high cost of transmission line as the plant is located is hilly areas which is quit away from consumers.

Choice of site of hydropower plant :-

The following point should be consider while selecting the hydro electric power plant

(1) Availability of water :-

The primary requirement of hydroelectric power station is the availability of huge amount of water. such plant should be built ___ adiquite water available at a good head.

(2) Storage of water :-

There are variousions in water supply from a river or canal during the year.

There for it is necessary to store water by constructing a dam so there generating of power will be possible throughout the year.

The storage helps equalising the flow of water so that excess quantity of water can be made available. when the flow of water is low in the river.

Since the site selected for a hydroelectric plant should provide adequate facilities for constructing a dam & storage of water.

(3) Cost and type of land :-

The land for construction of the plant ~~for ground~~ should be available. at a reasonable price.

Forethere the bearing capacity of the ground should be adequate with stand the wait of weight of heavy equipment to be instal

Transportation facilities :-

(i) The site selected from the hydro electric power plant should be connected as rail & road so the necessary equipment and machinery can be easily transported

(ii) There force it is clear that the ideal choice of site for hydro electric plant is near a reivver in hilly areas where dam can be conveniently build and large reservoir can be expected.

NUCLEAR POWER STATION

A generating station in which nuclear energy is converted into electrical energy is known as nuclear power station. heavy elements like uranium (U^{235}) and Thorium (Th^{232}) are subjected to nuclear fission in a special apparatus.

This special apparatus is known as reactor. The heat energy release from nuclear element is utilised to convert

water in to steam at high temprature & pressure.

* The stem runs the steam turbine which convert steam energy into mechanical energy the turbine drives the alternator which convert mechanical energy into electrical energy.

* In the nuclear power plant huse amount of electrical energy can be produced from a relativity small amount of nuclear fuel as compaired to other ~~co~~ types of one plant.

1kg of uranium U^{235} can produced as much energy as can be produced by ~~by~~ burning by 450 term.

* The recovery of nuclear fuel is very dificult and expensive but total energy contain in the world is higher than the energy contained of coal, oil or gas.

Schematic Arrangement of Nuclear power station

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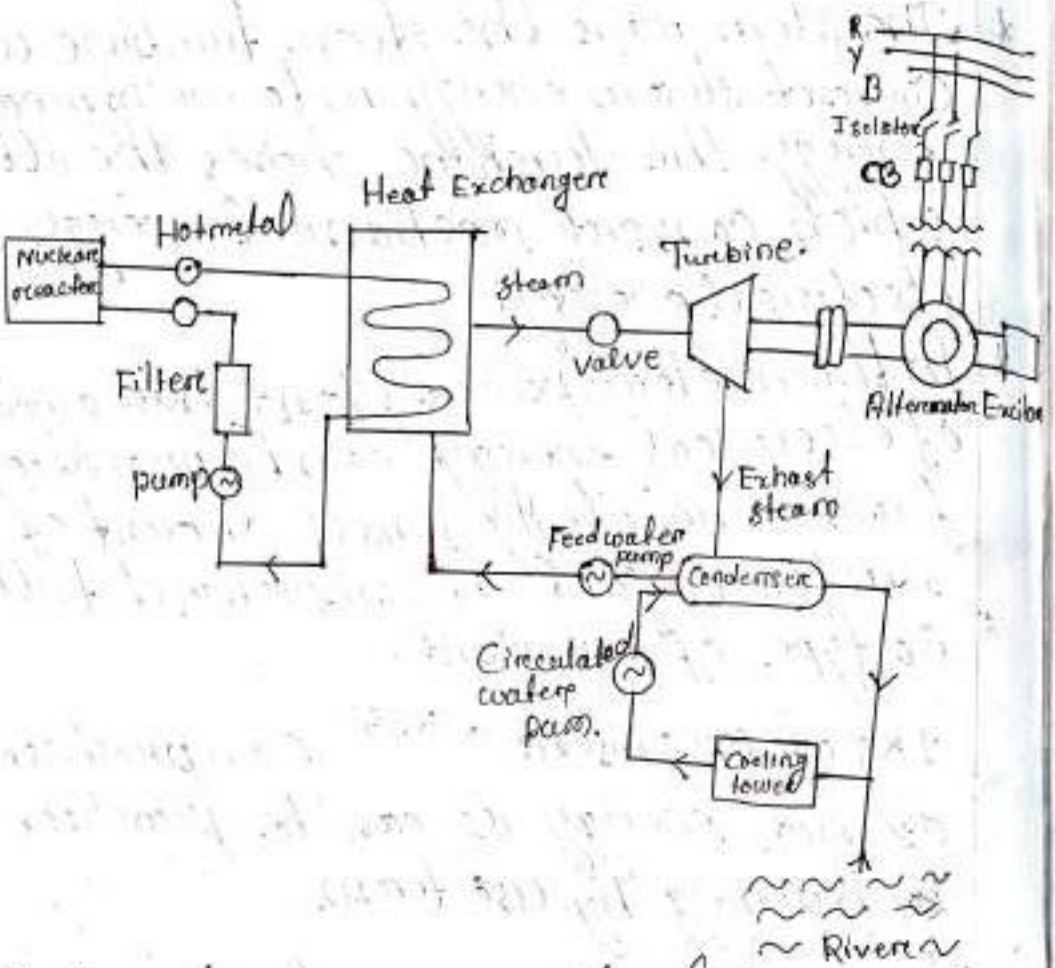


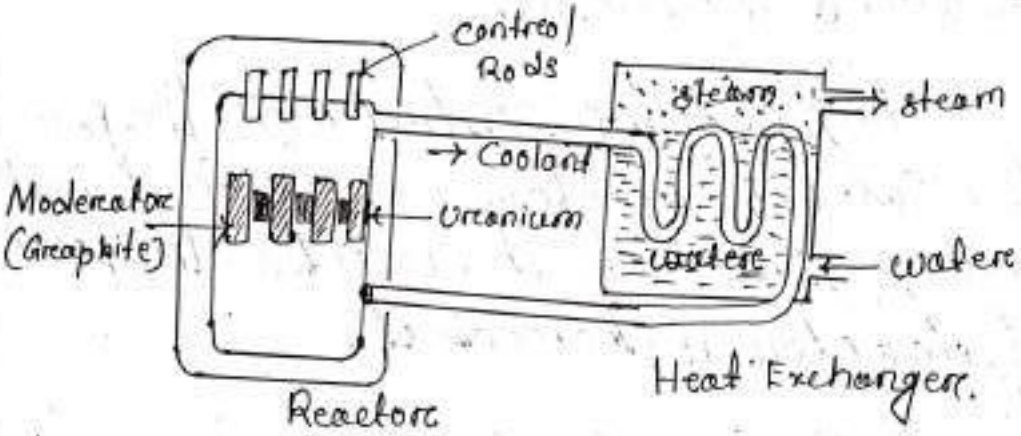
* The schemeling arrangement of chemical reactor is shown in the figure.
* It is devided in to the following stages :

(I) Nuclear Reactor.
(II) Heat Exchanger.
(III) Steam turbine.
(IV) Alternator.

Nuclear Reactor :

* It is an apparatus in which nuclear fuel $_{92}U^{235}$ is subjected to nuclear fision.

* It control the chain reaction that starts once the fission is done.
* If the chain reaction is not control this result on explosion due to the ~~fore~~ fast increase in the energy relieved.



* A nuclear reactor is a cylindrical pressure vessel and houses and fuel rods or Uranium, moderator & control rods. (contains)
* The fuel rods constitute the fission material and relies huge amount of energy when bombarded with slow moving neutron.
* The moderator consist of graphite rods which includes fuel rods.
* The moderator slowes down the neutron before the bombarded with the fuel rods.
* The control rods are of cadmium and are inserted in to the reactor.
* Cadmium is a strong neutron absorver and thus regulats the supply of neutrons for fission.
* When control rods are pushed in deep.

enough they observe most of fission neutrons. There fore a few neutrons are available for chain reae but if their with drawn more and more of these fission neutrons cause fission and intensity of chain reae is increased so heat produced is increased.

* By cooling out the control rods the power of nuclear reactor is increased but pussing them in to the reactor the power of reactor is decreased.

* In actual practice lowering and raising of control rod are done automatically according to the requirement of load

* The heat produced in the reactor is removed by the ~~coltant~~ coolant which is a sodium metal the collant carries heat to the heat exchanger.

Moderator :-

The moderator consist of graphite rod which enclosed the fuel rods neutrons produce by the fission process are ejected from the nucleus at a very high velocity

* The moderator oposes the slow moving neutron on the way when striking

on the nuclear fuel.

Heat Exchanger :

The coolant gives of heat to the heat exchange which is utilised to produced steam after giving of heat the coolant is again faid to the reactor.

To the heat exchanger water is circulated and is contact with coolant so water is converted in to stem by increasing its exchanger.

Steam Turbine :

* The steam produced in the heat exchanger is led in to the steam turbine through a valve
* After doing the usefull work in the turbine the steam is exausted to the condenser.

The condenser condenses the steam which is fed to the heat exchanger through the feed water pump.

Alternator :

The steam turbine drives the alternator which converts mechanical energy into electrical energy

The output to the alternator is through the bus bars through transformer circuit breakers and isolators.

Advantages :-

(i) The amount of fuel required is quit small there fore there is a considerable ~~training~~ saving in the cost of fuel transpotation.

(ii) A nuclear power plant requires less place as compair to any other type of same out put

(iii) It has low running charges as a small amount of fuel is used for producing bulk of electrical energy.

(iv) This type of plant is very economical for producing bulk (large amount) electric power.

(v) It can be located near the local conture because it does n't require large quantity of water and need not be pure coal minds so constant of primary distribution

(vi) There are large diposit of nuclear fuels available all over the world.
There fore surge power It can produced electrical energy for thousand of years.

(vii) It ensures relibility of operation.

Disadvantages :-

* The fuel use is expensive and it dificult to recovere.
* The capital cost on a nuclear plant is very high as compaire to other plant of high.
* The inrection of commissoning of a plant requires greater technical knowlege.
* The fission by products by radio active and may cause a dengerous amount of radio active polution.

Selection of site fore Nucleare power station :-

The following point should be consider by the selecting the side fore a nuclear powere station.

① Availability of watere :-

As sufficent watere is required is cooling perposes therefore the plant side should be located where plenty of watere is available. So the plant should be locate near the river site or sea side.

② Disposal of waste :-

The wast produced by fission in a nuclear powere station ingenerale

radio active so it must be disposed cupperely to avoid to ~~help~~ helth hazards the wast should be ithere buried in a deep treains or disposed off in sea quite away from a sea shore.

There fore the side selected for such a plant should have adiquete arrangement fore the disproposal of radio active wast.

(3) Distance of populated areas :-

The side selected for a nuclear power station should be quite away from the populated areas because there is a dengear of presence of radio activity in the atmosphere near the plant.

For precaution a dome is used in the plant which doesn't alow the radio activity to spread ~~to~~ by wind or condensed water ~~wast~~ ways.

(4) Transmission Facilities :-

The side selected for a nuclear power station should have adiquate facilities in ordere to transport to heavy equipment during plant instalation and facilitate the movement of workers employed in the plant.

From the above factores it is clear that the ideal choice of nuclear powerstation should be near sea are riveros on away from thickly populated areas.