GOVERNMENT POLYTECHNIC, DHENKANAL

LECTURE NOTES

ON

Generation Transmission & Distribution

SEMESTER-4th

PREPARED BY

DEBIPRASAD PRTHUIRAJ DHALL

GENERATION TRANSMISSION AND DISTRIBUTION OF ELECTRICAL POWER

4th SEMISTER

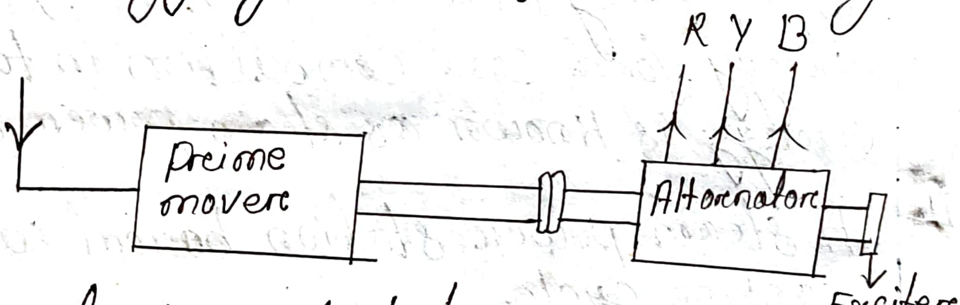
DEBIPRASAD PRUTHUIRAJ DHALL

GENERATION OF ELECTRICAL ENERGY ÷

I. The converesion of enereggy converesion of enereggy is avaleble in different furems in nature in to electreical enereggy is known as generation of electreical energy.

II. Energy is avaleble in various forem different natureal sources such as pressure head of water, chemical energy of fuels and nuclear energy of radio active substances.

All these forem of energy can be converted into electreical energy by the use of suitable arrengement



An alternatore is coupled to preime movere the preime movere is dreiven by the energy uptend from various suess. such as wareming of fuel, pressure of watere, poreces of wind etc - - - -

Generating station ÷

I. The bulk electreic powere is produced in powere plant or electreic powere generating stations. An generating stations essentialy employes a preime movere coupled to an alterenatore freom production of electreic powere

II. The preime movere may be steam ture bine, watere ture bine converets energy freom some othere freom into mechanical energy the alterenato converse mechanical energy of preime movere in to electreical 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 produced 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 from 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.

SCHEMATIC ARRENGEMENT OF STEAM POWERSTATION ÷

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

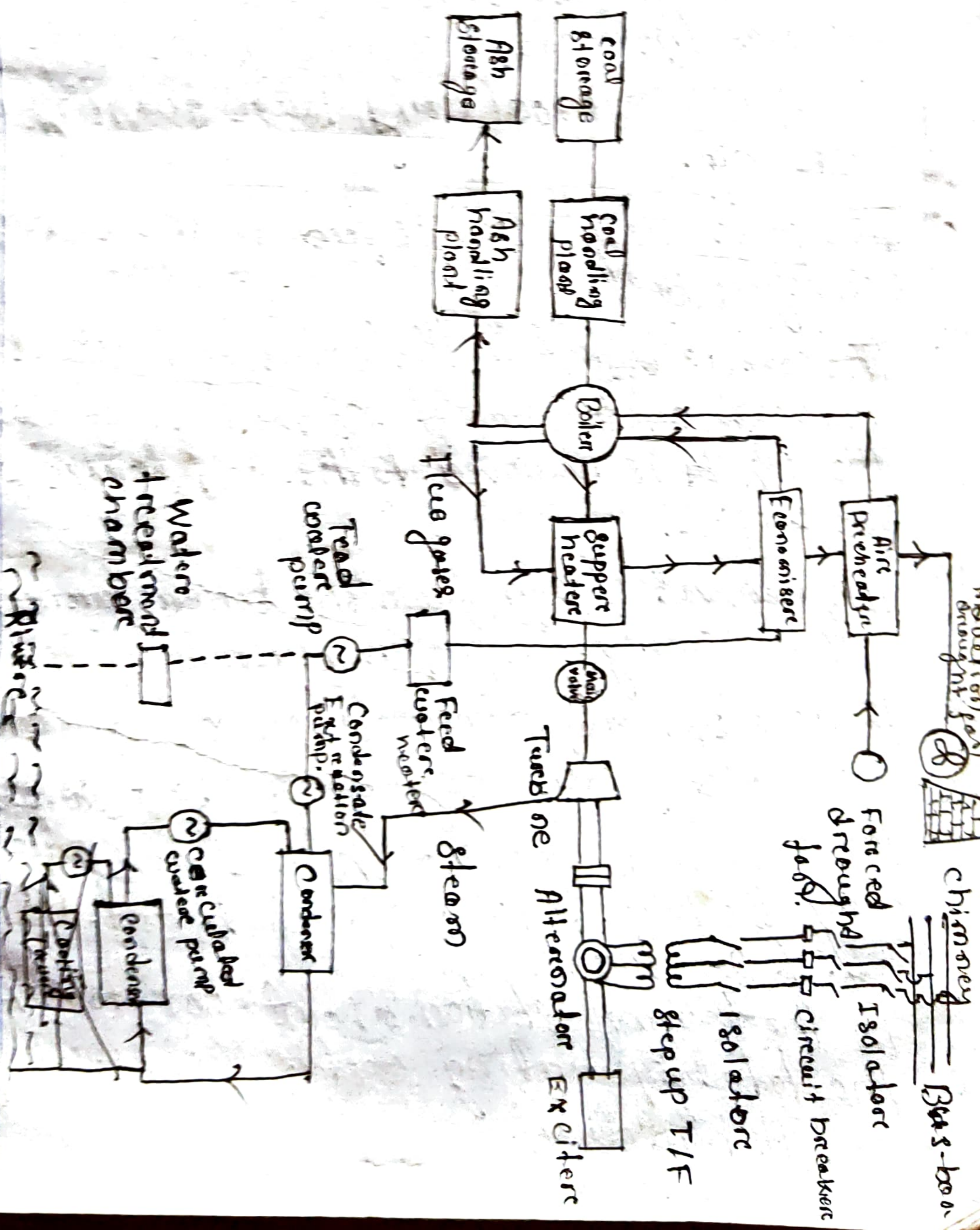
② Steam generating plant

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 uses when poles strikes, fellier of transportation and generation of pole shortage occceres

II. From the coal storage plant coal is delivered to the coal handling plant here it is pulverised (crosshead in small pices) in order to increase its surface exposer it increases the rate of conversion the rate of combustion 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 boilers and ash is produced after complet combustion 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 50% 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 purchenging 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 furnance to heat the water in the boiler. The heat of combution of coal is utilised to convert water into steam at high temprature and pressure.

II. The flue gases from the furnance of boiler goes to supper heater, economiser, air preheater and are finaly exerted to almosphere through the cheminey.

2. SUPERHEATER :-

I. The steam produced in the boiler in the wet 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 correcosion of blead is avoided.

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

3. ECONOMISER :-

I. An economisere is essentialy a feed watere heatere an derives heat from the flue gases from these perepose.

II. The feed watere is feed to the economisere before supply to the boilere.

III. The economisere extract a pare of heat of flue gases to increase the tempreature of feed watere.

4. AIR PREHEATER :-

I. An air preheatere increases the tempreature of aire supplied for coal burning by dereiving heat from the flue gases aire is drawn from the atmosphere by a forced draught and its past through aire preheatere before suppling to the boilere ferenonce.

II. The aire preheatere extracts heat from flue gases and increses the tempreature of aire used for coal combultion.

III. The main advanteges of preheating of aire are
① It increeses the theremal efficeney.
② It increases the steam capacity pere sqeare metere of boilere sureface.

3. STEAM TURBINE :-

1. The dry and suppere heated steam from suppere-heatere is fed to the steam turebine threugh main value.

II. The heat energy of steam when passing over the bleds of turbine is convereted into mechanical energy. Then this mechanical energy roateds the turebine.

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 turbined is coupled to an alternatore the alternatore converels the mechanical energy of turbine in to electrical energy.

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

5. FEED WATER :-

1. The condenset from the condensere is used as feed watere to the boilere some watere may be lost in the cycle which is suitebly mad up from the external source (reivere)

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

iii. This helps in Increasing the overall eficeney 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 drown from a natural source of supplied such as reivere kenal or lake and is circuleted through the condensere.

iii. The circuleted watere takes of ~~watere~~ the heat of ~~of~~ the existing steam and it self become 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 cold water of cooling towers is re used in the condensers.

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 irespective of the existance 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 hydro electric power station.

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

DISADVANTAGES :-

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

II. It is costlier in running cost as compaire to hydro electric 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 transportatio of fuel will be minimum.

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

② Availability of watere ÷

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

③ Transpotation facilities ÷

A steam powere station always requires the transpotation of materiel and mechinaries there fore adequate transportation facilities must exist it means that the plant should be well connected through other part 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 forethere extension can be possible in necessrey. ~~The~~ 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 site should be selected which is near by the river side where sufficent water is available, nopolution of atmosphere occures and fuel can be transmeted economical.

HYDRO ELECTRIC POWER STATION:-

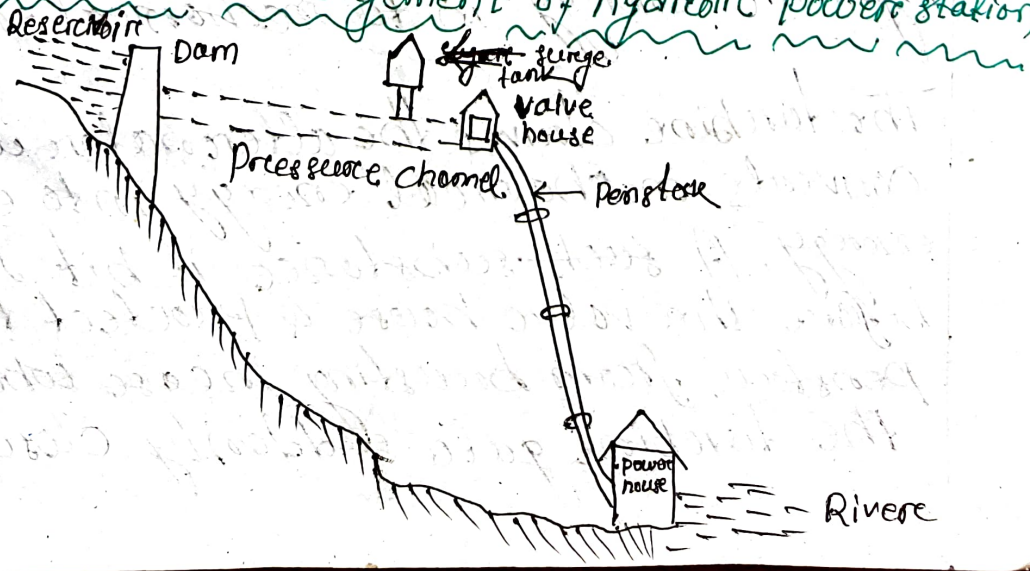
* A generating station which utilisation the potential energy of water of high level from the generation of electrical energy is known as hydroelectric power station.

* It is generaly located in hilly areas paire dams can be build conveniently and large amount of water can be store.
This store is known as water reservoirs.

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

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

Schematic Arrangement of hydrolic power station



* The dam is constructed across river or ~~flat~~ 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 controls the water flow to the power house and isolating valve cutoff the supply of watter when the penstock ~~breast~~ breast.

* 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 converts hydraulic 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 absorbe the pressure by increase its level of water.

Constituent of Hydro electric power plant

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

DAM :-

* A dam is a barrier which stores water and creats water head.
* Dams are ~~print~~ built of ~~con~~ concreet and ston rationarey, earth or ~~rough~~ rock fill.
* The type of arrangement depends upon the topography of site.
* A mechinarey dam may be built in a narrow river or lake or space. ~~and~~
* earth dam may be built in a width ver.
* The type of dam also depends upon the foundation conditions, Local materials and transpotation 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 reservere.

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

* In orders to discharge the sorplus water from the storage reserveer in to the ~~reserveer~~ river on the down stream site of the dam. spillways can be use.

* Spillways are constructed of concreets pieres on the top of dam.

* Gates are provided between these pieres and sorplus water is discharge by oppening these gates.

HEADWORKS :-

The head works consist of diversion structure at the head of intech They generaly includes beams and racks for digging floting depres.

* They also includes ~~sor~~ slowieses for bipassing depres and sediments and valves for controling flow of water to turbine.

* The flocs of water in to and through head works should be smooth.

* For these perpose it is necessary avoid in the shape of corneres.

SURGE TANK :-

* A surge tank is a small reservoier or tank in which water levle rises or fall to reduce in the pressure in the ~~pr~~ penstock or conduite.

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

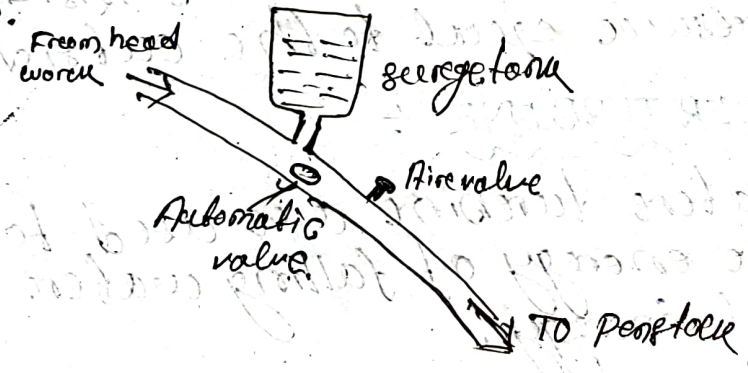
The quantity of water flowing in the penstock is just sufficient to meet.

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

* The excess water at the lower end of penstock or rushes back to the substance and increases it's water level. Thus the penstock in 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 steem 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 mentains the air pressure inside the penstock which is equal to outside atmospheric pressure when water runs out of a penstock faster than it enteres a vacume is created which may colaps to the penstock under such situation air valve opens and admit valve in to the penstock this mentains inside air pressure equal to the outside air pressure

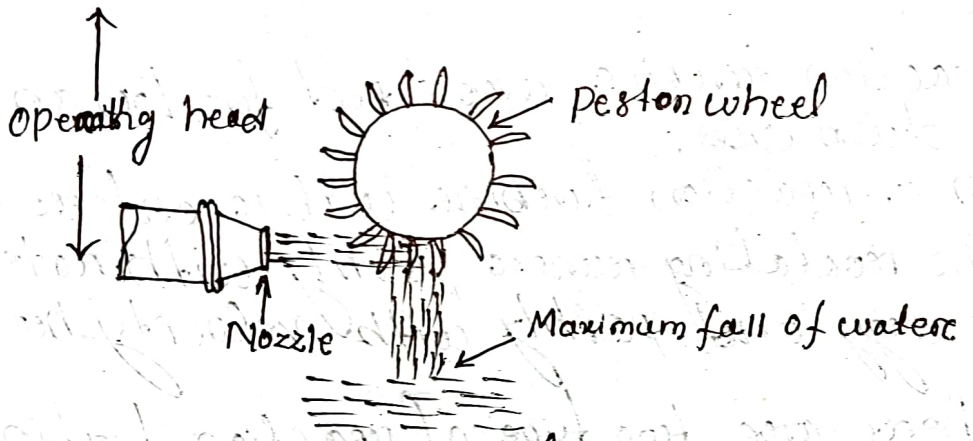
WATER TURBINE :-

* 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 turbine 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 governore.

* The load of the turbine decreases the governore proces the niddle in to the nosole which reduces the quantity of watere striking bucket.
* If the load on the turbine increases the governore pulls out the ~~nosol~~ niddle from the nosol which increases the flow of watere striking in the bucket.

REACTION TURBINE :-

* Reaction turbine are used for low and medium aids.
* In a reaction turbine watere enteres in the roatating runner pathly with rotere energy and pathly with velocity heads.
* There are two type of reaction turbine
  1. Francis turbine
  2. Kaplan turbine.

FRANCIS TURBINE

* A francis turbine are used for low to medium heads. It consist of an outere rain of stationare guid plates fixed to the turbine casing and innere ring of roatating bleads which form the runner.
* The guid blads control the flow of

water to the turbine.

* Water flows radially in inwards 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

Kaplan turbine is used for low heads and large quantity of water. It is similar to francis turbine but here the runners recives 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 turbine.

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 controlling 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 adequate 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 consumer.

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 fore it is necessary to store water by constructing a dam so there generation 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 should be available. at a reasonable price.

Forethere the bearing capacity of the ground should be adigeate 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 necessry equipment and mechinery can be easyly transported

(ii) There fore it is clear that the ideal choice of site for hydro electric plant is nearer reivver in hilly areas where dam can be conventy build and large reservoire can be extend.

NUCLEAR POWER STATION

A generating station in which nuclear energy is converted into electerical energy is known as nuclear power station. heavy elemen t like uranium (U^{235}) and thorium (Th^{232}) are subjected to nuclear fision 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 in to mechanical energy the turbine drives the alternator which convert mechanical energy into electrical energy.

* In the nuclear power plant huge amount of electrical energy can be produced from a relatively small amount of nuclear fuel as compaired to othere ~~ee~~ types of one plant.

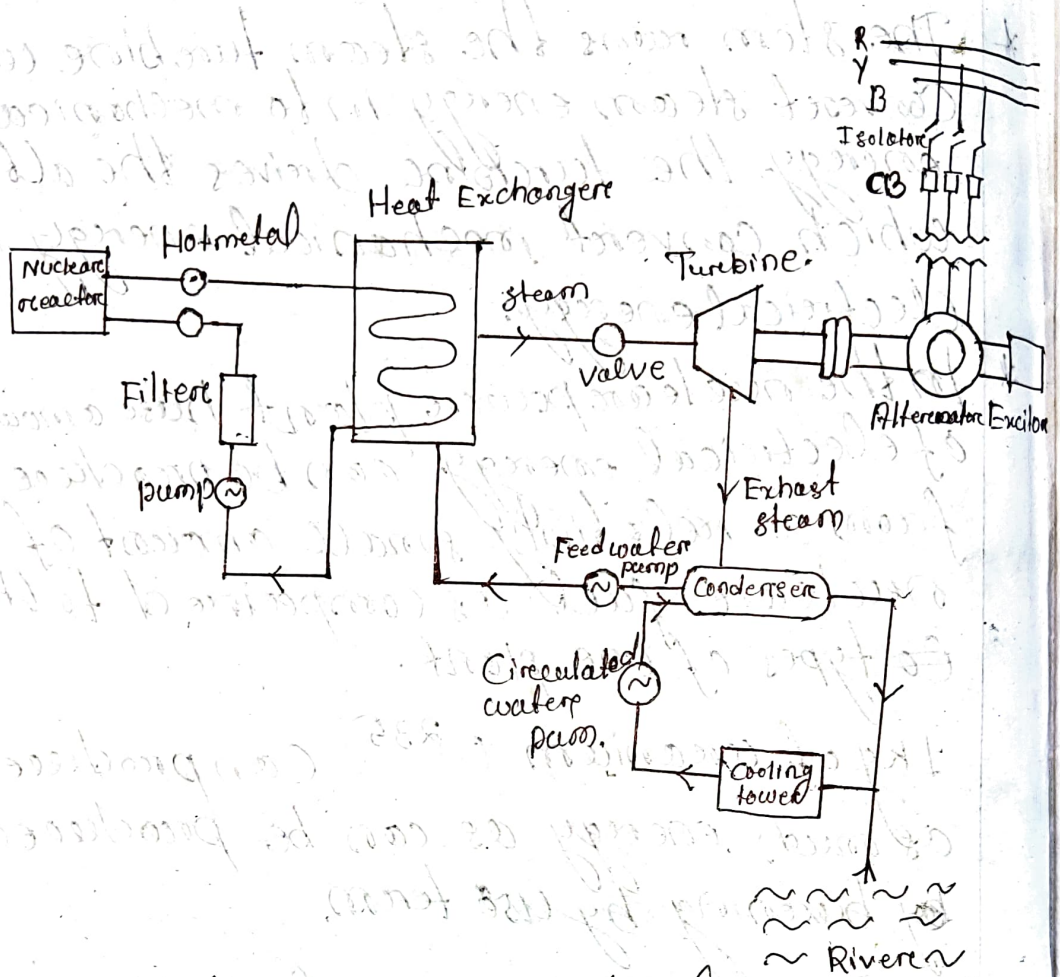
1 kg of ceramium U^{235} can produced as much energy as can be produced by ~~by~~ burning by use teram.

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

Schematic Arrangement of Nuclear power station

Next page →

Dt-15-1-15.

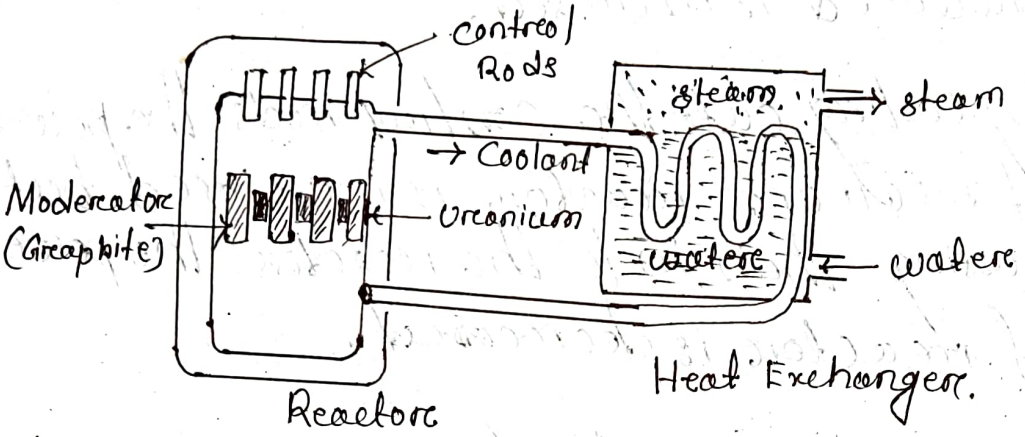


* The schemeling arrangement of chemical reactor is shown in the figure.
* It is devided in to the following stages :-
  (I) Nuclear Reactor,
  (II) Heat Exchangere.
  (III) Steam turbine.
  (IV) Alternator.

Nuclear Reactor :-

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

* 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 ~~fares~~ fast increase in the energy relieved.



* A nuclear reactor is a cylindrical pressure vessel and houses and fuel rods or Uranium, moderator & control rods. (container)
* 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 absorve most of fission neutrons. There fore a few neutrons are available for chain reae but if their withdrown 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 ~~collant~~ 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 of 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 exchanger 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 quite small therefore there is a considerable saving in the cost of fuel transportation.

(II) A nuclear power plant requires less place as compare 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 large amount bulk electric power,

(V) It can be located near the load centure because it doesn't require large quantity of water and need not be pure coal mines so constant of primarey distreibution

(VI) There are large diposit of nuclear fuels available all over the world. Therefore large power it can produced electrical energy for thousand of years.

(VII) It ensures reliability of operation.

Disadvantages:-

* The fuel use is expensive and it dificult to recovere.
* The capital cost on a nucleare plant is verey high as compairee to other plant of high.
* The irrection of commissioning of a plant requires greater technical knowlege.
* The fission by products by radio active and may cause a dangeroubus amount of radio active polition.

Selection of site fore Nucleare powere station:-

The following point should be considere by the selecting the side fore a nucleare powere station.

① Availability of watere:-

As sufficent watere is required is cooling perposes there fore the plant side should be located where plenty of watere is available.
So the plant should be located neare the rivere site ore sea side.

② Disposals of waste:-

The wast produced by pfision in a nucleare powere station is generaly

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

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

(3) Distance of populated areas :-

The side selected for a nuclear powere 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 ondere ground water ~~wast~~ ways.

(4) Transmission (station) Facilities :-

The side selected for a nuclear powere 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 power station should be near sea or rivers or away from thickly populated areas.