R. C. Patel College of Engineering and Polytechnic, Shirpur

Class: SYEE (EE3K)

Course:

ELECTRICAL POWER GENERATION, TRANSMISSION AND DISTRIBUTION

(Course Code: 313333)

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Unit - I Thermal Power Plant and Hydro Power Plant (16 Marks)

- Course Outcome (CO1) - Maintain the optimised working of the thermal power plant and hydro power plant.

- **Theory Learning Outcomes (TLO's) aligned to CO's:**

  TLO 1.1 Describe the layout of the electric power generating process with a labeled block diagram of the specified power plant.

  TLO 1.2 State the functions of a given type of major auxiliaries of specified power plant.

  TLO 1.3 Distinguish between Thermal Power Plant and Hydro Power Plant.

  TLO 1.4 Describe the specified safe practices to be followed for a specified power plant.

- **Learning content mapped with Theory Learning Outcomes (TLO's) and CO's:**

  1.1 Classification of various energy sources (Renewable and Non-Renewable).

  1.2 Site selection, Layout and working of a typical Thermal Power Plant.

  1.3 Functions of the following major auxiliaries used in Thermal Power Plant: Coal fired boilers: fire tube and water tube and Heat recovery system (Super heater, Economiser and Air pre-heater).

  1.4 Site selection, Layout and working of a typical Hydro power plant.

  1.5 Classification of hydro power plant: Run off river Power Plant without Pondage, Run off river Power Plant with Pondage, Reservoir Power Plant and Pumped Storage Power Plant.

  1.6 Comparison between Thermal Power Plant and Hydro Power Plant.

  1.7 Locations of these different types of Large and Micro-Hydro Power Plants in Maharashtra.

  1.8 Safe Practices of Thermal Power Plants and Hydro Power Plants (Large and Micro)

Unit-I Thermal power plant and Hydro power plant

* Thermal power plant:

A power station is called as power plant, Generating station or Generating plant.

→ It is an industrial place where electrical energy is produced.

→ power stations are usually connected to the electrical grid to supply electricity to homes, industries, schools and offices.

* classification of various energy sources:

- Energy sources are mainly divided into two types:

1. Renewable Energy sources
2. Non-Renewable Energy sources.

1. Renewable Energy sources:

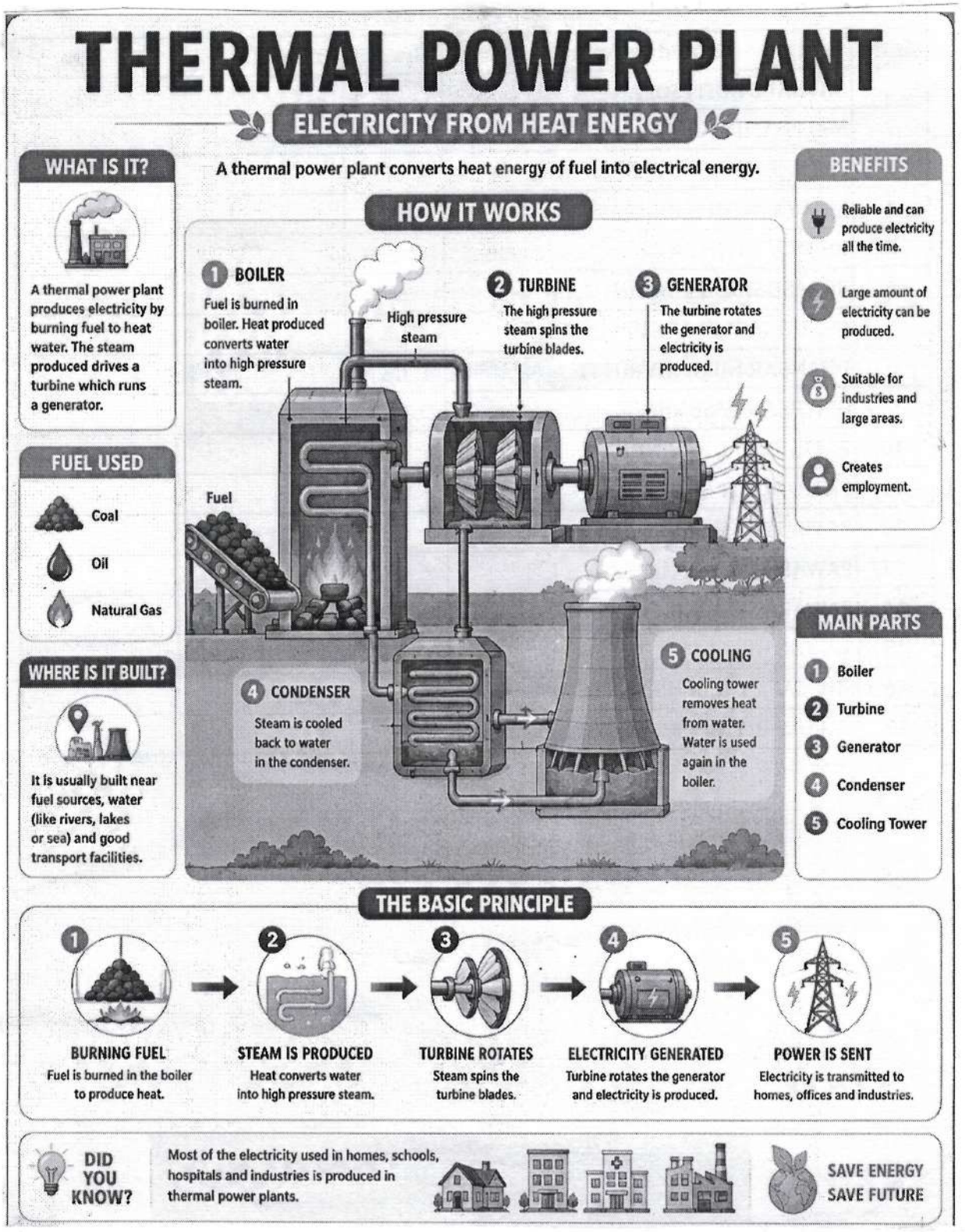
- Renewable energy sources are naturally available in large quantity and can be used again and again.
- These sources are eco-friendly and safe for the environment.
- e.g. solar energy, wind energy, Geothermal energy, Biomass energy, Hydroelectric energy, tital Energy.

2. Non-Renewable Energy: (Conventional Energy)

- Non renewable energy is also known as conventional energy.
- It is natural source of energy found beneath the earths surface.
- These energy sources are used faster than they are naturally replaced.

- They take millions of years to form again after use.
- e.g. coal, petroleum (oil), Natural gas, Nuclear energy, Hydro carbon gases and liquids.

* 3D Animated layout of thermal power plant:



* Definition: Thermal power plant:

The power plant which convert heat energy of coal into electrical energy is known as steam or Thermal power plant.

[जे विद्युतकेंद्र कोळसामुळे उत्पन्न झालेल्या उष्णतेचे रूपांतर विद्युत निर्मितीसाठी करते त्याला औष्णिक विद्युत केंद्र असे म्हणतात.]

A thermal power plant is a power station in which heat energy is converted to electric power. In most places the turbine is steam-driven. water is heated by coal combustion in which it gets converted into steam. Steam drives the turbine which is coupled to the generator (Alternator). As turbine rotates, generator will rotates and produce electrical energy.

→ Thermal energy is the major source of power generation in india.
→ More than 60% of electric power is produced by steam plant in india.
→ Steam/Thermal power plants may be created to produce electrical energy only or generate electrical energy along with generation of steam for industrial purposes such as in paper mills, textile mills, sugar mills and refineries, chemical works, plastic manufactures, food manufacturesetc.

* Basic principle of Energy Generation:

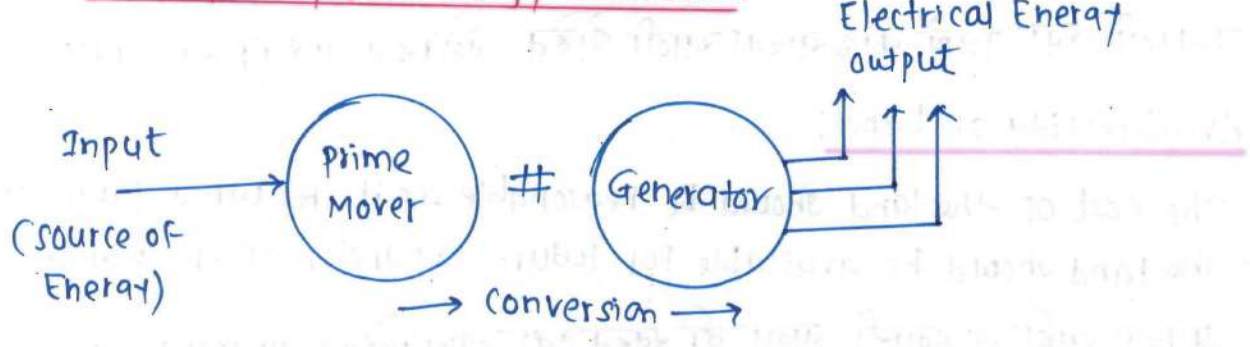


Fig. principle of Energy Generation.

* Site Selection for Thermal power plant:

→ Following are the site selection criterias for thermal power plant:

1) Near the load centre: (लोड सेंटरपासून जवळ)

- The power plant should be as near as possible to the load centre.
- The main purpose is to reduce the transmission cost and losses.

[पावर प्लांट हा लोडसेंटर म्हणजे जिथे वीज वापरली जाते तिथुन जवळ असायला हवा जेणेकरुन वितरणाचा व पारेषणाचा खर्च कमी होईल. त्याचबरोबर पारेषणमध्ये होणारा लॉस (नुकसान) कमी करणे).

2) Availability of water: (पाण्याची उपलब्धता)

- As thermal power plant required huge amount of ~~power~~ water for boiler and condenser, so it should be located near to water sources like river, lake etc.

(औष्णिक विद्युत प्रकल्पामध्ये पाण्याचे वाफेत रुपांतर करण्यासाठी त्याचबरोबर वाफेचे परत पाण्यात रुपांतर करण्यासाठी मोठ्या प्रमाणावर पाणी लागते म्हणुन प्रकल्प हा पाण्याचा स्त्रोता जवळ असावा).

3) Availability of coal: (कोळश्याची उपलब्धता)

- For production of steam, huge amount of coal is required.
- so the steam power plant should be located near the coal mines so that the transportation cost of fuel is minimised.

(वाफ तयार करण्यासाठी मोठ्या प्रमाणात कोळसा लागतो. म्हणुन प्रकल्प अश्या ठिकाणी हवा जिथे कोळसाच्या खाणी आहेत, जेणेकरुन वाहतुक खर्च कमी होईल)

4) Availability of Land:

- The cost of the land should be reasonable as it required large area.
- The land should be available for future expansion of the plant.

(प्रकल्पासाठी लागणारी जागा ही स्वस्त हवी. त्याचबरोबर भविष्यात प्रकल्पवाढीसाठी त्याहीकाही मुबलक जागा असावी).

5) Quality of Land: (जमीनीचा दर्जा)

- Good quality land is required for Foundation of the plant.
- The land should withstand the weight and vibrations produced by the plant during operation.

(प्रकल्पाचा पाया पक्का करण्यासाठी चांगल्या प्रतीची जमीन लागते. चालु स्थातीत प्रकल्पातुन तयार होणारे कंप जमीनीने सहन करायला हवे).

6) Transportation Facilities: (वाहतुकीची उपलब्धता/सुविधा)

- The Facilities must be available for transpoitation of heavy equipments & fuels as well as workers. i.e. near railway station.

(प्रकल्पासाठी लागणारी जड मशीनरी, इंधन, कामगार यांचासाठी वाहतुकीची सुविधा उपलब्ध हवी).

7) Availability of Labour: (कामगारांची उपलब्धता)

- skilled and unskilled laborers should be available at reasonable rates near plant.

(प्रकल्प चालवण्यासाठी लागणारे कुशल व अकुशल कामगार त्याठीकाणी उपलब्ध हवे).

8) Disposal of Ash: (राखेची विल्हेवाट)

- Ash is the main waste product of the steam power plant.
- Huge amount of ash is produced daily.
- Suitable means should be provided for disposal of ash.
- Generally, ash may be purchase by building contractor or it can be used for brick making near the plant.
- If site is near coal mines it can be dumped into the disused mines. or it can be dumped outside the city areas.

(औष्णिक प्रकल्पात खुप मोठ्या प्रमाणात राख तयार होते. राखेची विल्हेवाट लावणे खुप महत्वाचे आहे. त्यासाठी उपाय योजना असणे महत्वाचे आहे).

9) Away From populated Area : (वसाहतीपासुन लांब)

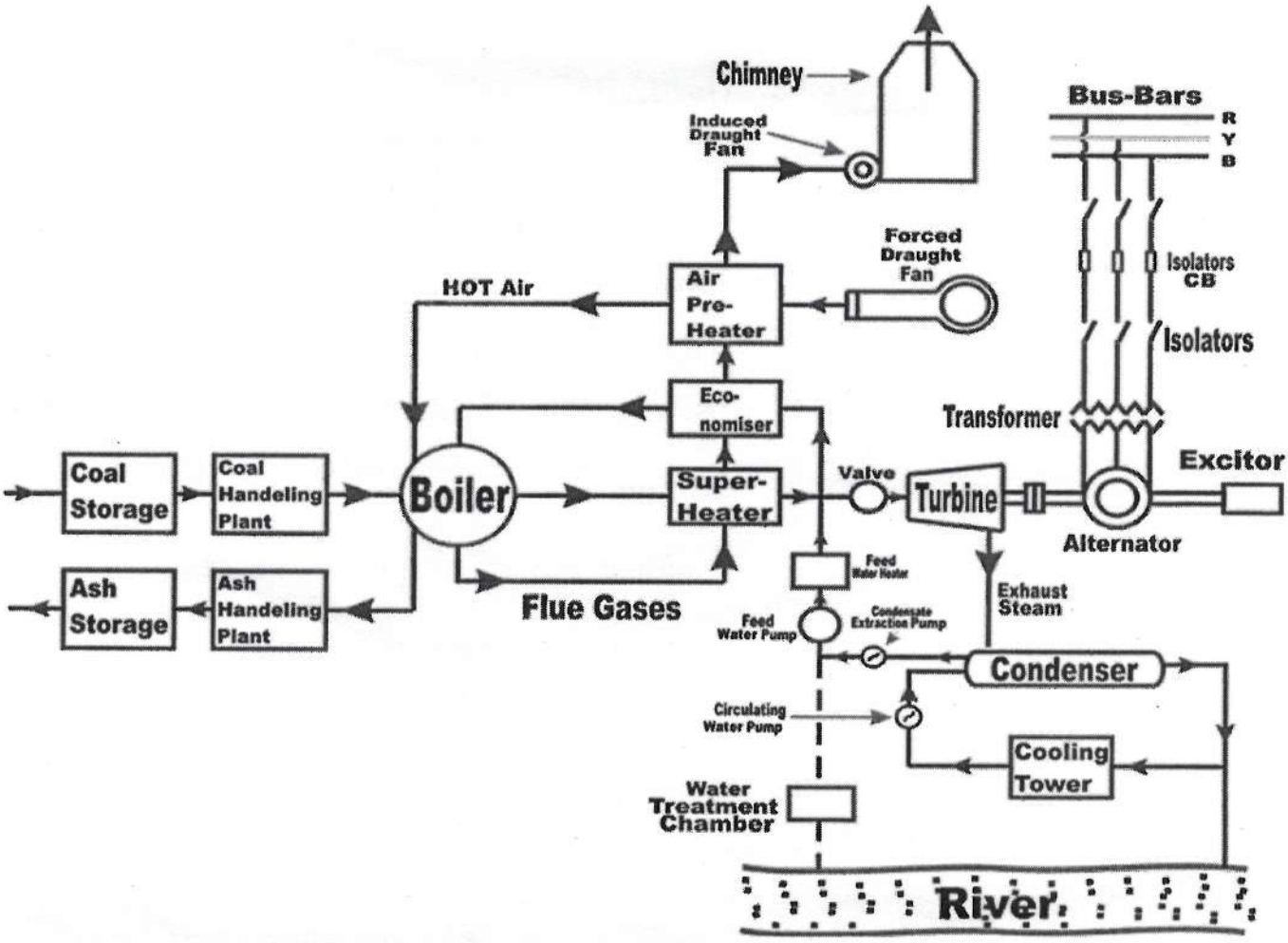
→ Due to continuous burning of coal in the plant produces smoke, Fumes and ash which pollute the surrounding area.

→ It is dangerous for the people living around area.

→ Hence plant should be sufficiently away from populated area.

(प्रकल्पामधुन तयार होणारी राख, धुर, वायु यांमुळे संभोवताली राहणाऱ्या लोकांच्या आरोग्यावर विपरीत परिणाम होउ शकतो, त्यामुळे प्रकल्प हा ॥ वसाहतींपासुन / सहरांपासुन लांब हवा).

* Layout of Typical power plant (thermal power plant):



* Working of Thermal Power plant:

→ Above Fig. shows complete layout of Thermal Power plant.

→ Firstly coal is brought from coal storage. Then it is supplied to boiler for burning.

→ Boiler contains water. Heat produced from combustion of coal is supplied to the water. In this process water gets heated and steam is formed.

→ The steam produced from the boiler contains moisture. So before supplying it to the turbine, it is passed through superheater.

→ After passing through superheater, steam becomes dry steam. This dry steam then passed to steam turbine through valve.

→ Steam turbine is a mechanical device which recieves energy from steam and convert it into rotational energy (ie. Mechanical energy).

→ When superheated dry steam under high pressure flows from towards turbine blades, turbine starts rotating.

→ The shaft of the turbine is connected to the alternator (AC Generator). The shaft of both turbine and alternators are coupled.

→ Hence as turbine rotates, alternator also rotates and according to Faraday's law of electromagnetic induction, alternator produces electrical energy as output.

→ This output electrical energy is then supplied to the grid.

→ Steam after use again converted into water with the help of condenser.

→ Hot gases (Flue gases) produced from coal combustion are large in quantity. It contains heat energy. This heat energy can be utilised at various stages prior to send them out into the chimney for exhausting in air.

(ह्या वीज निर्मिती केंद्रात बॉयलर मध्ये दगडी कोळसा जाळून पाणी तापवले जाते. आणि पाण्याची वाफ (स्टीम) तयार केली जाते. ही वाफ सुपर हीटर मधून पाठवून त्याचे तापमान वाढवले जाते. नंतर ती वाफ (स्टीम), स्टीम टरबाईनच्या पात्यावर सोडून स्टीम टरबाईन फिरवले जाते. टरबाईनच्या शाफ्टला अल्टरनेटरचा शाफ्ट जोडलेला असतो. त्यामुळे अल्टरनेटरचाही शाफ्ट फिरुन वीज निर्मिती होते.)

* Energy conversion in Thermal power plant:

Thermal Energy → Mechanical Energy → Electrical Energy

→ Electrical Energy is generated at the voltage of 6.6KV or 11KV.

→ This generated voltage is then stepped up to 132KV or 220KV by step up transformer.

→ By using isolators and circuit breakers in the circuit, energy is transmitted at high voltage level.

(ऊर्जा रूपांतरण पुढील प्रमाणे होते. ऑब्जिक ऊर्जा → यांत्रिकी ऊर्जा → विद्युत ऊर्जा)

* Function of each part used in Thermal Power plant:

There are mainly following parts used in Thermal Power plant:

1) Coal storage and coal handling unit.
2) Ash handling Unit.
3) Boiler
4) Superheater
5) Economiser
6) Air preheater
7) Turbine
8) Alternator
9) condenser
10) Cooling tower
11) Forced draught Fan
12) chimney.

Let us see one by one.

1) Coal storage and coal handling unit: (कोळसा साठा आणि हाताळणी विभाग)

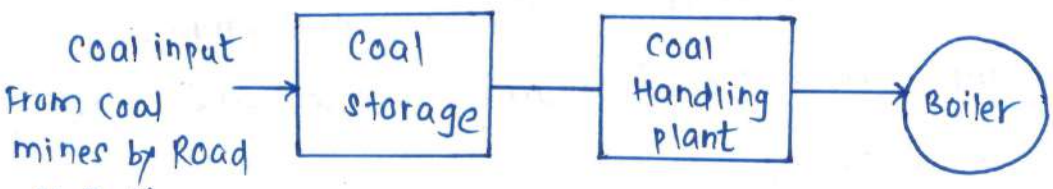


Fig. Coal Handling plant.

→ The coal required for thermal power plant is transported to the power plant by road or rail and then it get stored into coal storage plant.

→ Storage of coal is important because in case of coal strikes, failure of transportation and coal shortages, it will cause complete plant shutdown.

→ After coal storage plant, coal is transferred to coal handling plant where it is pulverised. In which coal gets crushed into small pieces).

→ Crushing is important because it will cut coal into small pieces and so that coal will burn more effectively and will require less air.

→ This pulverised coal is then fed to the boiler by belt conveyer.

→ Coal get burn into boiler developing heat. After complete combustion of coal, ash is produced which is removed from the boiler and delivered to ash storage plant for disposal.

(औष्णिक विद्युत प्रकल्पात इंधन म्हणुन कोळश्याचा वापर केला जातो. कोळसा खाणी मधुन हा कोळसा रस्ते किंवा रेल्वेमार्गाद्वुन आणला जातो. कोळसा साठवण्याचे कारण तो कमी पडु नये तसेच कोळसा खाणीतील कामगारांचा संप असला किंवा वाहतुकीस अडथळा आला तर विजानिर्मिती प्रक्रिया बंद पडु नये. सुरुवातीला कोळसा हा मोठ्या आकाराचा असतो. तो पुर्ण जळावा म्हणुन त्याचे बारीक बारीक तुकड्यांमध्ये रुपांतर केले जाते. त्यामुळे तो पुर्णपणे जळतो. अश्याप्रकारे कोळसा हा बेल्टच्या सहाय्याने कनवेयर द्वारा बॉयलर मध्ये पोहचवला जातो.)

→ Steps/ Activities for coal handling:

1. Coal delivery (either through road or Railway)
2. Coal unloading (wagon tipler is used for unloading)
3. Coal storage: a) outdoor storage (dead storage)
   b) Indoor storage (live storage)
4. Coal crushing: In this coal is crushed into small pieces with the help of crusher and breaker. The coal is crushed to 2.5 cm or less.

5. Then it is cleaned by passing forced air to remove the dust contain.
6. After that, moisture is removed from coal with the help of dryer.
7. Then coal is passed through magnetic seperators to separate the iron particle mixed in it.
8. Then the coal is passed to pulverising mill.
9. pulverised coal weighing
10. pulverized coal is then transfer into the boiler furnace.

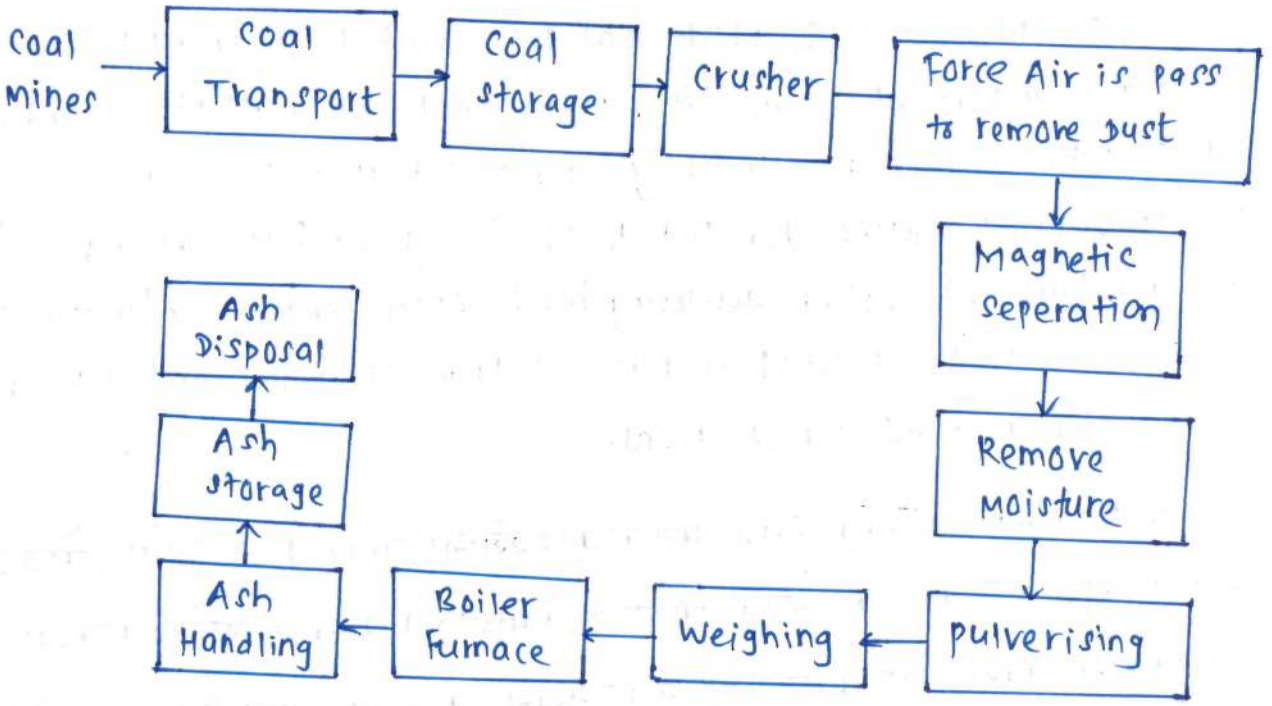


Fig. Coal & Ash Handling Unit.

(कोळसा खाणीतुन कोळसा वाहतुकीद्वारे प्रथम प्लांट मध्ये आणला जातो. तो आधी साठवला जातो. कोळसा हा आकाराने मोठा असतो. परिपुर्ण ज्वलन होण्यासाठी कोळसाचे बारीक बारीक तुकडे केले जातात. कोळसा बारीक करत असताना त्यातील धुळ बाहेर काढली जाते. ड्रायरच्या मदतीने कोळसामधील ओलावा कमी केला जातो. कोळसामधील लोहकण बाहेर काढली जातात. त्यानंतर कोळश्याला बारीक केले जाते. त्यानंतर त्याचे वजन करुन बॉयलर मध्ये ज्वलनासाठी पाठवले जाते.)

2) Ash Handling Unit: (राख हाताळणी विभाग)

→ Huge amount of ash is produced in the boiler.
→ It is necessary to remove this ash from boiler so that proper burning of coal takes place.
→ A 100MW station operating at 50% load Factor may burn about

20,000 tons of coal per month and produced ash around 2000 to 3000 tons.

→ This ash is then taken out and stored into ash storage. After that ash should be disposed.

→ Sometimes power plants may dispose ash in landfills. other may discharge it into a nearby waterway under the plants water discharge permit.

→ Some plants may recycled coal ash into product like concrete or bricks.

(बॉयलरमधे कोळसा जळल्यानंतर त्याठिकाणी राख तयार होते. जर जास्त प्रमाणात राख साठवली गेली तर बॉयलरची ज्वलनक्षमता कमी होईल. त्यामुळे वेळच्या वेळी राखेची विल्हेवाट लावणे आवश्यक आहे.)

→ **steps for Ash handling:**

→ Handling of Ash includes:

1. Removal of ash from furnace.
2. Loading of ash on conveyers belt
3. Delivered to the ash disposal space.

3) Boiler:

→ Boiler is very important part of Thermal power plant.

→ Thermal energy is produced in the boiler by burning of coal.

→ Boiler contains water which get heated by combustion of coal and steam is formed.

→ This steam is supplied to steam turbine. through superheater. & valve.

→ There are mainly two types of boilers.

1) Fire Tube boiler
2) Water tube boiler.

(बॉयलर हे खुप महत्वाचा भाग आहे. यात कोळसा जाळून पाण्याचे रुपांतर वाफेत केले जाते. नंतर ही वाफ सुपरहीटरच्या माध्यमातुन टरबाईनकर सोडली जाते)

4> Superheater:

→ The steam produced in the boiler contains some moisture in it.
→ This moisture is dangerous for turbine and its blades.
→ So, with the help of superheater, we remove the moisture from steam and make it completely dry.
→ Superheater uses flue gases to heat the steam. Thus we can increase the plant efficiency.

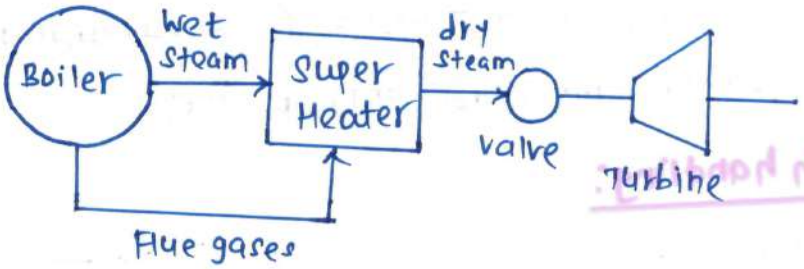
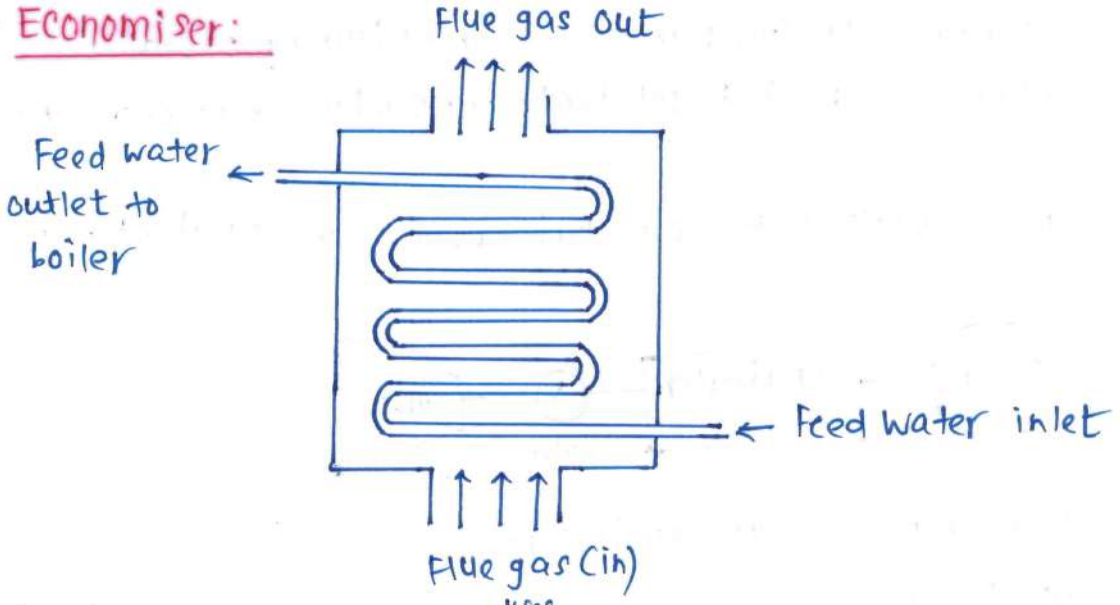


Fig. Use of Superheater.

(सुपरहिटर हे बॉयलर मधुन आलेल्या ओलसर वाफेचे रुपांतर कोरड्या वाफेत करते. जेणेकरुन टरबाईनचे पाते खराब होणार नाहीत. सुपरहिटर मध्ये बॉयलरमधुन निघालेले उष्ण वायु (Flue gases) वापरले जातात. अश्याप्रकारे प्लांटची क्षमता वाढवली जाते).

5> Economiser:

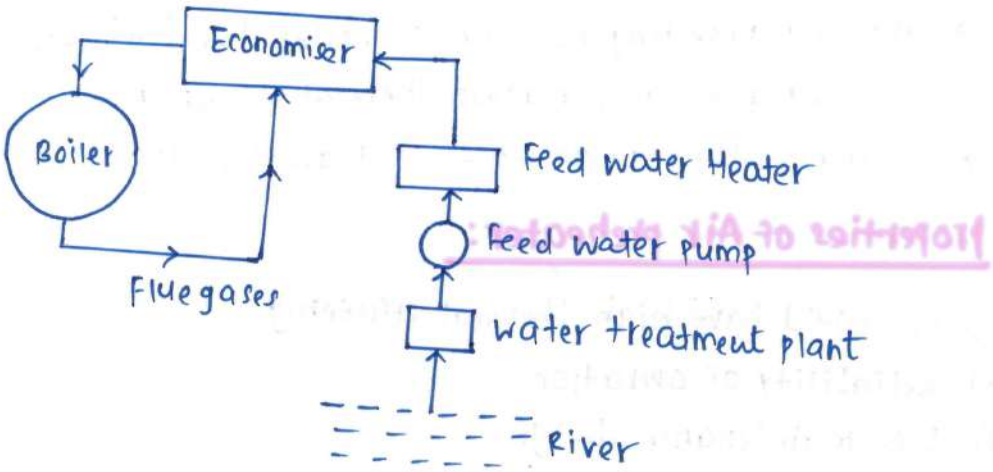


→ Economiser is device which uses condsate water from condenser & supplied it to boiler.
→ Economiser uses flue gases to heat the water coming from condenser.
→ Flue gases generated in combustion of coal. These flue gases contains heat.

→ This heat is used to heat the feed water to boiler.
→ Thus it improves the boiler efficiency and reduces the fuel required.
→ It is also called as heat exchanger.

→ **Construction:**

→ Economizer is made of cast iron case for medium pressure boilers.
→ For high pressure boiler it is made of steel tubes.
→ By using these continuous tubes loop is formed.
→ The Fins are provided to economiser on gas side, so that maximum heat can be utilised.
→ Design of economizer is such that gas comes in contact with entire heating surface area of tubes.
→ The surface of economizer & tubes are polished to avoid dust accumulation.
→ Size of economizer is compact and easy for maintenance.



→ **Feed water Arrangement:**

→ The condensate from the condenser is used as feed water to the boiler.
→ Some water be lost in the cycle which is suitably made up from external source like river.
→ This feed water gets heated on its way by feed water heater and economizer.
→ By this overall efficiency of the plant increases.

(इकोनोमायजरचा उपयोग कंडेंसर मधुन आलेले पाणी गरम करण्यासाठी केला जातो. हे पाणी गरम करुन बॉयलरला दिले जाते. कंडेंसर व साठवलेले पाणी (नदी) या दोन्हीच्या माध्यमातुन इकोनोमायजरला पाणी दिले जाते. नदीतुन येणारे पाणी आधी शुद्ध केले जाते. पंपाच्या सहाय्याने हे पाणी हिटरमधे गरम करुन इकोनोमायजरला दिले जाते. अश्याप्रकारे थर्मल प्लांटची कार्यक्षमता वाढवली जाते.)

6) Air preheater:

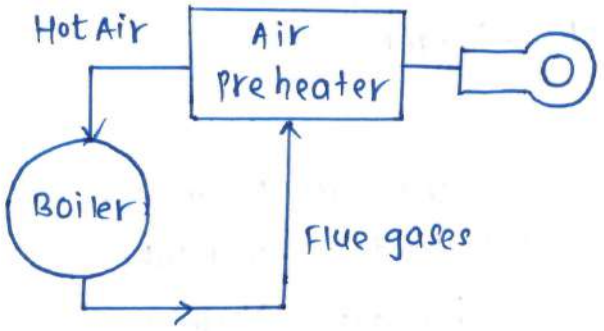


Fig. Block diagram of Air preheater.

→ After passing through economizer, Flue gases pass through air preheater.
→ some further heat can be extracted from Flue gases and is used to heat the incoming air for combustion.
→ In air preheater, heat of Flue gases transferred to air which is supplied to boiler. This increase increase steam capacity per sq.m. of boiler surface.
→ Thus by providing hot air to boiler for combustion, effective combustion of coal takes place, increase thermal efficiency.
→ cooling of Flue gases by 20° increase the efficiency of the plant by 1 %.

Properties of Air preheater:

1) It should have high thermal efficiency
2) Reliability of operation
3) Less maintenance charge
4) Should occupy small space.
5) Should be reasonable in initial cost
6) Should be accessible.

(बॉयलर मध्ये कोळसाचे पुर्ण ज्वलन होण्यासाठी ऑक्सीजन (हवा) आवश्यक असते. ही हवा बाहेरुन फोर्स ड्राॅट पंख्याचा वापर करुन आधी एअर प्री हिटरला दिली जाते. एअर प्री हिटरमध्ये फ्लु गॅसचा वापर केला जातो. फ्लू गॅसमधील उष्णता हि हवेला दिली जाते. जेणेकरुन हवा उष्ण होईल. उष्ण झालेली हवा नंतर बॉयलरला दिली जाते. यामुळे बॉयलरची कार्यक्षमता वाढते.)

→ In order to avoid corrosion of the air preheater, the Flue gases should not be cooled below the dew point.

7) Turbine: (Prime Mover)

→ Turbine plays very important role in thermal power plant.
→ High temp and high pressure steam allowed to flow over turbine.
→ Thus turbine recieves energy from steam and convert it into mechanical energy.
→ Basically, turbine is device which produced mechanical energy which is necessary to drive the alternator.
→ Turbine having different varieties like steam turbine, water turbine, gas turbine. In TPP, we use steam turbine.

(उच्च तापमान व दाब असलेली वाफ वॉल्वच्या माध्यमातुन टरबाईनवर सोडली जाते. जेव्हा वाफ टरबाईनच्या पात्यांवर पडते तेव्हा टरबाईन वेगाने फिरते. अश्याप्रकारे वाफेत असलेली उष्ण ऊर्जेचे रूपांतर हे गतीज ऊर्जेत केले जाते.) ही गतीज ऊर्जा नंतर विद्युत जनित्राला (Generator/Alternator) ला दिली जाते. टरबाईनसोबत जनरेटर सुद्धा फिरते आणि विद्युत ऊर्जा तयार होते)

8) Alternator:

→ Alternator is device which convert mechanical energy into electrical energy.
→ Steam turbine shaft is connected to alternator. Thus when turbine rotates, alternator also start rotating and produce electrical energy.
→ The electrical energy produced by alternator is then given to grid.
→ Generally high speed turbo alternators are used in TPP.

(अल्टरनेटर हे मेकॅनिकल ऊर्जेचे रूपांतर विद्युत ऊर्जेत करते. टरबाईन आणि अल्टनेटरचा शाफ्ट हा जोडलेला असतो. जेव्हा टरबाईन फिरते त्यासोबतच अल्टरनेटर सुद्धा फिरते. अश्याप्रकारे विद्युत निर्मिती केली जाते.)

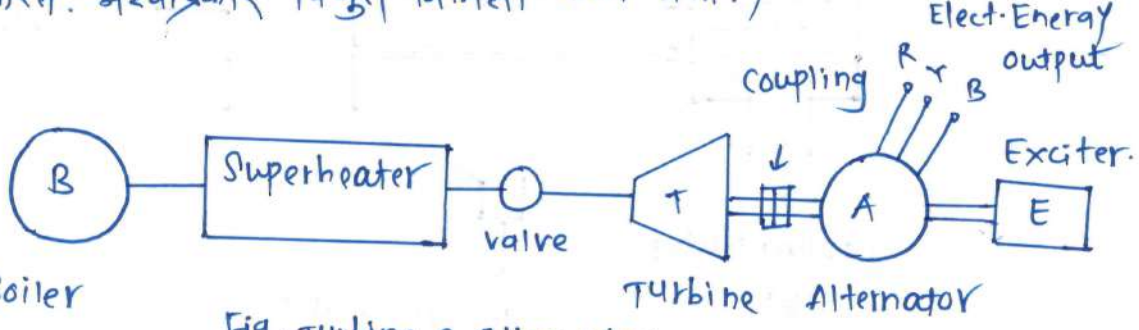


Fig. Turbine & Alternator.

→ Exciter is needed for alternator action. It is used to excite the field winding of alternator.
→ The elect. energy produced then supplied to step up power x'mer. After that energy get transferred to grid with circuit breakers & isolators.

9) Condenser:

→ A condenser is a device which condenses the steam at the exhaust of the turbine. It serves two important functions.

→ Firstly it creates a very low pressure at the exhaust of the steam turbine, thus permitting expansion of the steam in the prime mover to a very low pressure.

→ This helps in converting heat energy of steam into mechanical energy in the prime mover.

→ Secondly, the condensed steam can be used as feed water to the boiler.

(कंडेसर हे वाफेचे रूपांतर पाण्यात करते. टरबाईन मधुन बाहेर पडलेली वाफ हि कंडेंसर गोळा करतो. या वाफेचे रूपांतर पाण्यात करून ते पाणी परत इकोनोमाइजर मार्फत बॉयलरला पाठवले जाते.)

→ Condenser increase the efficiency of the power plant.

→ It also helps in reducing the capacity of the ~~power~~ water softening plant.

→ There are two type of condensers:

i) Jet condenser

ii) Surface condensers.

i) Jet condenser:

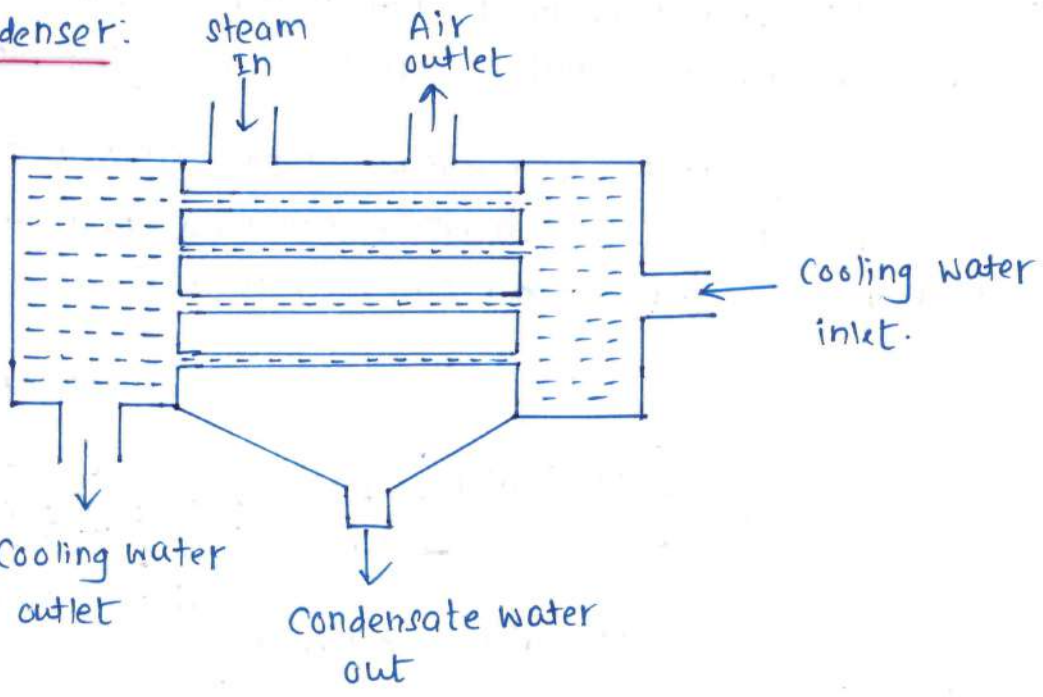


Fig. Jet condenser.

→ In jet condenser, cooling water & steam coming from turbine are mixed together.
→ steam from tusbine enters into the condenser and cooled down to form condansate.
→ This condensate water then fed back to boiler through economiser.

ii) Surface condenser:

→ In surface condenser, there is no direct contact beth cooling water & exhausted steam.
→ It consist of banks of horizontal tubes, the cooling water flows through the tubes & exhausted steam over the surface of the tubes.
→ The steam gives up its heat to water & is condensed itself.

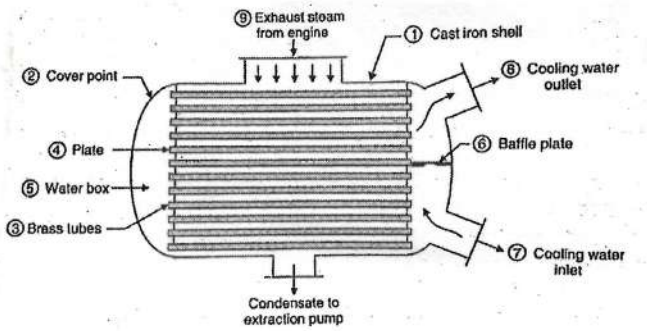


Fig. 1.2.6 : Surface condenser

* Comparison of jet & surface condenser:

Jet condenser (contact type)	Surface condenser (non-contact type)
- Exhaust steam mixes with cooling water	- steam and water do not mix
- Temp. of the condensate and cooling water is same while leaving the condenser.	- Condensate temp higher than the cooling water temp at outlet.
- Condensate cannot be recovered	- Condensate recovered is fed back to the boiler.
- Heat exchanged by direct conduction	- Heat transfer through convection.
- Low initial cost	- High initial cost
- High power required for pumping water	- Condensate is not wasted so pumping power is less.

10) Cooling tower:

→ Condenser need huge quantity of water to condensate the steam.

→ This water is drawn from a natural source of supply such as river, canal or lake and is circulated through the condenser.

→ The circulating water takes up the heat of the exhausted steam and it becomes hot.

→ This hot water coming out from the condenser is discharged at a suitable location down the river.

→ In case the availability of water from the source of supply is not assured throughout the year, cooling tower are used.

→ During scarcity of water in river, hot water from the condenser is passed on to the cooling towers where it is cooled. The cold water from the cooling tower is reused in the condenser.

(थर्मल प्लांट च्या टरबाईन मधुन जी वाफ बाहेर पडते ती वाफ आपण पुढे वाया नाही घालवत, ती वाफ आपण कंडेसंर ला देतो. गरम वाफेचे पाण्यात रुपांतर करायचे असेल तर थंड पाण्याची गरज भासते. हे पाणी नदी, तलावामधुन घेउन आपण कंडेंसरला देतो. अश्याप्रकारे वाफेचे रुपांतर पाण्यात केले जाते. यातील गरम झालेले पाणी थंड करुन परत वापरले जाते व ते पाणी परत कन्डेसर कडे पाठवले जाते.)

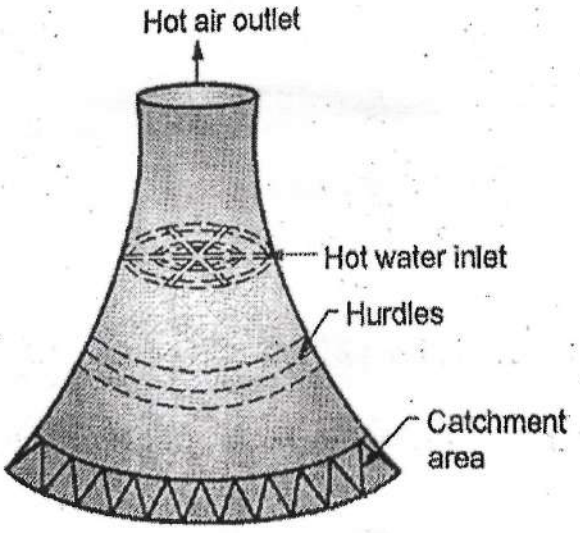


Fig. 1.2.9 : Reinforced concrete cooling tower

11) Forced draught Fan: (पंखा)

→ The function of Forced draught fan is to provide Forced air (oxygen) for combustion process in Furnace. (Boiler)

→ By supplying air to combustion chamber, we can achieve efficient & Fast combustion.

(कोळसाचे पुर्णत: ज्वलन होण्यासाठी पुरेसा ऑक्सीजन ची आवश्यकता असते. हा ऑक्सीजन पंख्याचा सहाय्याने बाहेरुन बॉयलरला दिला जातो.)

12) chimney:

→ As we know, huge amount of flue gases are produced during coal Combustion.

→ These flue gases are hot gases contains harmful elements.

→ It can produce air pollution, so to reduce air pollution it should be passed into the atmosphere as high as possible with the help of chimney.

→ The standard hight of chimney is 275 m for thermal power plant.

(कोळसाचे ज्वलन होत असतांना त्यातुन प्रदुषीत वायु बाहेर पडतात. हे वायु वातावरणाला प्रदुषीत करु शकतात. त्यामुळे जनमानसात आरोग्य समस्या निर्माण होवु शकतात. त्यामुळे हे वायु वातावरणात उंच पातळीवर सोडण्यासाठी चीमनीचा उपयोग केला जातो.)

* Advantages and Disadvantages of Thermal power plant:

* Advantages:

1) less space required as compared to hydro power plant.
2) coal is cheap as compared to other fuels like diesel & nuclear fuels.
3) less initial cost as compared to other.
4) steam turbines can be capable to withstand over loads.
5) Located near load centers, thus reduce the cost of transmission.
6) cost of energy produced per KWh is less as compared to other.
7) power generating capacity is much more.

* Disadvantages:

1) Efficiency of the plant is less as compared to other.
2) More quantity of water required.
3) Operating cost, labour cost and maintenance cost is much more.
4) Coal transportation, loading, unloading and pulverizing is difficult and costly task.
5) Difficult task of ash storage as it needs much space.
6) Area is polluted due to noise, heat, smoke, ash particles etc.
7) Starting time of plant is more. (more than 6 to 7 Hrs)
8) This plant creates more pollution as compared to other.

* Overall efficiency of the Thermal Power plant:

Basically there are 4 major component where efficiency is considered:

i) Generator ii) Turbine iii) Condenser iv) Boiler.

i) Generator efficiency: It is about 97%.
ii) Turbine efficiency : efficiency of steam turbine usually low.
iii) Air preheater : 60%.
iv) Condenser : 60%.
v) Boiler : 50%.

At every step of power plant energy is lost. Hence effective (overall) efficiency of the thermal power plant is about 30 to 35%.

* Flue Gas Flow diagram of Thermal Plant:

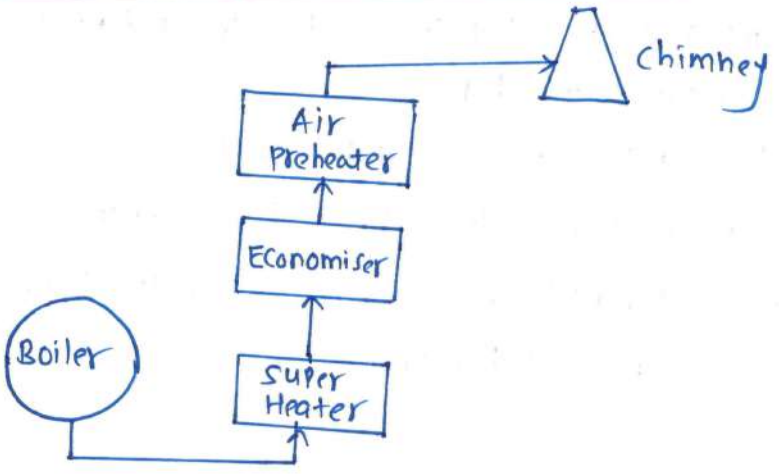


Fig. Flue gas flow diagram.

* Safe practices in Thermal power plant:

→ Basically there are two locations where safety is important:
  i) In plant location ii) on Field.

→ In these locations, safety is important for workers.

→ Accidents may takes place due to
  i) Direct contact of electricity Fires
  ii) Explosion of boilers equipment
  iii) Contact with hazardous chemicals.

→ The national thermal corporation limited (NTPC) has laid several clauses for safety. They are as follows:

  i) Electricity Act/Rule
  ii) Boilers Act/Rule/Regulations
  iii) Explosive Act/Rule
  iv) Petroleum Act/Rules
  v) Motor Vehicles Act/Rule
  vi) Dangerous Machines Act
  vii) Environment (protection) Act/Rule.
  viii) Mines Act/Rule etc.

[प्लांटमध्ये काम करत असताना, मजुर/कामगारांची सुरक्षितता खुप महत्वाची असते. काम करत असताना अपघात होण्याचा धोका उद्भवु शकतो. NTPC या संस्थेने सुरक्षिततेसाठी काही नियम व अटी घालुन दिले आहेत. ते कंपन्यांना (प्लांट) पाळणे बंधनकारक आहेत.]

Also, there are safety management audits includes:
  i) Review of documented safety policies and programs
  ii) Manager, safety specialist and supervisor interview
  iii) Workplace inspection and workplace observations.

→ A detailed safety audit report is submitted by the authorities after safety audit survey work is complete.

* Action plan in case of accidents:

→ If any accident occurs on the field or in plant, it should be reported to concerned authorities & the engineer incharge in specified form annexed as schedule, under acknowledgement.

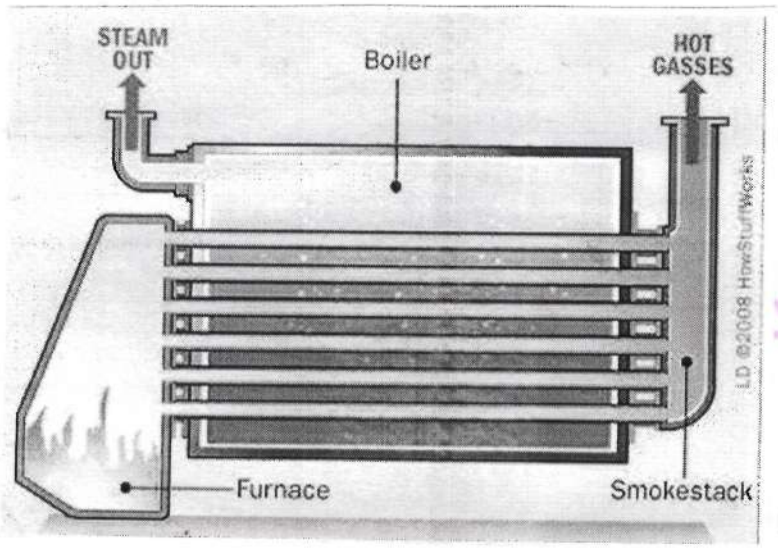
→ An investigation of accident and dangerous occurrences is done.
→ If any flaw in safety is found then concerned department / person has to give explanation about the same.

* Different types of Boiler:

→ A boiler is a closed vessel in which water, under pressure, is converted into steam.
→ The heat is transferred to the boiler by all three modes of heat transfer i.e. conduction, convention and radiation.
→ There are two main types of boilers:
1) ~~Vertical tu~~ Fire Tube boiler
2) Water tube boiler.

1) Fire Tube Boiler:

→ In Fire tube boilers, as the name suggest, Flue gases are pass through tubes which are surrounded by water.
→ A Fire tube boiler is simple, compact and rugged in construction.
→ Its initial cost is low.
→ Heat from hot gases is transferred to water to produce steam.
→ pressure of steam is lesser in such system and it is about 17.5 kg/cm².
→ steam formation is about 9000 kg to 15000 kg per Hour.
→ For the same output the outer shell of Fire tube boiler is much larger than that of a water tube boiler.



→ In the event of sudden and major tube failure, steam explosions may be caused in the furnace due to rush of high pressure water into the hot combustion chamber which may generate large quantities of steam in the furnace.

→ Fire tube boilers use is therefore limited to low cost small size and low pressure plants.

→ **Advantage of Fire tube boiler:**

1. cheaper in cost
2. very compact
3. Fluctuation in steam demand can be very easily met.

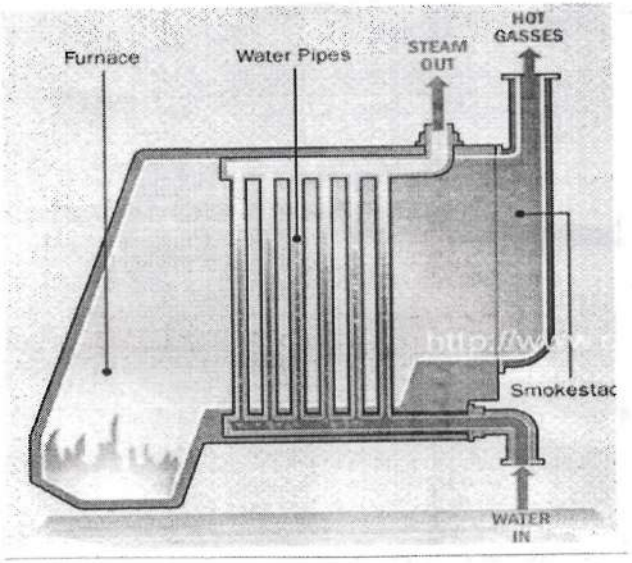
→ **Disadvantage:**

1. Formed steam is somewhat wet not dry.
2. More time required to form large steam.
3. steam pressure is low.
4. output of fire tube boiler is small and limited.

Due to these drawbacks this type of boilers is not used in large capacity thermal power plants.

2) **Water tube boilers:**

→ In this boiler, the water flows inside the tubes and hot gases flow outside the tube.



→ They can be classified as: 1. vertical tube boiler 2. Horizontal tube boiler. 3. Inclined tube boiler.

→ The circulation of water in the boiler is may be natural or forced.

→ For central steam power plants large capacity of water tube boilers are used.

→ These boilers have smaller drums and Tubes.

→ weight of metal is therefore less and rare possibility of explosion.

→ They can produce high steam pressure about 125 kg/cm² & high temp.

→ water tube boiler have capacity of about 10,00000 kg (1000 ton) per hour of steam per hours.

(अश्याप्रकारच्या बॉयलर मध्ये नळीतुन पाणी सोडले जाते व नळीच्या भोवती उष्ण वायु सोडले जातात. या बॉयलरची क्षमता जास्त असते. यात तयार होणारी वाफेचा दाब हा उच्च असतो. म्हणुन मोठ्या प्लांटमध्ये याचा उपयोग केला जातो.)

* Comparison between Fire tube boiler and water tube boiler:

Fire Tube Boiler	Water tube boiler
1. Hot gases are inside the tube and water is outside	1. Water is inside the tube and hot gases outside.
2. Operating pressure limited to 25 bar	2. High pressure as more than 25 bar.
3. Rate of steam generation is lower.	3. Rate of steam generation is higher.
4. Not suitable for large power plant.	4. Suitable for large power plant
5. Chance of explosion is less due to low pressure	5. chance of explosion is higher due to high pressure.
6. Floor space requirement is more	6. Floor space requirement is less.
7. Cost is less	7. Cost is more.
8. Required less skill for efficient and economic working.	8. Required more skill and careful attendion for efficient and economic working.
9. For producing process steam	9. For producing steam for power generation as well as process heating.
10. There is no problem of scale deposition and less problem of overheating and bursting	10. Small deposition of scale will cause overheating and bursting of tubes.

* List of Thermal power plant in Maharashtra & India:

Sr. No.	State	place	NO. OF units & its rating (MW)	Total Installed capacity (MW)
1.	Maharashtra	Koradi	4×120 1×200 2×210	1100 MW
2	MH	Nashik	2×140 3×210	910 MW
3	MH	Bhusawal	1×62.5 2×210	482.5 MW
4	MH	Parli	2×30 3×210	690 MW
5	MH	Khaper-Kheda	4×210	840 MW
6	MH	chandrapur	4×210 3×500	2340 MW
7	MH	Trombay (Mumbai)	2×500 1×150 1×120 1×60	1330 MW
8	MH	Dahanu	2×250	500 MW
9.	Madhya pradesh	korba	3×30 1×10 4×50	300 MW
10.	Tamil Nadu	Ennore	2×60 3×110	450 MW
11.	Orissa	Talcher	4×63.5	254 MW
12.	Delhi	Badrapur	3×100	300 MW
13	West Bengal	chandrapur	3×140	420 MW
14		Bandel	4×82.5	330 MW
15	Uttar pradesh	kanpur	2×32	64 MW

* Hydro power plant:

- **Definition:** A Hydroelectric power plant is a generating station that converts the stored water (potential energy) into electrical energy by using water turbine and generator.

* Site selection criteria for Hydro power plant:

- While selecting a site for a hydro power plant, the following criteria's (points) should be considered:

1) Availability of water:

- A large amount of water is required for a hydro-electric power plant.
- Therefore, the plant should be located near rivers, dams, or waterfalls where sufficient water is available.

2) storage of water:

- During the rainy season, rivers and canals carry a large amount of waters.
- A dam is built to store this water. For future use.
- stored water helps maintain a continuous flow throughout the year.
- The site should be suitable for dam construction and should provide enough space for water storage.

3) Cost of Land:

- Land for the plant should be available at a reasonable cost.

4) Type of Land:

The land should be strong enough to support heavy equipment and plant structure.

5) Transportation facilities:

- The selected site should have good road and railway facilities.
- This helps in easy transportation of heavy machinery, equipment and construction materials.

6) water head:

- High water head is economical.
- The power plant should have sufficient high head.

7) Near the Load Center:

- possibly, the hydro power plant should be located near Load center so that transmission cost will be decreased.

8) Earthquake:

- site should be selected where there is no chance of earthquake.

* Layout and working of a typical Hydro power plant:

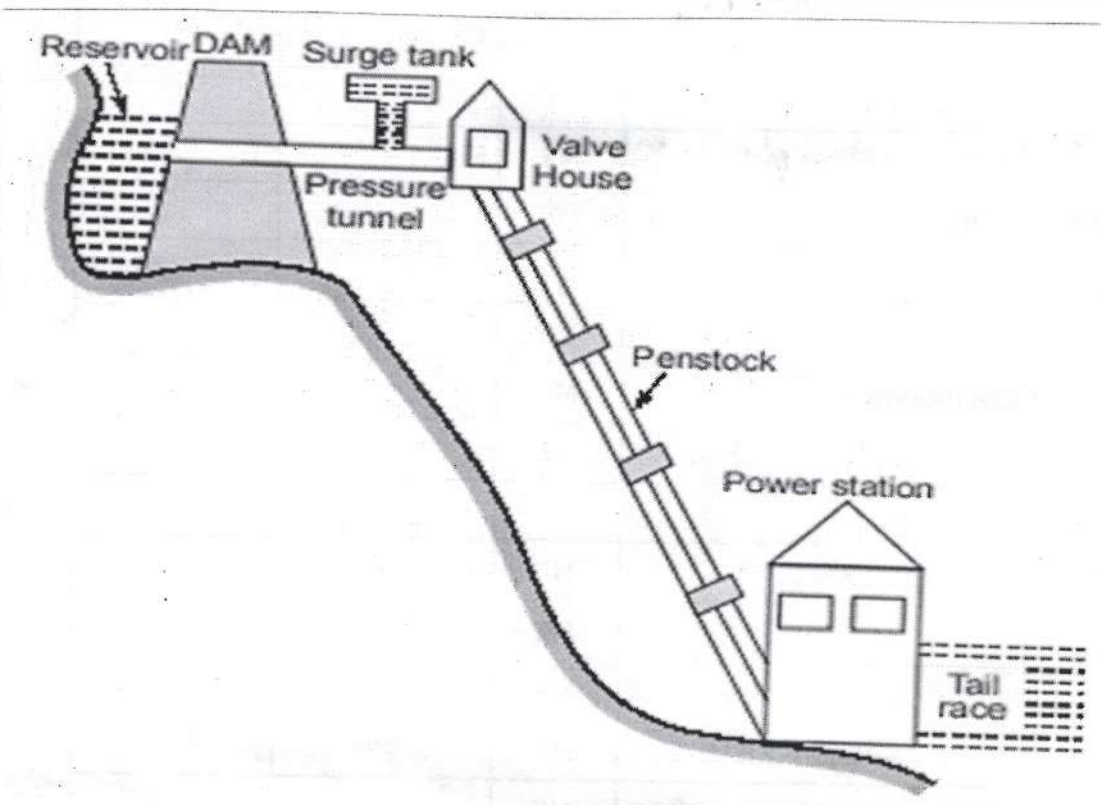


Fig. Layout of Hydro power plant.

HYDRO POWER PLANT

CLEAN ENERGY FROM FLOWING WATER

WHAT IS IT?

A hydro power plant produces electricity by using the energy of flowing or falling water.

It is a clean, renewable and natural source of energy.

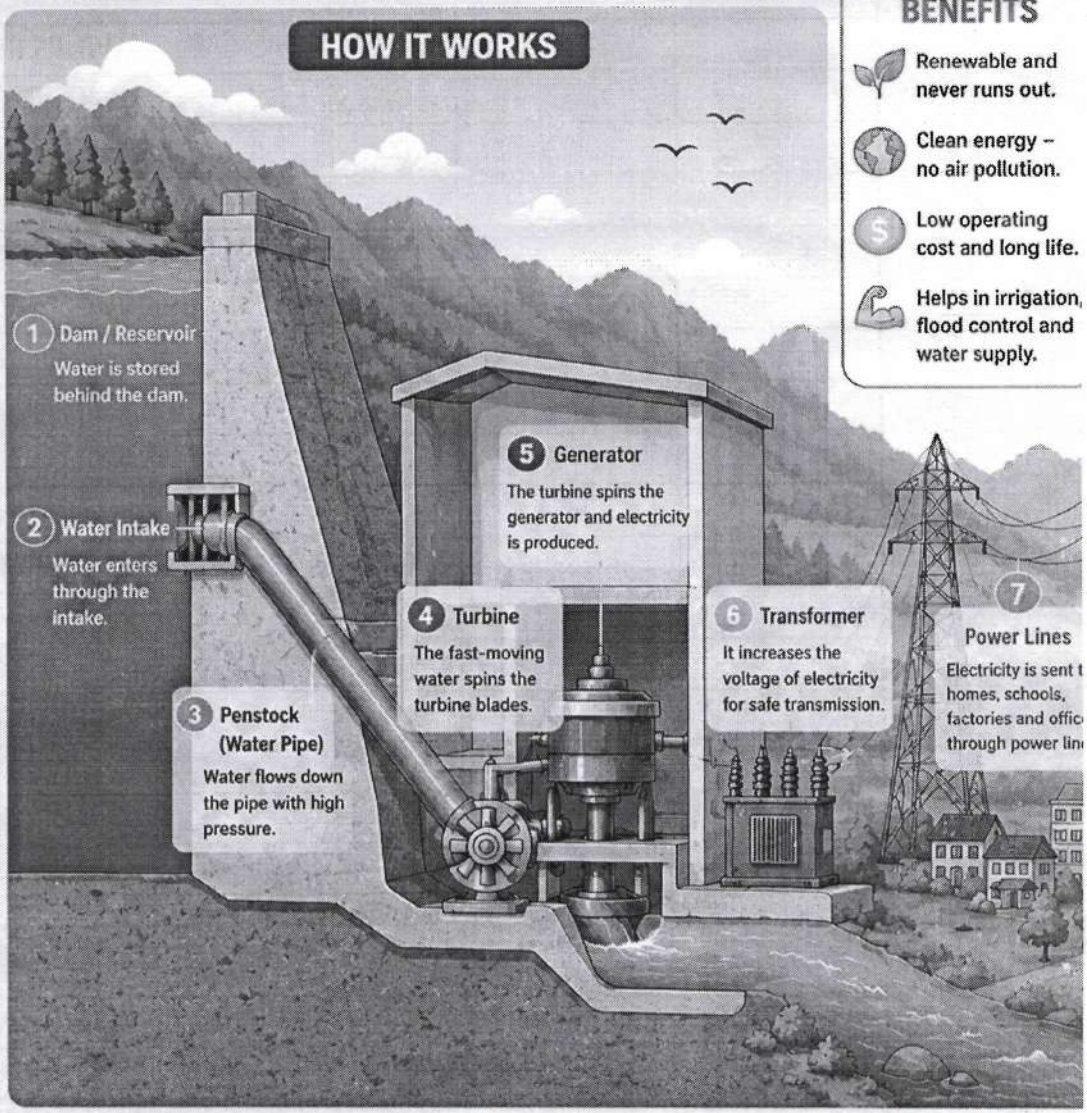
WHERE IS IT BUILT?

It is usually built near rivers, dams or waterfalls where water is available in large quantity and height.

MAIN PARTS

1. Dam / Reservoir
2. Water Intake
3. Penstock (Water Pipe)
4. Turbine
5. Generator
6. Transformer
7. Power Lines

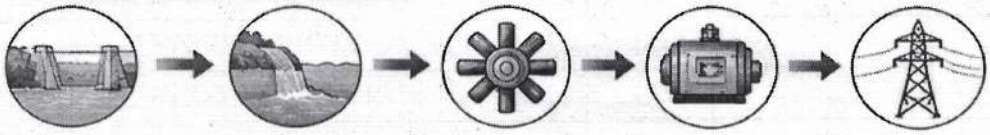
HOW IT WORKS



BENEFITS

- Renewable and never runs out.
- Clean energy – no air pollution.
- Low operating cost and long life.
- Helps in irrigation, flood control and water supply.

THE BASIC PRINCIPLE



1. Water stored at a height has energy.
2. When water flows down, its energy increases.
3. This energy rotates the turbine.
4. The generator converts this motion into electricity.
5. Electricity is then transmitted to our homes and industries.

DID YOU KNOW?

Hydroelectric power is one of the oldest and most reliable sources of electricity in the world!

WATER TODAY, ENERGY TOMORROW – SAVE WATER, SAVE ENERGY

- A hydro power station uses the stored energy of water at a high level to generate electricity.
- Hydro power plants are generally located in hilly areas where dams and large water reservoirs can be constructed easily.
- A dam is built across a rivers or lake to store water and create water head (height of water).
- The stored water is allowed to flow through large pipes called penstocks.
- The flowing water rotates the turbine.
- The turbine is connected to an alternator (generator) which converts mechanical energy into electrical energy.
- Hydroelectric power plants have low operating cost and low maintenance cost.
- Availability of water storage and flowing water is very important for efficient operation.

* Main parts of Hydroelectric power plant:

1. Hydraulic structures
2. Water turbine
3. Electrical Equipment

1. Hydraulic structure:

- Hydraulic structures in a hydroelectric power station include: Dam, Reservoir, Gates, channels, Accessories.

i) **Dam:** A dam is a barrier used to store water and create water head (height of water).

- Dams are constructed using: concreate, stone masonry, soil (earth), rocks etc.
- In narrow valleys, stone masonry dams can be constructed.
- For wide valleys, earth dams are generally more suitable.
- The type of dams depend on:
  - Foundation condition.
  - Availability of local materials
  - Transportation facility
  - Earthquake ~~reactivity~~ possibility
  - other safety factors.
- In many cases, more than one type of dam may be suitable, and the most economical dam is selected.

ii) Spillway:

- sometimes, the water flow in a river becomes more than the storage capacity of the reservoir.
- This condition mainly occurs during heavy rainfall in the catchment area.
- A spillway is used to release extra water from the reservoir safely into the river on the downstream side of the dam.
- The spillway is generally constructed with concrete piers on the side of the dam.
- Gates are provided in the spillway and by opening these gates, excess water is discharged safely from reservoir.

iii) Headworks:

- Headworks are structures provided at the head of the intake of a hydroelectric power plant.

- Headworks generally include:
  - Trash racks to stop floating waste materials.
  - Gates and valves to control water flow in pipes & turbines.
- The flow of water through the headworks should be smooth and safe.
- This prevents damage to the headworks and avoid the formation of the vortices (whirlpools).
- For this purpose:
  - sharp bends should be avoided
  - sudden expansion or contraction of water passages should be also avoided:

iv) surge Tank:

- Open water channels supplying water to turbines usually do not require protection devices.
- However, when penstock is used, protection against abnormal pressure is necessary.
- Therefore, a surge tank is always provided with penstock.
- A surge tank is small reservoir or tank connected near the penstock.
- It controls sudden pressure changes by allowing the water level to rise or fall.

* Working of surge Tank:

- when the load on the turbine decreases suddenly, the turbine gates close partially.
- As a result, the water requirement of the turbine decreases.
- The excess water flows back into the surge tank and rises the water level.

- This protects the penstock from bursting due to high pressure.
- on the other hand: when the load on the turbine increases suddenly, more water is required.
- water from the surge tank flows into the penstock to meet the extra demand.
- Thus, the surge tank reduces abnormal pressure changes and helps maintain smooth operation of the turbine.

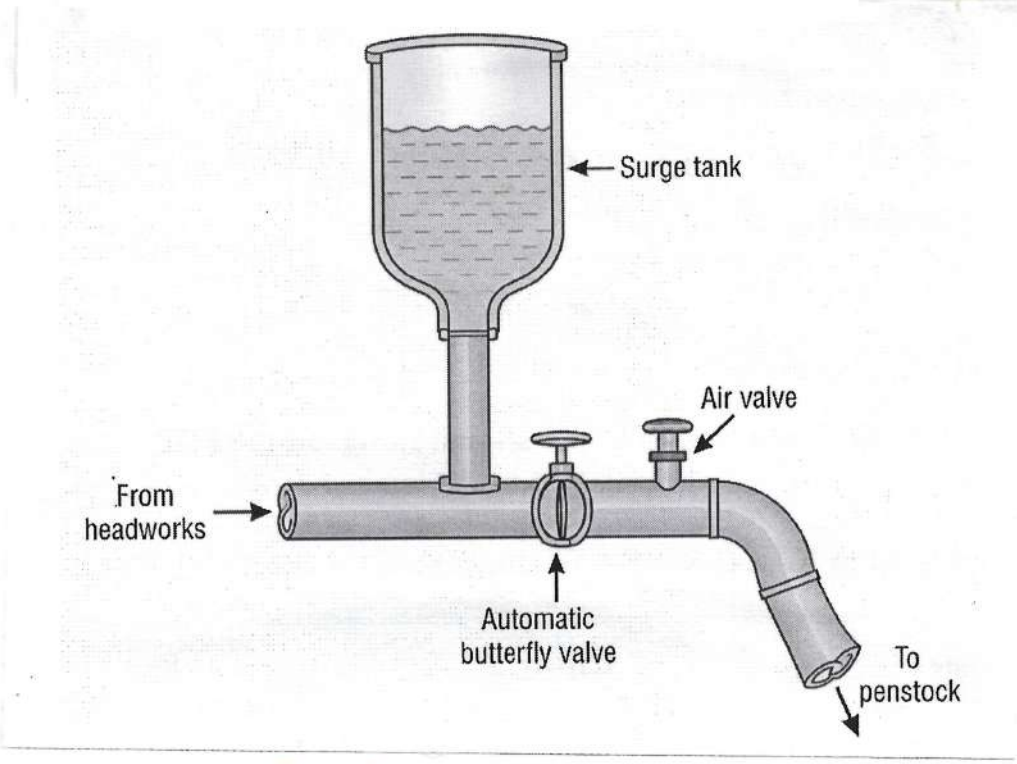


Fig. Surge Tank

v) Penstock:

- A penstock is an open or closed pipe that carries water to the turbine.
- Penstocks are generally made of: concrete, steel.

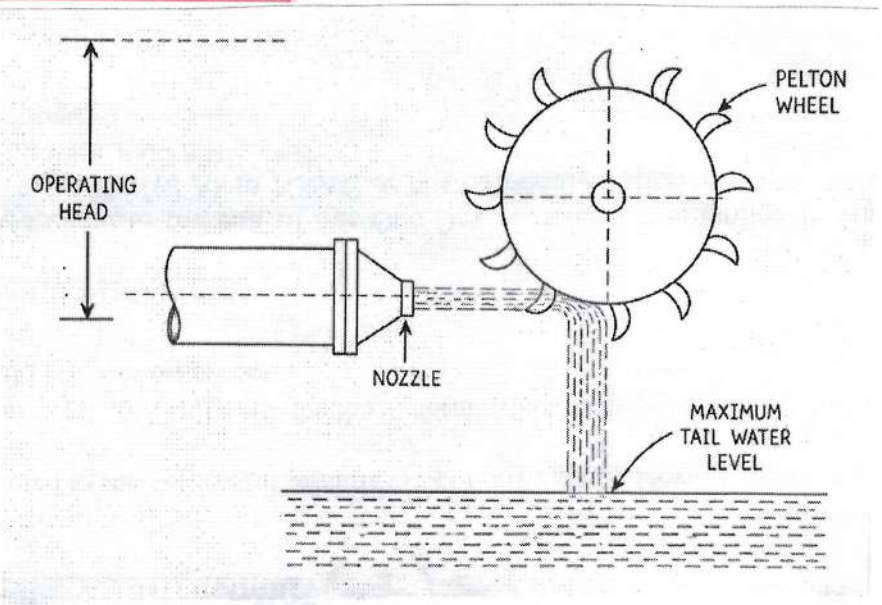
* Types of water turbine:

- water turbines are used to convert the energy of falling water into mechanical energy.
- the main types of water turbines are:
  1. Impulse Turbine
  2. Reaction Turbine.

i) Impulse Turbine:

- Impulse turbines are used for high head applications.
- In this turbine, the entire pressure energy of water is converted into kinetic energy in the nozzle.
- The high-speed water jet strikes the turbine wheel and rotates it.
  e.g. pelton wheel turbine.

* Pelton wheel Turbine:



- The pelton wheel consists of buckets of elliptical shape mounted around the wheel.
- when the water jet strikes the buckets, the turbine wheel rotates.
- The flow of water to the turbine is controlled by a needle or spear provided inside the nozzle.

* Working control:

- The spear controls the quantity of water flowing through the nozzle,
- When the load on the turbine decreases, the spear moves forward into the nozzle,
- This reduces the flow of water on the buckets.
- As a result, the turbine speed is controlled.

- when the load increases, the spear moves backward, allowing more water to flow and increasing turbine action.

ii) Reaction Turbine:

- Reaction turbines are used for low and medium head applications.
- In a reaction turbine, water enters the turbine runners with both pressure energy and kinetic energy.
- The main types of reaction turbines are:
  1. Francis Turbine
  2. Kaplan Turbine

(a) Francis Turbine:

- Francis turbines are mainly used for low and medium head power plants.
- This turbine consist of: - stationary guide blades
  - A runner with curved blades.
- The guide blades control the flow of water entering the turbine.
- As water passes through the runner:
  - water flows radially inward
  - The direction of water flow changes inside the runner.
- while water passes over the moving blades of the runner.
- Both pressure and velocity of water decrease.
- Due to this, a reaction force is produced which rotates the turbine.
- This turbine is suitable for medium heads and medium water flow.
- Their shape is very large and it is vertical axis type turbine.
- this turbine has effiiency more than 90%.

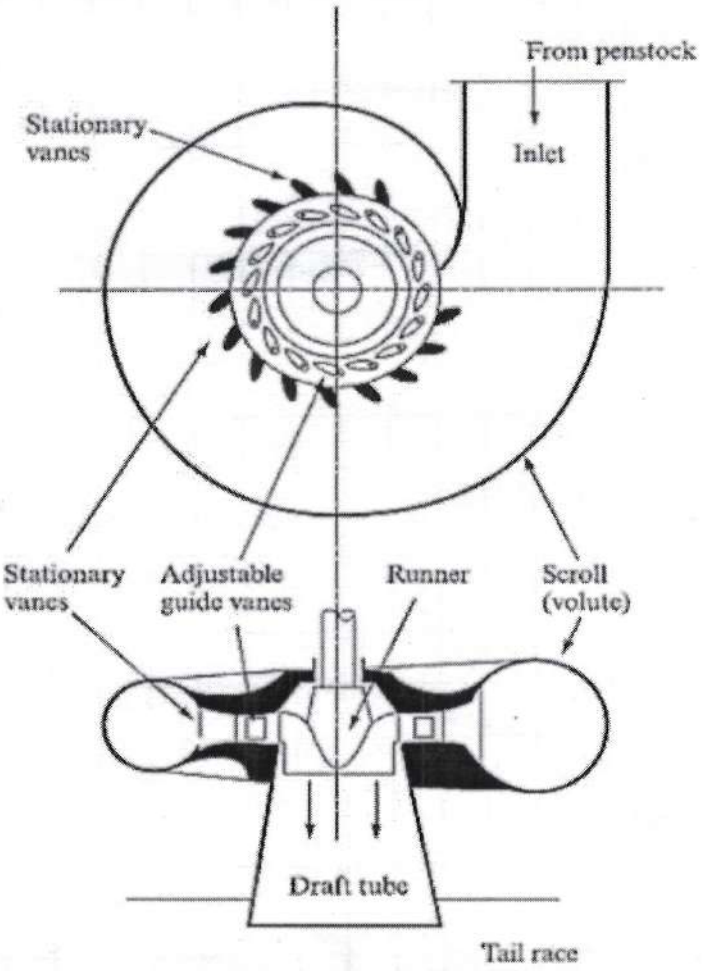


Fig. Francis Turbine.

(b) * Kaplan Turbine :

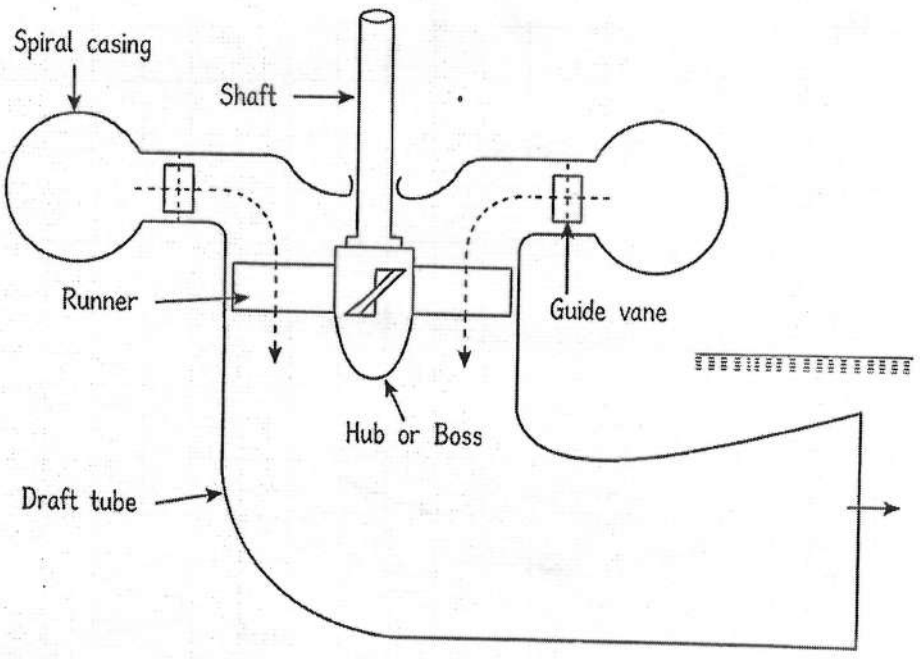


Fig. Kaplan Turbine

- Kaplan turbines are used for low head and large quantity of water.
- In a kaplan turbine, water enters the runner in axial direction.
- Except for this, its construction and working are similar to a Francis turbine.
- water flows radially inward through regulating gates provided around the turbine. Then the direction of water changes and flows axially through the runner.
- Due to this change in direction of water flow, a reaction force is produced which rotates the turbine.

3) Electrical Equipment:

- The electrical eqj equipment used in a hydroelectric power station includes: Alternator, transformers, circuit breakers, other control and protective devices.

* classification of Hydro power plants:

- Hydro power plants can be classified in different ways as follows:

A) According to Availability of Head:

1. High Head plant
2. Medium Head plant
3. Low Head plant.

B) According to Nature of Load:

1. Base load plant
2. peals load plant.

C) According to Quantity of water Available:

1. Run-off River plant with pondage
2. Run-off River plant without pondage
3. Reservoir Type plant.
4. pumped storage plant.

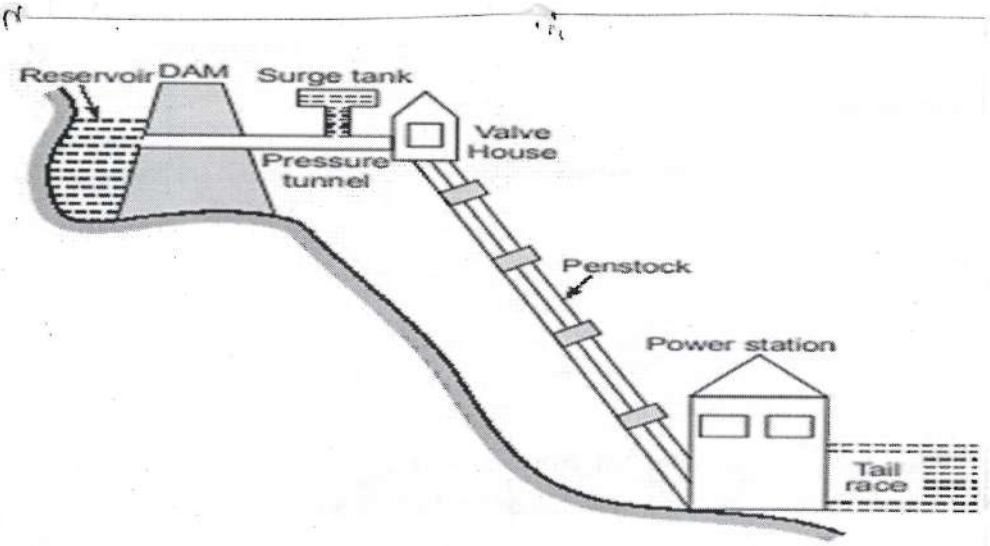
A) According to Availability of Head:

- Head means the vertical height difference between the point where water enters and the point where water leaves in a hydroelectric system.
- Head is measured in meters.

1. High Head plant: (500m to 2000m)

- In a high head hydroelectric plant, the head ranges from 500m to 2000m.
- the dam constructed in this type of plant is generally used to maintain a large storage of water at a high level.
- A surge tank is provided to store water, which supplies water to the turbine during peak load periods when extra power is required.
- Turbine used in high head plant: Pelton wheel Turbine

2.



2. Medium Head plant: (30m to 500m)

- In a medium head plant, the head ranges from 30m to 500m.
- this type of turbine requires a medium quantity of water.
- In this power plant, a forebay is mainly constructed for storing water.
- The forebay acts as a storage tank that collects river water and supplies it to the turbine through the penstock.
- Turbine used: Francis Turbine.

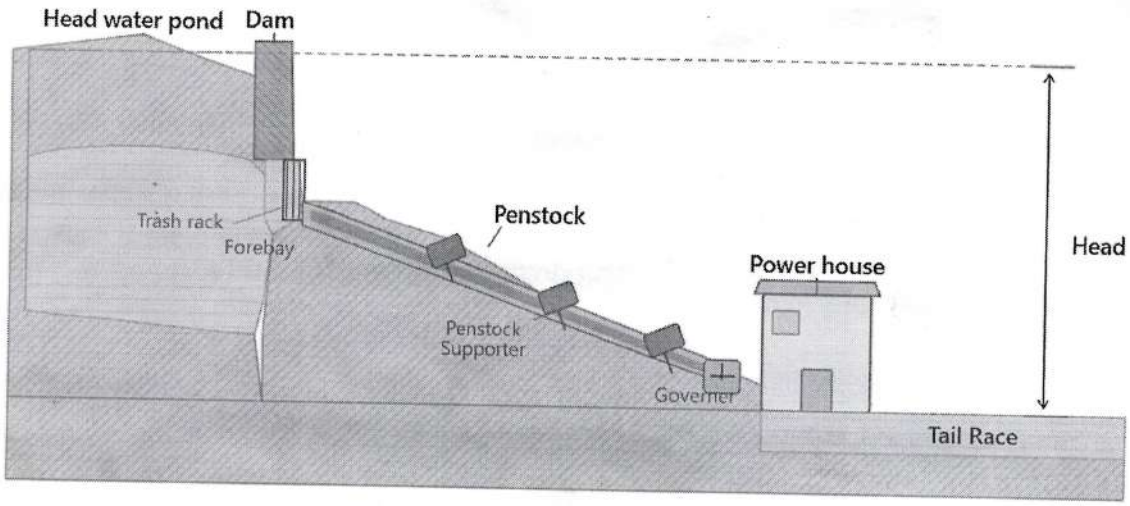
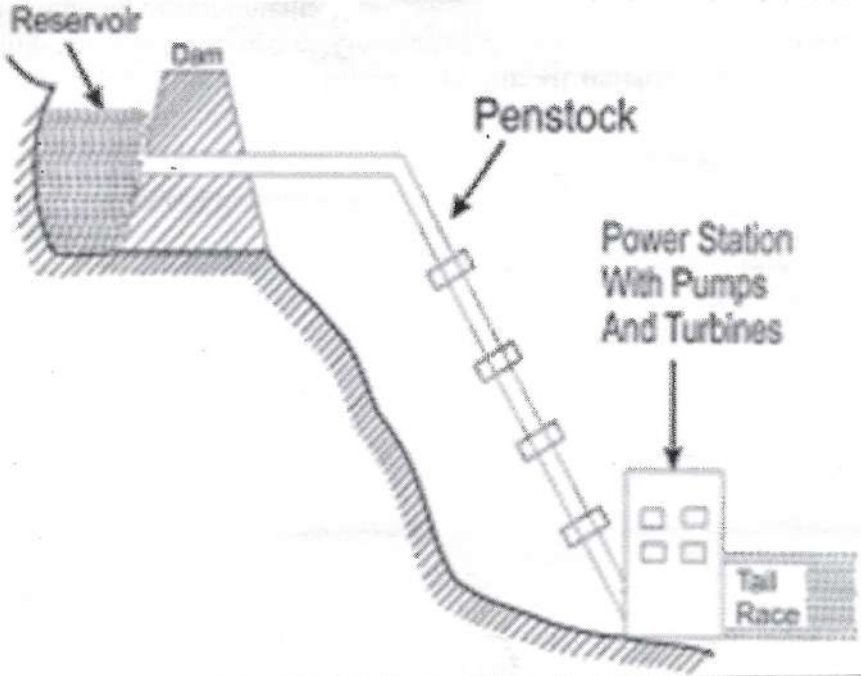


Fig. Medium Head plant

3) Low Head plant: (upto 30m)

- In a low head hydroelectric plant, the head is upto 30m.
- Low head plants operates with low water head.
- They require a large amount of water flow.
- Kaplan and propeller turbines are commonly used in low head plants.
- No surge tank is required here.
- Low speed generator required.
- As head is low, the big diameter, small length pipes are required.
- principle of working is same like previous plants.



B) According to Nature of Load:

1. Base Load plant:

- A power plant that supplies the base load of the electrical system is called a base load plant.
- When connected to the electrical grid, these plants must supply electricity without interruption.

2. Peak Load plant:

- A plant that supplies electricity during peak load periods is called a peak load plant.
- These plants operate when the demand for electricity becomes very high.

C) According to quality of water Available:

1. Run-off River plant with pondage:

- A run-off river plant with pondage is designed to provide power during peak load conditions.
- In this type of plant, a small storage reservoir called pondage is provided near the dam.
- The storage in pondage is generally seasonal and is used to store water behind the dam near the plant.
- This stored water helps in supplying additional power during periods of high electricity demand.
- These power plants can be used as base load plant or peak load plant.
- This plant is more reliable than run-off river plant without pondage.

2) Run-off River plant without pondage:

- A run-off river plant without pondage does not store water.
- It uses the river water directly as it flows.
- There is no control over the flow of water.
- Therefore during floods or low load conditions, water may be wasted.
- During low water flow conditions, the usefulness and efficiency of this plant become much lower compared to other types of plants.
- These plants are only used when their is sufficient water flow.
- As the flow of water is not fixed, the capacity of generation is not definite.
- These plants are rarely used.
- These plants are shut off in summer.

3) Reservoir type plant:

- A reservoir type plant has a large water storage reservoir to provide a steady and reliable water supply greater than the minimum natural river flow.
- This type of plant can be used for:
  - Base load operation
  - Peak load operation.
- The stored water helps in continuous and controlled power generation.
- Majority of the hydroelectric plants in india are reservoir type.
- These power plant are more reliable and efficient as they can generate electricity throughout year.

4) Pumped storage plant:

- A pumped storage hydro power plant is a type of hydro-electric energy storage system.
- It consist of two water reservoirs located at different heights.
- Electricity is generated when water flows from the upper reservoir to the lower reservoir (tail water pond) through the turbine.

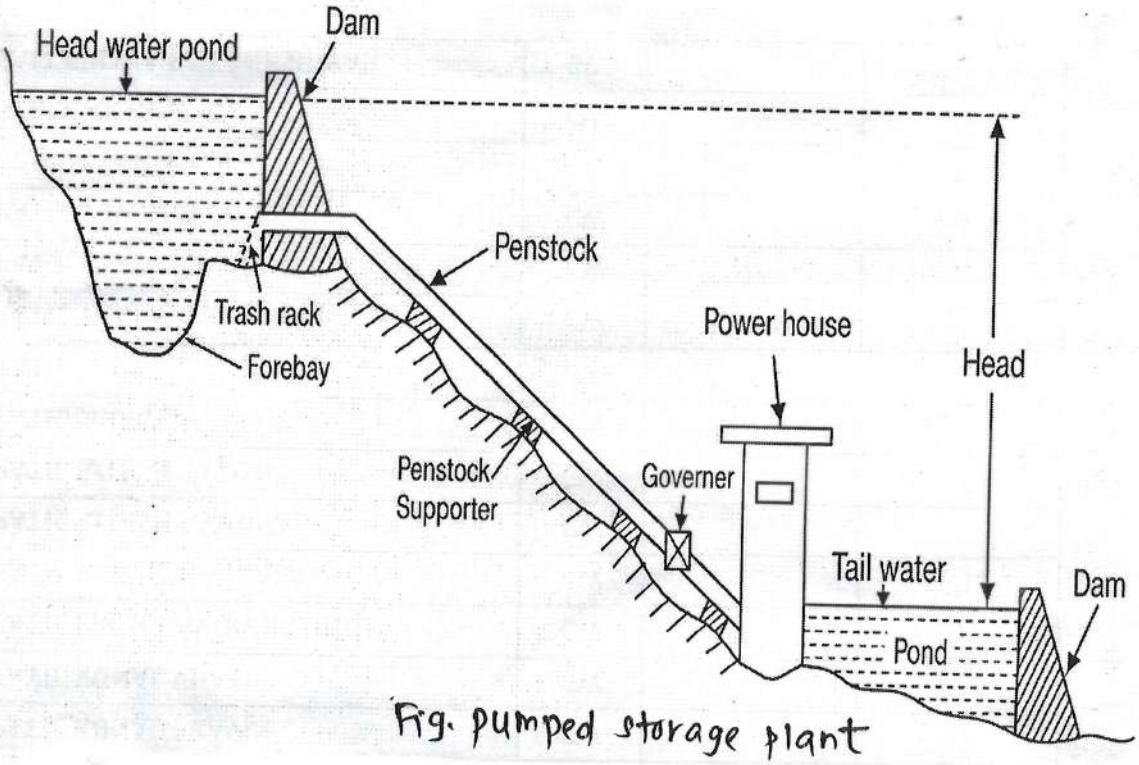


Fig. pumped storage plant

- The system also requires electrical energy because water is pumped from the lower reservoir to the upper reservoir for a reuse.
- During peak load period, water is flow from head water pond to tail water pond. via penstock.
- During off peak period, water flows from tail water pond to head water pond.
- It uses reversible turbine pump unit because such a unit can be used as turbine while generating power and it is used as a pump when water to be stored.

* Advantages of pumped storage plant:

1. **Water conservation:**
   - The same water can be reused again and again which helps in saving water

2. **Low pumping cost:**
   - The cost of pumping water is low because pumping is usually done when extra electricity is available.

3. **Useful during peak load:**
   - The plant can be brought into service quickly.
   - Therefore, it is very useful for supplying power during peak load periods.

4. **Improves Load Factor:**
   - This power plant helps in improving the load factor of the power system.

5. **Reduces Reserve capacity requirement:**
   - It helps in reducing the reserve capacity of the power plant because it can provide additional power during peak load conditions.

* Comparison between Thermal power plant and Hydro power plant:

Sr. No	Parameters	Thermal Power Plant	Hydro Power Plant
1	**Site**	Built near coal and water sources, in flat/plain areas	Built where large dams can be constructed, usually in hilly/mountainous areas
2	**Initial Cost**	Low	High (due to dam construction)
3	**Running Cost**	High (fuel needed continuously)	Very low
4	**Cleanliness & Simplicity**	Less clean, more pollution	Very clean and simple
5	**Overall Efficiency**	Very low — around 25%	Higher — around 85%
6	**Starting**	Takes long time to start	Starts very quickly
7	**Space Required**	Requires large land area	Requires large area due to reservoir
8	**Maintenance Cost**	High — needs skilled operators, so very expensive	Very low
9	**Transmission & Distribution Cost**	Very low (built near cities)	Very high (built far from cities)
10	**Standby Loss**	Loss occurs when on standby	No standby loss

Quick Memory Tips for Exam:

- Thermal = cheap to build, expensive to run, polluting, slow start
- Hydro = expensive to build, cheap to run, clean, fast start
- Efficiency: Hydro (85%) is much better than Thermal (25%)
- Hydro has no standby loss - a key advantage
- Thermal has low Transmission and distribution cost because plants are near load centers.

* Location of different types of Large and Micro-Hydro power plants in Maharashtra:

Sr. No	Location	Capacity
1	Koyana	1960 MW
2	Ghatghar Dam	250 MW
3	Bhira TATA	150 MW
4	Mulu Dam	150 MW
5	Bhira Tail Race	80 MW
6	Bhivapuri TATA	72 MW
	Khopoli (TATA)	72 MW
	Tillari	60 MW
9	Pench Project	50 MW
10	Bandara	34 MW
11	Dudhgaon	24 MW
12	Chadholi	16 MW
13	Jayakwadi	12 MW
14	Ujjani	12 MW
15	Veer	9 MW
16	Bhatghar	16 MW

* Micro-Hydro power plants in Maharashtra:

Sr. No	Location Name in Maharashtra
1	Terwanmedhe
2	Ganagamshet Project (Kolhapur)
3	Karwa Project Nasik
4	Shenur Project Amravati
5	Dham Project (Wardha)
6	Mukne Project Nasik
7	Khaner Project Satara
8	Hetwane Project Raigad
9	Kadwi Project Kolhapur
10	Wan Project Akola
11	Sasari Project Kolhapur
12	Kumbhoi Project Kolhapur
13	Patgaon Project
14	Dom
15	Vaitarana D.T

* Advantage of Hydroelectric power plant:

1. NO fuel is needed to generate electrical energy, so there is no worry about fuel cost.
2. Running cost is very low because no fuel is required and the energy source (water) is free and natural.
3. It is very simple to operate and requires very little maintenance.
4. It is fully automatic, no need to start or stop manually and maintenance required is minimal.
5. A hydro power station can be started or stopped quickly within a very short time. If there is no load, the plant can be kept on standby easily.
6. They are very reliable.
7. They have a long working life.
8. These plants serve multiple purposes - like they generate electricity, control floods, provide water for irrigation and also support fish farming.
9. Even if a plant is shut down for maintenance, some units can still operate, so the work can continue partially without full shutdown.

* Disadvantages of Hydroelectric power plant:

1. Initial cost is very high because of dam construction expenses.
2. It takes a long time to construct and requires large amount of land.
3. The availability of water depends on weather and rainfall conditions, so power generation can be uncertain during droughts.
4. High transmission and distribution cost.

* Safe practices of Thermal power plants:

Two main safe practices:

1. Ash Disposal (Ash Management)
2. Smoke collector or Ash precipitator.

1) Ash Disposal :- How ash is safely managed:

a) Reserve land (empty open land) is kept aside specially for dumping and storing ash produced from burning coal.

b) Dry ash can be mixed with sand and used in construction work like filling low areas or strengthening the ground.

c) open ash ponds (ash lagoons) are created and ash mixed with water is pumped into these ponds.

d) once the pond is completely full, the top surface is covered with soil and trees or grass are planted on it. This makes the land green and useful again.

2) Smoke collector or Electrostatic precipitator (Esp):

- Before releasing smoke (Flue gases) into the atmosphere, it is cleaned using an Electrostatic precipitator (Esp) also called as a Dust collector.
- Inside the precipitator, two sets of electrodes are placed which are completely insulated from each other and high voltage of 25kv to 100kv is applied across the electrodes.
- Due to this high voltage, an electrostatic field is created beth the two electrodes.
- When Flue gases (smoke) pass through this field, the gas molecules get ionized (electrically charged).
- Because of this ionization: positive dust particles get attracted towards the negative plates.

- Negative dust particles get attracted towards the positive plates.
- The dust particles get attracted towards the surface of the electrodes and they sticks there. and collected.
- only clean air (Fly ash Free) is then sent out through the chimney.
- In this way, the Flue gases become clean and pollution-Free.

* Safe practices of Hydro power plants:

1. PPE (personal protective Equipment) must be provided to all workers who may be affected by chemical or process hazards at the workplace.
2. Never allow any worker to work in unsafe conditions or with unsafe tools and equipment.
3. sufficient number of supervisors must be appointed at every workplace at all times for proper and continuous monitoring of all works.
4. All workers must be protected from hazards caused by their own work or by work done by other working nearby around them.
5. safety training must be given to all employees and a qualified and experienced safety officer must be appointed.
6. safety posters, slogans, special meetings and speeches must be organized regularly to spread safety awareness among workers.
7. To protect the power plant from lightning strikes, proper lightning Arresters must be installed and used.
8. At dangerous and important locations place barricades, warning signs and safety posters.
9. During Flood situations, plant should automatically shut down.

10. An emergency action plan must be prepared and kept ready to handle situations like fire and explosions.

11. There must be at least two separate exit routes from the station. If one route becomes difficult or blocked during an emergency, the alternative emergency exit route must always be available.

12. Adequate lighting must be provided for emergency exits.

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The Shirpur Education Society's

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Question Bank

Program Name: Electrical Engineering	Class: EE3K	Academic Year: 2026-27
Course Name: ELECTRICAL POWER GENERATION,TRANSMISSION AND DISTRIBUTION	Sub Code: 313333	Date-20/05/2026

Unit - I Thermal Power Plant and Hydro Power Plant (16 Marks)

1. Name hydropower stations in Maharashtra with their installed capacity. (Winter-24) (Winter-25)
2. Draw a typical layout of coal fired Thermal power plant and lable the parts : (Winter-24)
   i) Boiler
   ii) Turbine
   iii) Economiser
   iv) Condenser
3. Draw a neat diagram of Hydro electric power station and state function of – (Winter-24)
   i) Surge tank
   ii) Penstock
4. Give classification of Hydro power plant on basis of – (Winter-24)
   i) Water flow regulation
   ii) Water head
5. State any six safe practices to be followed in Thermal power plant. (Winter-2024)
6. Give the classification of energy sources with examples (Summer-25)
7. State the factors to be considered for site selection of Hydro Power Plant. (Summer-25)
8. State the functions of – (Summer-25)
   i) Super Heater
   ii) Economizer
   iii) Air pre-heater
   iv) Steam turbine.
9. Compare Thermal Power Plant and Hydro Power Plant. (Summer-25)
10. Explain water hammer effect and cavitational effect in Hydro Power Plant. (Summer-25)
11. Draw and explain fire tube and water tube boilers. (Summer-25)
12. State any two advantages of thermal power plant. (Winter-25)
13. State the factors governing the selection of site for thermal power plant. (Winter-25)
14. Draw the layout of a hydro-electric power plant and also state the function of reservoir and surge tank. (Winter-25)
15. Draw a neat labeled layout of thermal power plant and explain the function of coal and ash handling plant. (Winter-25)

20.5.2026

Subject Teacher
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