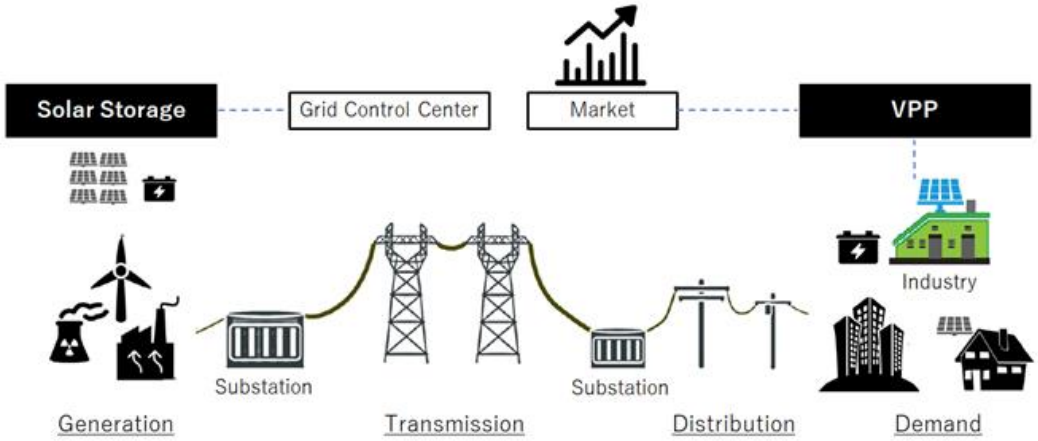
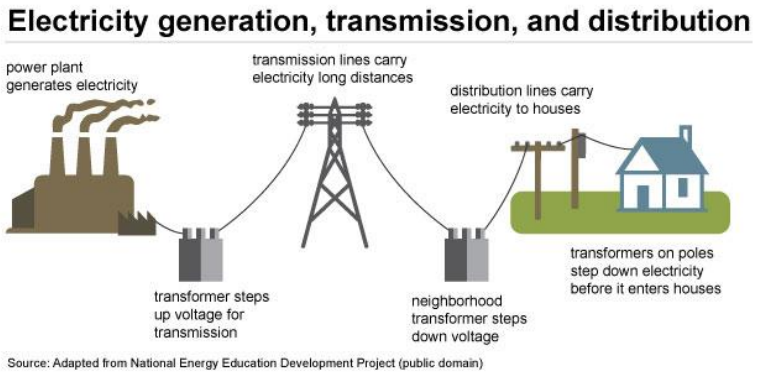
Course Name: Power Plant Engineering (ELO508)

B.Tech 5th Semester

Power Plant Engineering





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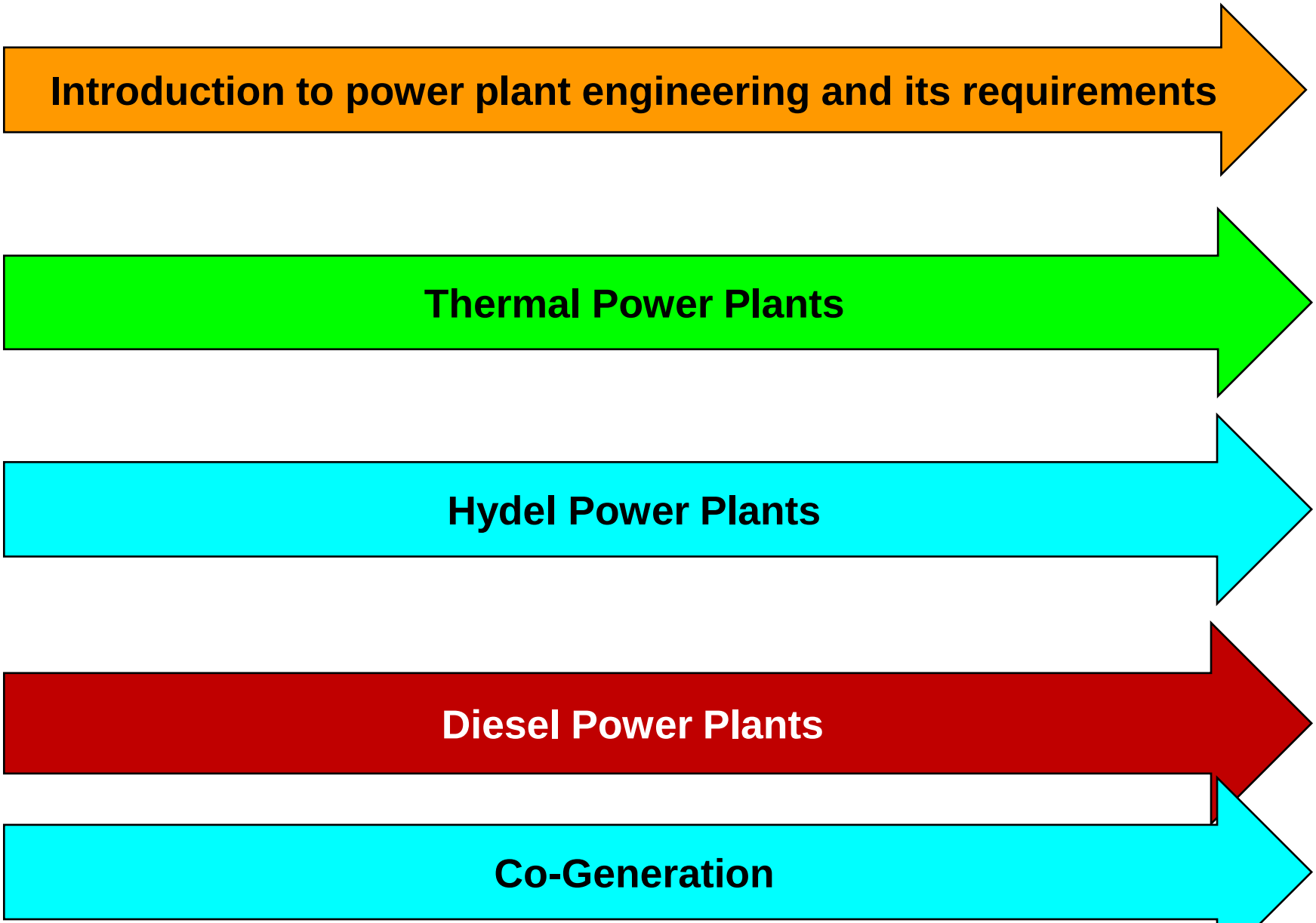
Objective of the present unit



Part 1

Introduction to power plant

Introduction

The whole world is in the grip of energy crisis and the pollution manifesting itself in the spiraling cost of energy and uncomforted due to increase in pollution as well as the depletion of conventional energy resources and increasing curve of pollution elements.

- ✓ ***To meet these challenges one way is to check growing energy demand but that would show down the economic growth as first step and to develop nonpolluting energy conversion system as second step.***
- ✓ ***The standard of living increases with increasing energy consumption per capita.***
- ✓ ***Any consideration of energy requirement and supply has to take into account the increase conservation measures.***
- ✓ ***On the industrial font, emphasis must be placed on the increased with constant effort to reduce energy consumption.***
- ✓ ***Fundamental changes in the process, production and services can affect considerable energy saving without affecting the overall economy.***

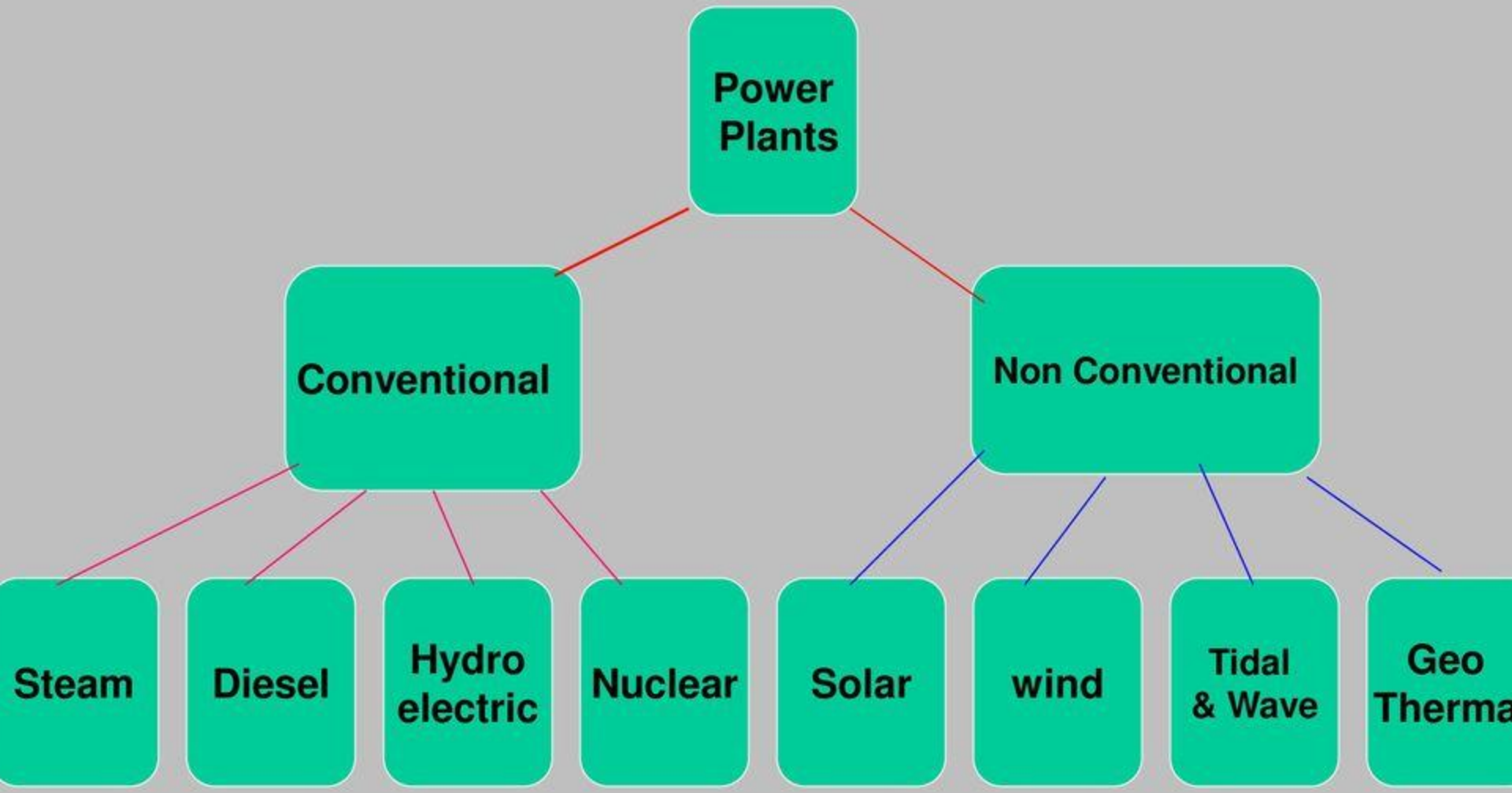
Concept of Power plant

A power plant is assembly of systems or subsystems to generate electricity, i.e., power with economy and requirements.

While the stress is on energy efficient system regards conventional power systems viz., to increase the system conversion efficiency the supreme goal is to develop, design, and manufacturer the non-conventional power generating systems in coming decades which are conducive to society as well as having feasible energy conversion efficiency and non-friendly to pollution.

At present due to energy crisis the first goal is to conserve energy for future while the second step is to develop alternative energy systems including direct energy conversion devices.

Classification of Power Plants



Definition of Power plants

A power plant may be defined as a machine or assembly of equipment that generates and delivers a flow of mechanical or electrical energy.

The main equipment for the generation of electric power is generator. When coupling it to a prime mover runs the generator, the electricity is generated. The type of prime move determines, the type of power plants.

The major power plants are:

1. *Steam power plant*
2. *Diesel power plant*
3. *Gas turbine power plant*
4. *Nuclear power plant*
5. *Hydro electric power plant*

Power Station Design

Power station design requires wide experience. A satisfactory design consists of the following steps :

- ✓ ***Selection of site***
- ✓ ***Estimation of capacity of power station.***
- ✓ ***Selection of turbines and their auxiliaries.***
- ✓ ***Selection of boilers, and their auxiliaries.***
- ✓ ***Design of fuel handling system.***
- ✓ ***Selection of condensers.***
- ✓ ***Design of cooling system.***
- ✓ ***Design of piping system to carry steam and water.***
- ✓ ***Selection of electrical generator.***
- ✓ ***Design and control of instruments.***
- ✓ ***Design of layout of power station.***

Quality of coal used in steam power station plays an important role in the design of power plant.

The various factors to be considered while designing the boilers and coal handling units are as follows :

- ***Slagging and erosion properties of ash.***
- ***Moisture in the coal. Excessive moisture creates additional problems particularly in case***
- ***of pulverized fuel power plants.***
- ***Burning characteristic of coal.***
- ***Corrosive nature of ash.***

1. Steam Power Plant

- ***Steam is an important medium of producing mechanical energy.***
- ***Steam is used to drive steam engines, steam turbines etc. Steam power station is most suitable where coal is available in abundance.***

The desirable characteristic for a steam power plant are as follows :

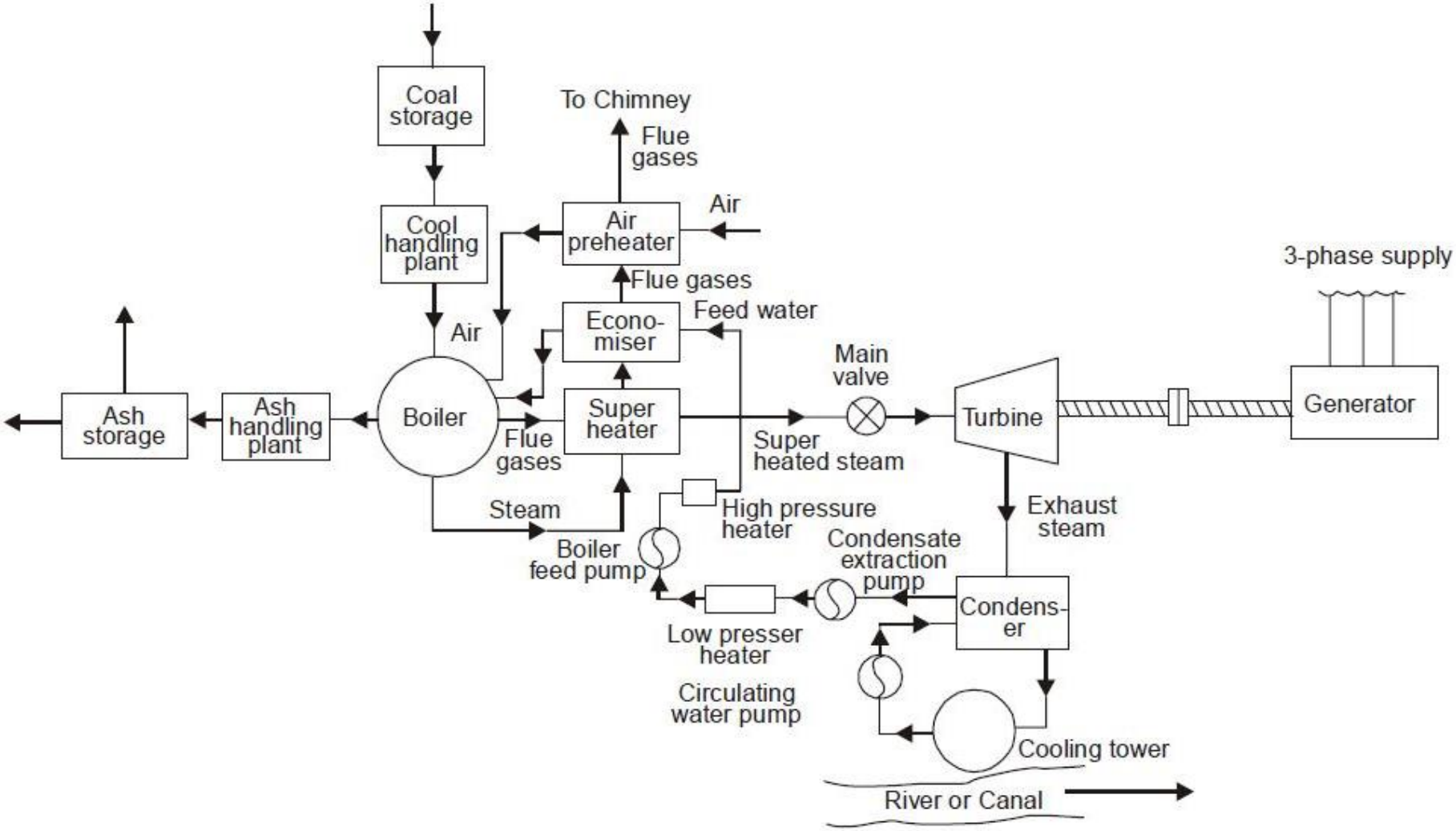
- ***Higher efficiency.***
- ***Lower cost.***
- ***Ability to burn coal especially of high ash content, and inferior coals.***
- ***Reduced environmental impact in terms of air pollution.***
- ***Higher reliability and availability.***

A steam power plant must have following equipments :

- ✓ ***A furnace to burn the fuel.***
- ✓ ***Steam generator or boiler containing water. Heat generated in the furnace is utilized to convert water in steam.***
- ✓ ***Main power unit such as an engine or turbine to use the heat energy of steam and perform work.***
- ✓ ***Piping system to convey steam and water.***

In addition to the above equipment the plant requires various auxiliaries and accessories depending upon the availability of water, fuel and the service for which the plant is intended.

Schematic of Steam Power Plant



Parts of Steam Power Plant

The flow sheet of a thermal power plant consists of the following four main circuits :

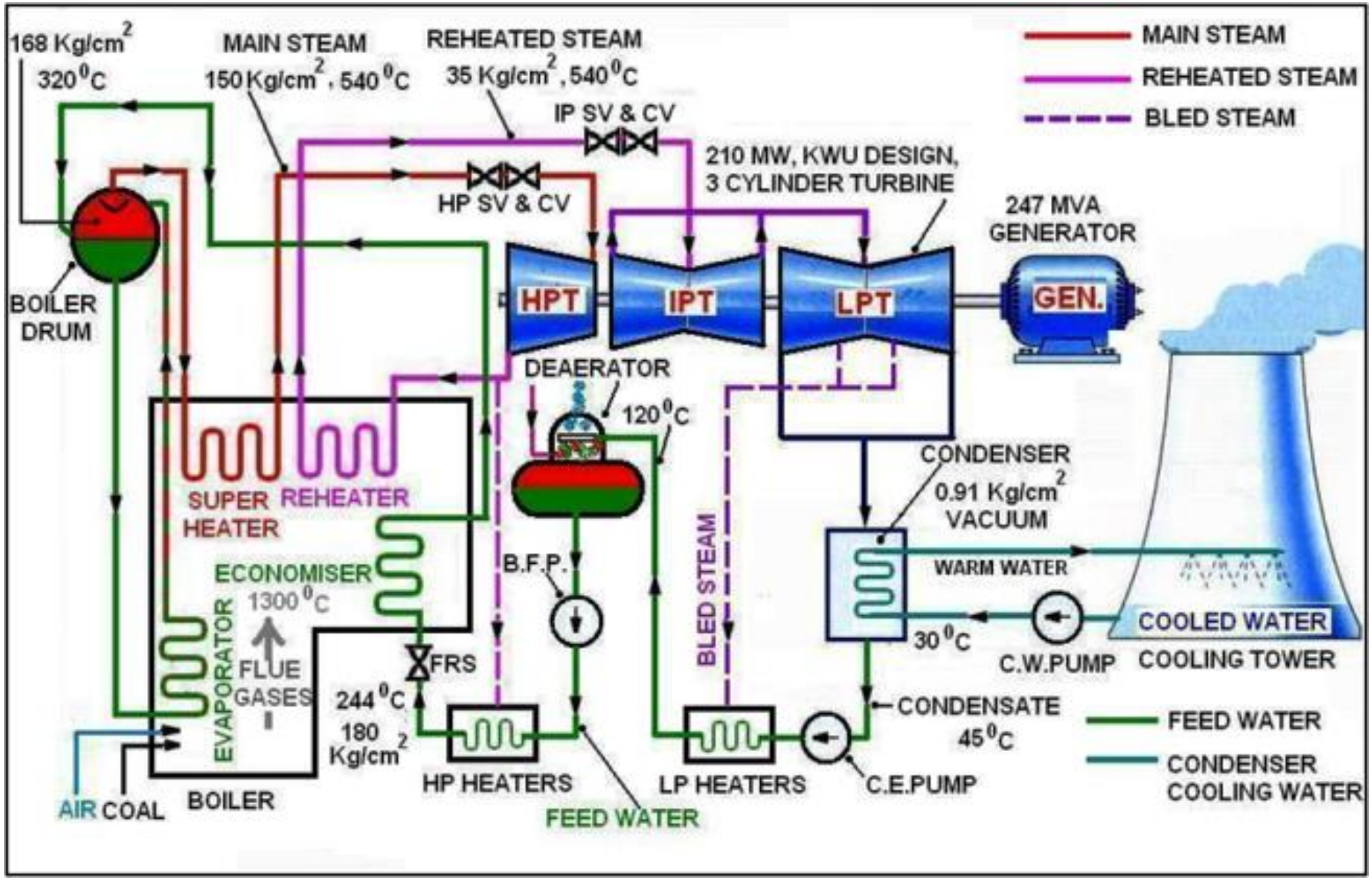
- ❑ ***Feed water and steam flow circuit***
- ❑ ***Coal and ash circuit***
- ❑ ***Air and gas circuit***
- ❑ ***Cooling water circuit.***

- ❖ ***A steam power plant using steam as working substance works basically on Rankine cycle.***
- ❖ ***Steam is generated in a boiler, expanded in the prime mover and condensed in the condenser and fed into the boiler again.***

The different types of systems and components used in steam power plant are as follows :

- ✓ ***High pressure boiler***
- ✓ ***Prime mover***
- ✓ ***Condensers and cooling towers***
- ✓ ***Coal handling system***
- ✓ ***Ash and dust handling system***
- ✓ ***Draught system***
- ✓ ***Feed water purification plant***
- ✓ ***Pumping system***
- ✓ ***Air preheater, economizer, super heater, feed heaters.***

Practical diagram of Steam Power Plant



Working Principle of Steam Power Plant

- *Coal received in coal storage yard of power station is transferred in the furnace by coal handling unit.*
- *Heat produced due to burning of coal is utilized in converting water contained in boiler drum into steam at suitable pressure and temperature.*
- *The steam generated is passed through the superheater. Superheated steam then flows through the turbine.*
- *After doing work in the turbine die pressure of steam is reduced. Steam leaving the turbine passes through the condenser which maintain the low pressure of steam at the exhaust of turbine.*
- *Steam pressure in the condenser depends upon flow rate and temperature of cooling water and on effectiveness of air removal equipment.*
- *Water circulating through the condenser may be taken from the various sources such as river, lake or sea. If sufficient quantity of water is not available the hot water coming out of the condenser may be cooled in cooling towers and circulated again through the condenser.*
- *Bled steam taken from the turbine at suitable extraction points is sent to low pressure and high pressure water heaters.*

Working Principle of Steam Power Plant

- *Air taken from the atmosphere is first passed through the air pre-heater, where it is heated by flue gases. The hot air then passes through the furnace.*
- *The flue gases after passing over boiler and superheater tubes, flow through the dust collector and then through economiser, air pre-heater and finally they are exhausted to the atmosphere through the chimney.*

Steam condensing system consists of the following

- *Condenser*
- *Cooling water*
- *Cooling tower*
- *Hot well*
- *Condenser cooling water pump*
- *Condensate air extraction pump*
- *Air extraction pump*
- *Boiler feed pump*
- *Make up water pump.*

Advantages of Steam Power Plant

- ✓ *As compared with the power generating plant, it has a low initial cost and hence economical.*
- ✓ *Less land area is required as compared with the hydro power plant.*
- ✓ *Coal is used as fuel and the cost of coal is cheaper than petrol and diesel fuel. So the power generation cost is economical.*
- ✓ *This power plant has easy maintenance cost.*
- ✓ *Steam power plant can be installed in any area where water sources and transportation facility are easily available.*

Disadvantages of Steam Power Plant

- ✓ ***High Running Cost:*** ***The running cost of the steam power plant is comparatively high because of fuel, maintenance, etc***
- ✓ ***Low Efficiency****: If we talk about the overall efficiency of the steam power plant then it is about 35 % to 41% which is low.*
- ✓ ***Global Warming:*** ***Due to the release of burnt gases of coal or fuel, it contributes to global warming to a larger extent.***
- ✓ ***Adverse Effect on the aquatic living organism:*** ***The heated water that is thrown in the rivers, ponds etc puts and adverse effect on the living organism and disturbs the ecology.***

2. Diesel Power Plant

- *In IC engines fuels burn inside the engine and the products of combustion form the working fluid that generates mechanical power.*
- *Whereas, in Gas Turbines the combustion occurs in another chamber and hot working fluid containing thermal energy is admitted in turbine.*
- *Reciprocating oil engines and gas engines convert chemical energy in fuel in to mechanical energy.*

A typical oil engine has:

- *Cylinder in which fuel and air are admitted and combustion occurs.*
- *Piston, which receives high pressure of expanding hot products of combustion and the piston, is forced to linear motion.*
- *Connecting rod, crankshaft linkage to convert reciprocating motion into rotary motion of shaft.*
- *Connected Load, mechanical drive or electrical generator.*
- *Suitable valves (ports) for control of flow of fuel, air, exhaust gases, fuel injection, and ignition systems.*
- *Lubricating system, cooling system*

Importance of Diesel as fuel

The main differences between the gasoline engine and the diesel engine are:

- ***A gasoline engine intakes a mixture of gas and air, compresses it and ignites the mixture with a spark. A diesel engine takes in just air, compresses it and then injects fuel into the compressed air. The heat of the compressed air lights the fuel spontaneously.***

- ***A gasoline engine compresses at a ratio of 8:1 to 12:1, while a diesel engine compresses at a ratio of 14:1 to as high as 25:1. The higher compression ratio of the diesel engine leads to better efficiency.***

- ***Gasoline engines generally use either carburetion, in which the air and fuel is mixed long before the air enters the cylinder, or port fuel injection, in which the fuel is injected just prior to the intake stroke (outside the cylinder). Diesel engines use direct fuel injection to the diesel fuel is injected directly into the cylinder.***

Diesel is recommended due to their:

a) Longevity-think of an 18 wheeler capable of 1,000,000 miles of operation before major service)

b) Lower fuel costs (lower fuel consumption per kilowatt (kW) produced)

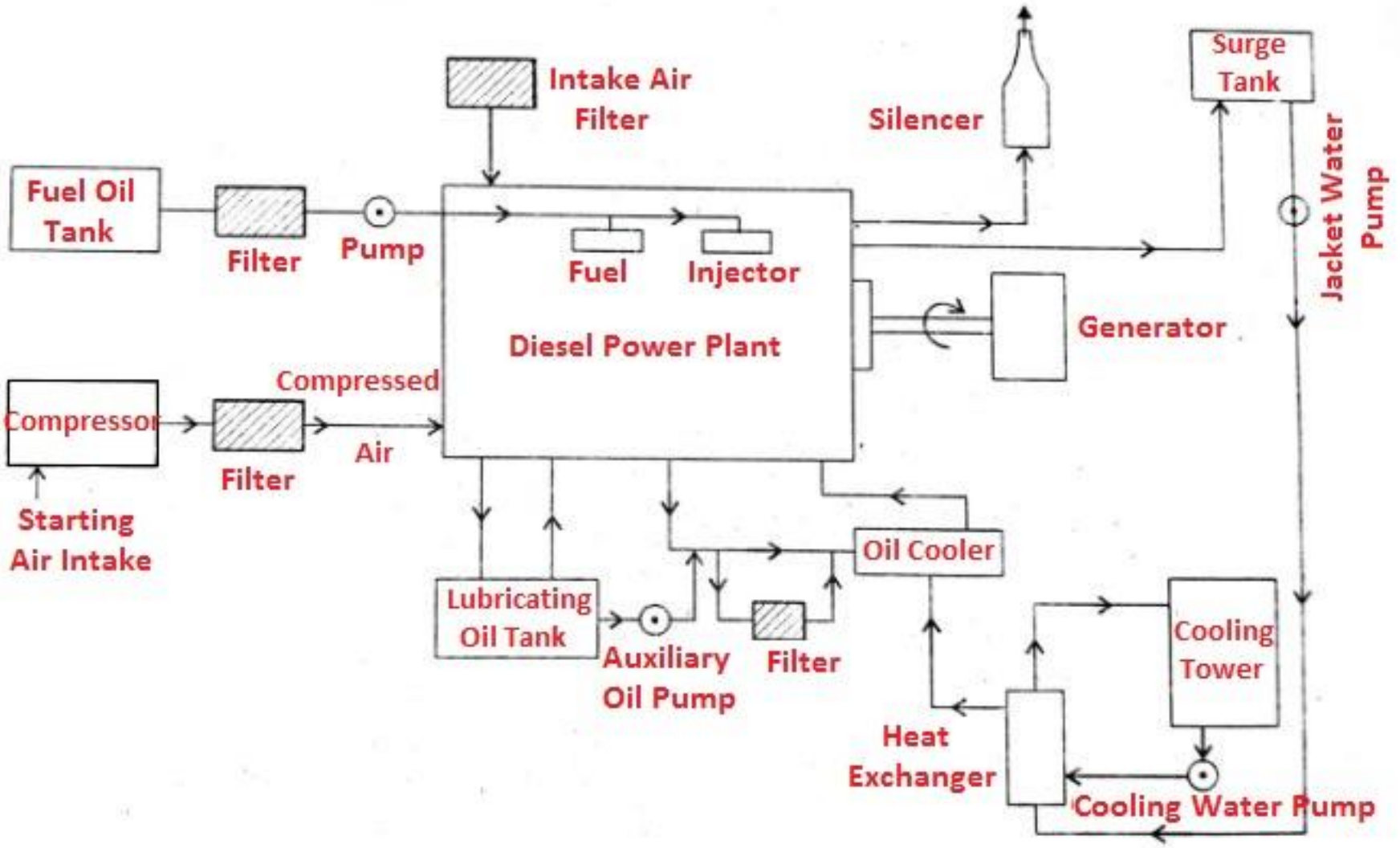
c) Lower maintenance costs-no spark system, more rugged and more reliable engine,

Importance of Diesel Power plant

Diesel engine power plants are installed where

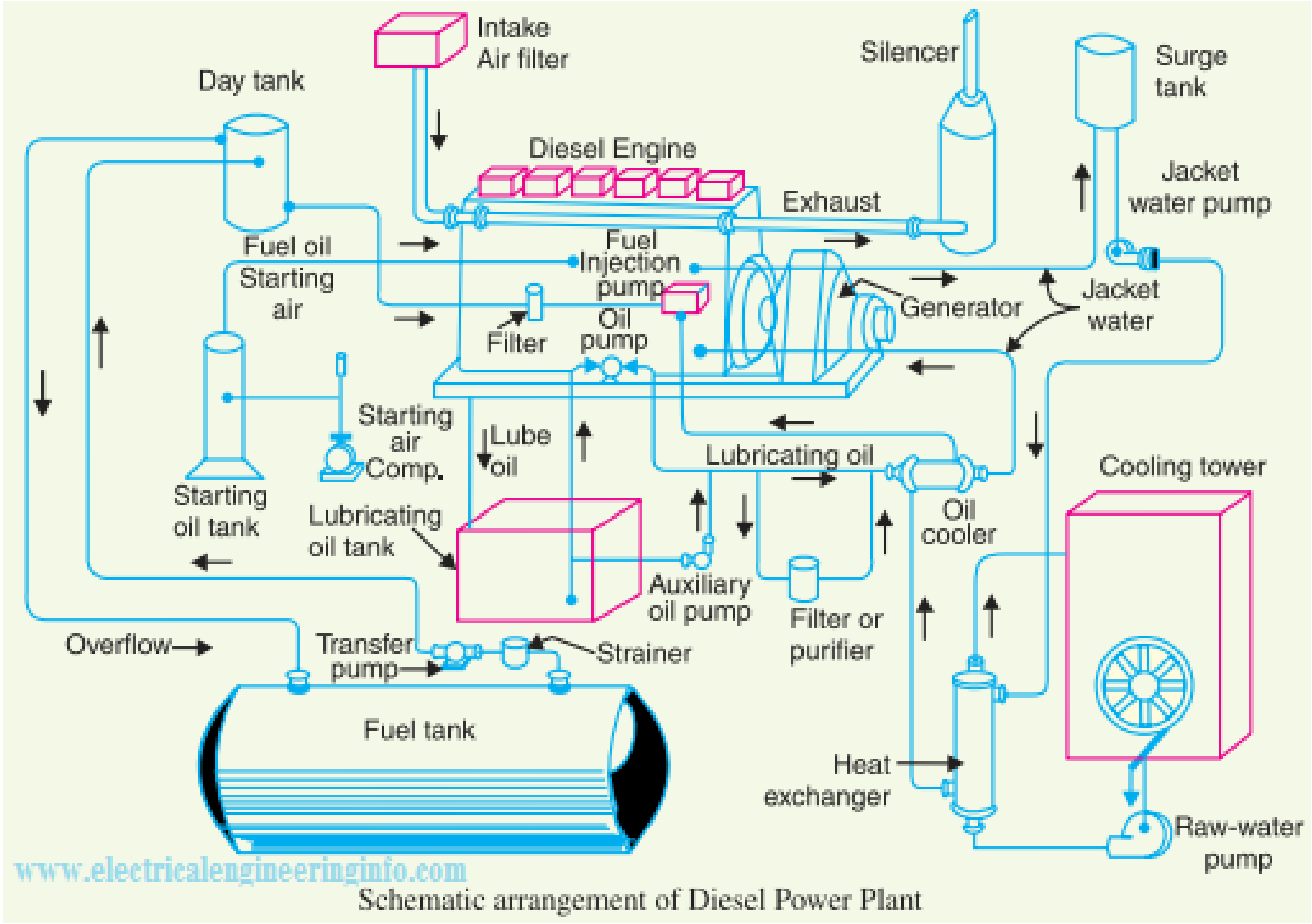
- *Supply of coal and water is not available in desired quantity.*
- *Where power is to be generated in small quantity for emergency services.*
- *Standby sets are required for continuity of supply such as in hospital, telephone exchange.*
- *It is an excellent prime mover for electric generator capacities of from 100 hp to 5000 hp.*
- *The Diesel units used for electric generation are more reliable and long - lived piece of equipment compared with other types of plants.*

Schematic of Diesel Power Plant



Schematic Diagram of Diesel Power Plant

Schematic of Diesel Power Plant



Schematic arrangement of Diesel Power Plant

Working Principle of Diesel Power Plant

All the gas engines and oil engines operate in the same general way. The working fluid undergoes repeated cycles. A thermodynamic cycle is composed of a series of sequential events in a closed loop on P-V or T-S diagram. A typical cycle has following distinct operations:

1. ***Cylinder is charged***
2. ***Cylinder contents are compressed***
3. ***Combustion (Burning) of charge, creation of high pressure pushing the piston and expansion of products of combustion.***
4. ***Exhaust of spent products of combustion to atmosphere.***

In diesel engines:

- ***Air is compressed as the compression stroke begins and the fuel enters the cylinder at the end of compression stroke. Heat of compression is used for ignition of fuel.***
- ***In a typical diesel engine, air is compressed to about 30 bars, which increases the temperature when finely atomised diesel fuel oil is sprayed into the heated air, it ignites and burns.***
- ***High compression ratio is therefore essential for reliable combustion and high efficiency. Compression ratios above those needed to achieve ignition do not improve the efficiency.***

Advantages of Diesel Power Plant

- *Very simple design also simple installation.*
- *Limited cooling water requirement.*
- *Standby losses are less as compared to other Power plants.*
- *Low fuel cost.*
- *Quickly started and put on load.*
- *Smaller storage is needed for the fuel.*
- *Layout of power plant is quite simple.*
- *There is no problem of ash handling.*
- *Less supervision required.*
- *For small capacity, diesel power plant is more efficient as compared to steam power plant.*
- *They can respond to varying loads without any difficulty.*

Disadvantages of Diesel Power Plant

1. High Maintenance and operating cost.

2. Fuel cost is more, since in India diesel is costly.

3. The plant cost per kW is comparatively more.

4. The life of diesel power plant is small due to high maintenance.

5. Noise is a serious problem in diesel power plant.

6. Diesel power plant cannot be constructed for large scale.

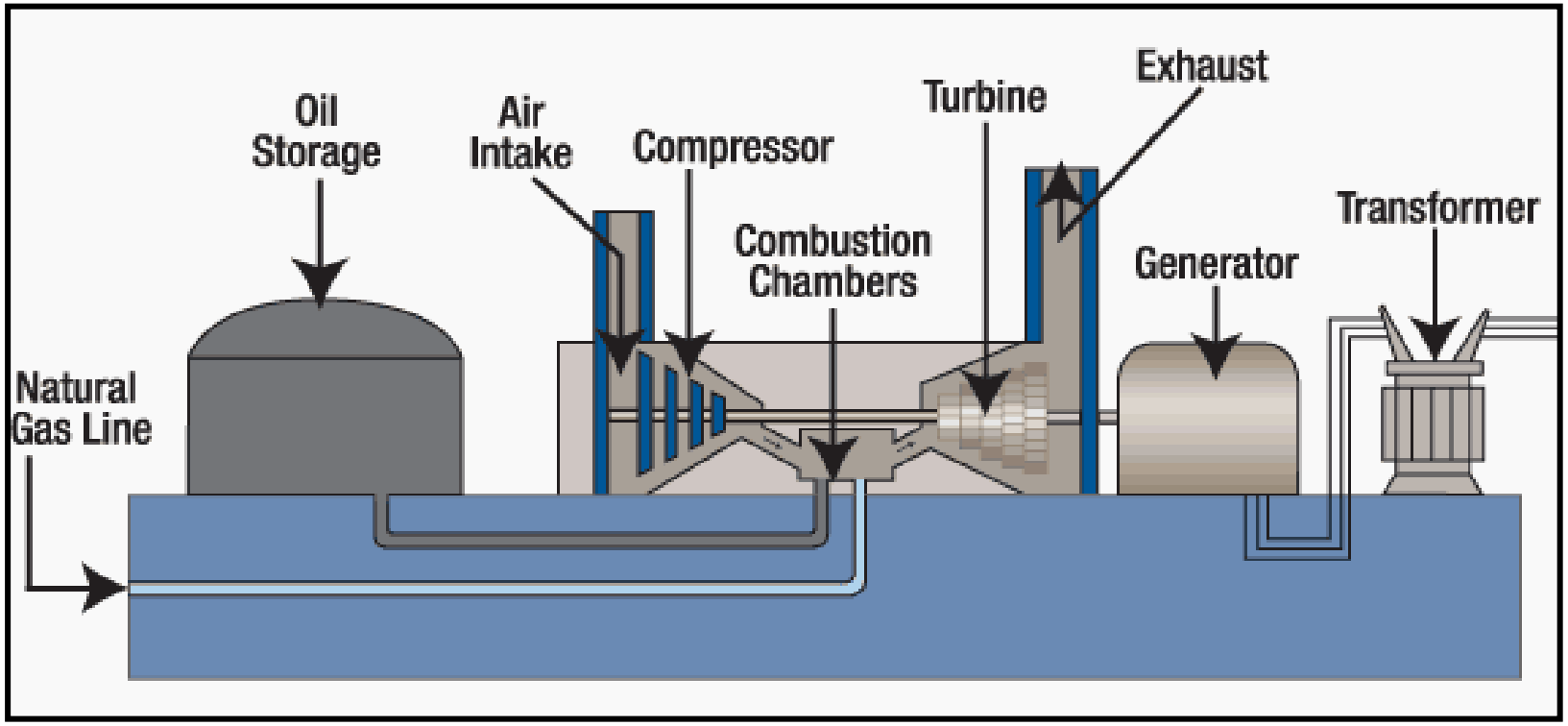
Applications of Diesel Power Plant

- ✓ ***They are quite suitable for mobile power generation and are widely used in transportation systems consisting of railroads, ships, automobiles and aeroplanes.***
- ✓ ***They can be used for electrical power generation in capacities from 100 to 5000 H.P.***
- ✓ ***They can be used as standby power plants.***
- ✓ ***They can be used as peak load plants for some other types of power plants.***
- ✓ ***Industrial concerns where power requirement are small say of the order of 500 kW, diesel power plants become more economical due to their higher overall efficiency.***

3. Gas Turbine Power Plant

- *The gas turbine obtains its power by utilizing the energy of burnt gases and air, which is at high temperature and pressure by expanding through the several ring of fixed and moving blades.*

- *It thus resembles a steam turbine. To get a high pressure (of the order of 4 to 10 bar) of working fluid, which is essential for expansion a compressor, is required.*



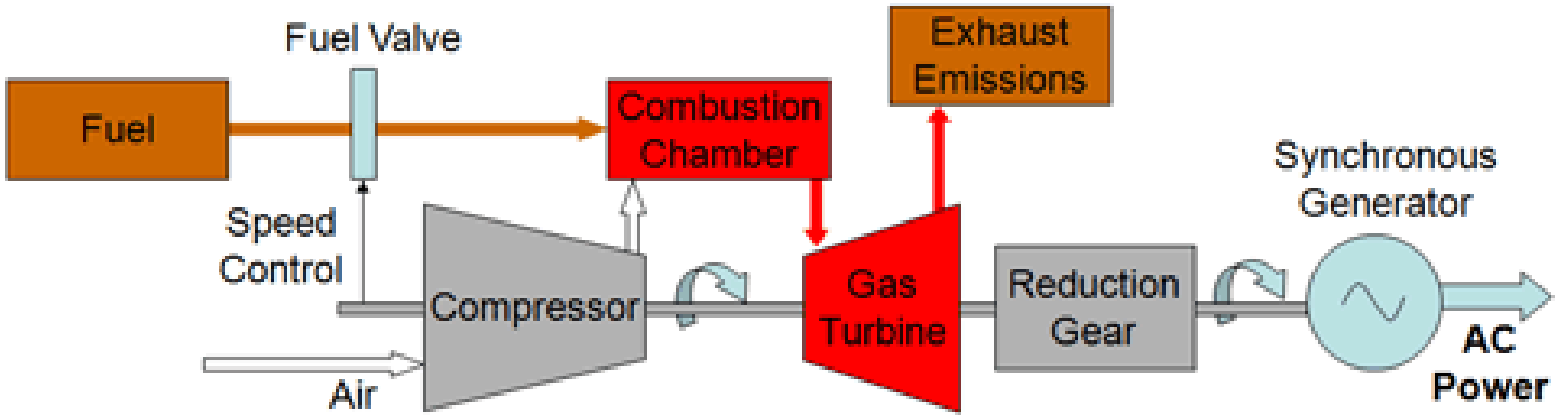
Working Principle of Gas turbine Power Plant

- ✓ *The quantity of the working fluid and speed required are more, so, generally, a centrifugal or an axial compressor is employed.*
- ✓ *The turbine drives the compressor and so it is coupled to the turbine shaft.*
- ✓ *If after compression the working fluid were to be expanded in a turbine, then assuming that there were no losses in either component the power developed by the turbine would be just equal to that absorbed by the compressor and the work done would be zero.*
- ✓ *But increasing the volume of the working fluid at constant pressure, or alternatively increasing the pressure at constant volume can increase the power developed by the turbine.*
- ✓ *Adding heat so that the temperature of the working fluid is increased after the compression may do either of these.*
- ✓ *To get a higher temperature of the working fluid a combustion chamber is required where combustion of air and fuel takes place giving temperature rise to the working fluid.*

Working Principle of Gas turbine Power Plant

Thus, a simple gas turbine cycle consists of
(1) a compressor,
(2) a combustion chamber and
(3) a turbine.

- ***Since the compressor is coupled with the turbine shaft, it absorbs some of the power produced by the turbine and hence lowers the efficiency.***
- ***The network is therefore the difference between the turbine work and work required by the compressor to drive it.***
- ***Gas turbines have been constructed to work on the following: oil, natural gas, coal gas, producer gas, blast furnace and pulverized coal.***

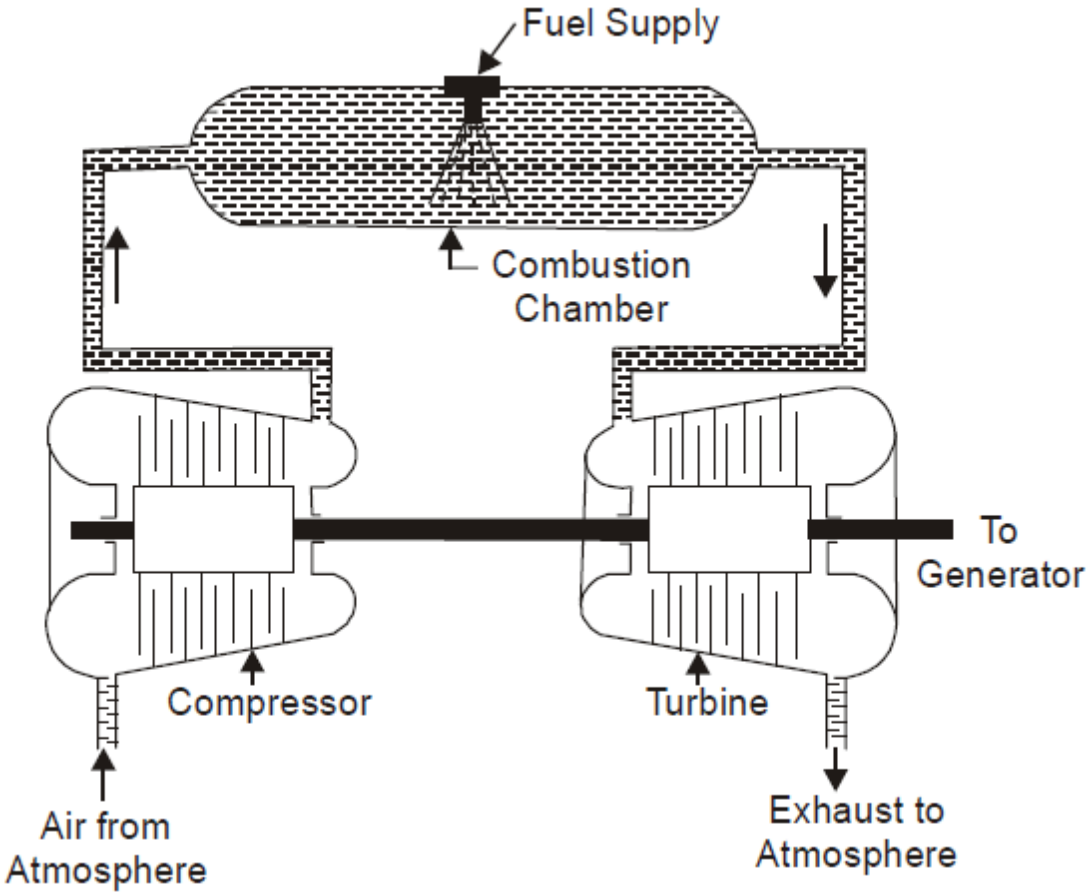


Gas Turbine Electric Power Generation

Open cycle gas turbine power plant

A simple open cycle gas turbine consists of a compressor, combustion chamber and a turbine. The compressor takes in ambient air and raises its pressure. Heat is added to the air in combustion chamber by burning the fuel and raises its temperature.

- ***The heated gases coming out of combustion chamber are then passed to the turbine where it expands doing mechanical work.***
- ***Part of the power developed by the turbine is utilized in driving the compressor and other accessories and remaining is used for power generation.***
- ***Since ambient air enters into the compressor and gases coming out of turbine are exhausted into the atmosphere, the working medium must be replaced continuously.***



Advantages of Open cycle gas turbine power plant

1. Warm-up time. *Once the turbine is brought up to the rated speed by the starting motor and the fuel is ignited, the gas turbine will be accelerated from cold start to full load without warm-up time.*

2. Low weight and size. *The weight in kg per kW developed is less.*

3. Fuels. *Almost any hydrocarbon fuel from high-octane gasoline to heavy diesel oils can be used in the combustion chamber.*

4. *Open cycle plants occupy comparatively little space.*

5. *The stipulation of a quick start and take-up of load frequently are the points in favor of open cycle plant when the plant is used as peak load plant.*

6. *Component or auxiliary refinements can usually be varied to improve the thermal efficiency and give the most economical overall cost for the plant load factors and other operating conditions envisaged.*

7. *Open-cycle gas turbine power plant, except those having an intercooler, does not require cooling water. Therefore, the plant is independent of cooling medium and becomes self-contained.*

Disadvantages of Open cycle gas turbine power plant

1. *The part load efficiency of the open cycle plant decreases rapidly as the considerable percentage of power developed by the turbine is used to drive the compressor.*

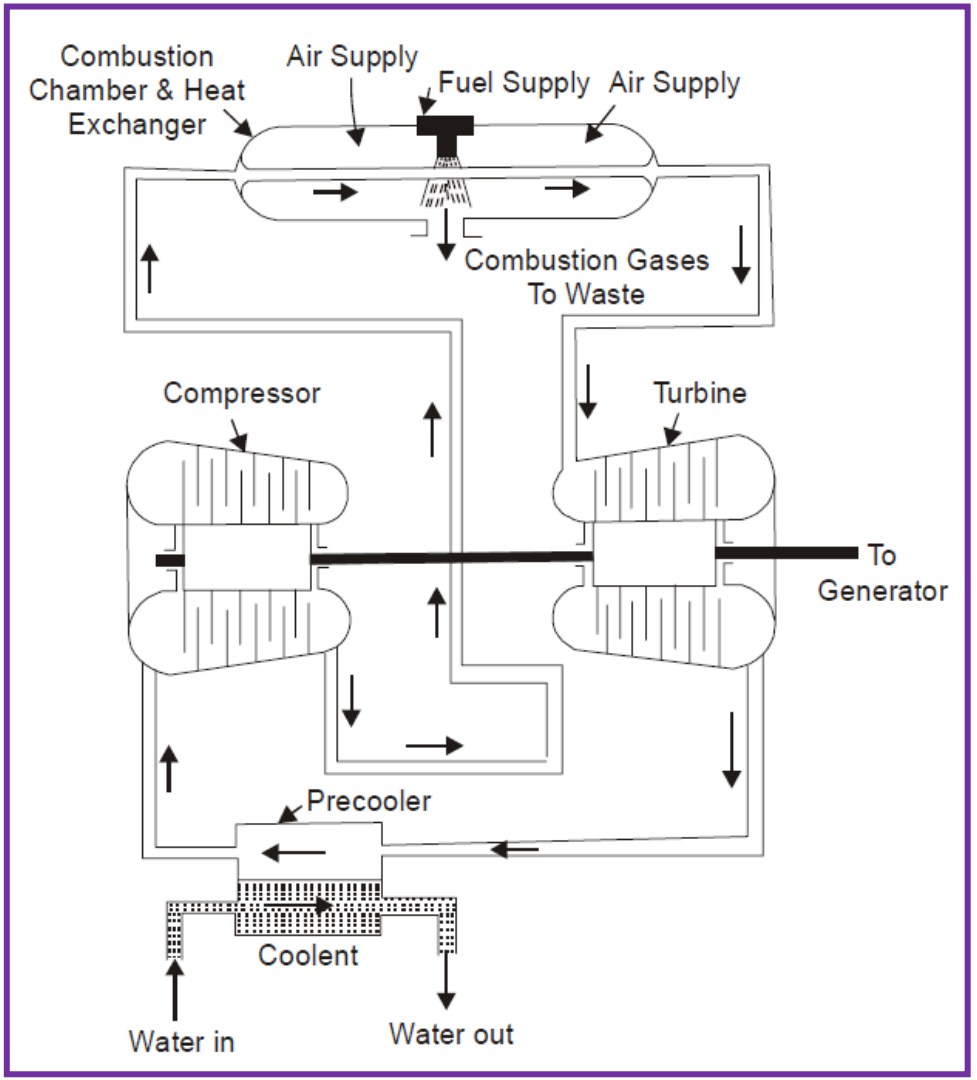
2*. The system is sensitive to the component efficiency; particularly that of compressor. The open cycle plant is sensitive to changes in the atmospheric air temperature, pressure and humidity.*

3. *The open-cycle gas turbine plant has high air rate compared to the other cycles, therefore, it results in increased loss of heat in the exhaust gases and large diameter ductwork is necessary.*

4. *It is essential that the dust should be prevented from entering into the compressor in order to minimize erosion and depositions on the blades and passages of the compressor and turbine and so impairing their profile and efficiency. The deposition of the carbon and ash on the turbine blades is not at all desirable as it also reduces the efficiency of the turbine.*

Closed cycle gas turbine power plant

- *In closed cycle gas turbine plant, the working fluid (air or any other suitable gas) coming out from compressor is heated in a heater by an external source at constant pressure.*
- *The high temperature and high-pressure air coming out from the external heater is passed through the gas turbine.*
- *The fluid coming out from the turbine is cooled to its original temperature in the cooler using external cooling source before passing to the compressor.*
- *The working fluid is continuously used in the system without its change of phase and the required heat is given to the working fluid in the heat exchanger.*



Advantages of Closed cycle gas turbine power plant

- ✓ *With closed cycle gas turbine plants, the backpressure can be increased. Therefore the machine can be smaller and cheaper than the machine used to develop the same power using open cycle plant.*
- ✓ *The closed cycle avoids erosion of the turbine blades due to the contaminated gases and fouling of compressor blades due to dust. Therefore, it is practically free from deterioration of efficiency in service with higher life.*
- ✓ *The need for filtration of the incoming air which is a severe problem in open cycle plant is completely eliminated.*
- ✓ *Load variation is usually obtained by varying the absolute pressure and mass flow of the circulating medium, while the pressure ratio, the temperatures and the air velocities remain almost constant.*
- ✓ *The density of the working medium can be maintained high by increasing internal pressure range, therefore, the compressor and turbine are smaller for their rated output. The high density of the working fluid further increases the heat transfer properties in the heat exchanger.*

Advantages of closed cycle gas turbine power plant

- *As indirect heating is used in closed cycle plant, the inferior oil or solid fuel can be used in the furnace and these fuels can be used more economically because these are available in abundance.*
- *Finally the closed cycle opens the new field for the use of working medium (other than air as argon, CO_2, helium) having more desirable properties.*
- *The maintenance cost is low and reliability is high due to longer useful life.*
- *The thermal efficiency increases as the pressure ratio (R_p) decreases. Therefore, appreciable higher thermal efficiencies are obtainable with closed cycle for the same maximum and minimum temperature limits as with the open cycle plant.*
- *Starting of plane is simplified by reducing the pressure to atmospheric or even below atmosphere so that the power required for starting purposes is reduced considerably.*

Disadvantages of closed cycle gas turbine power plant

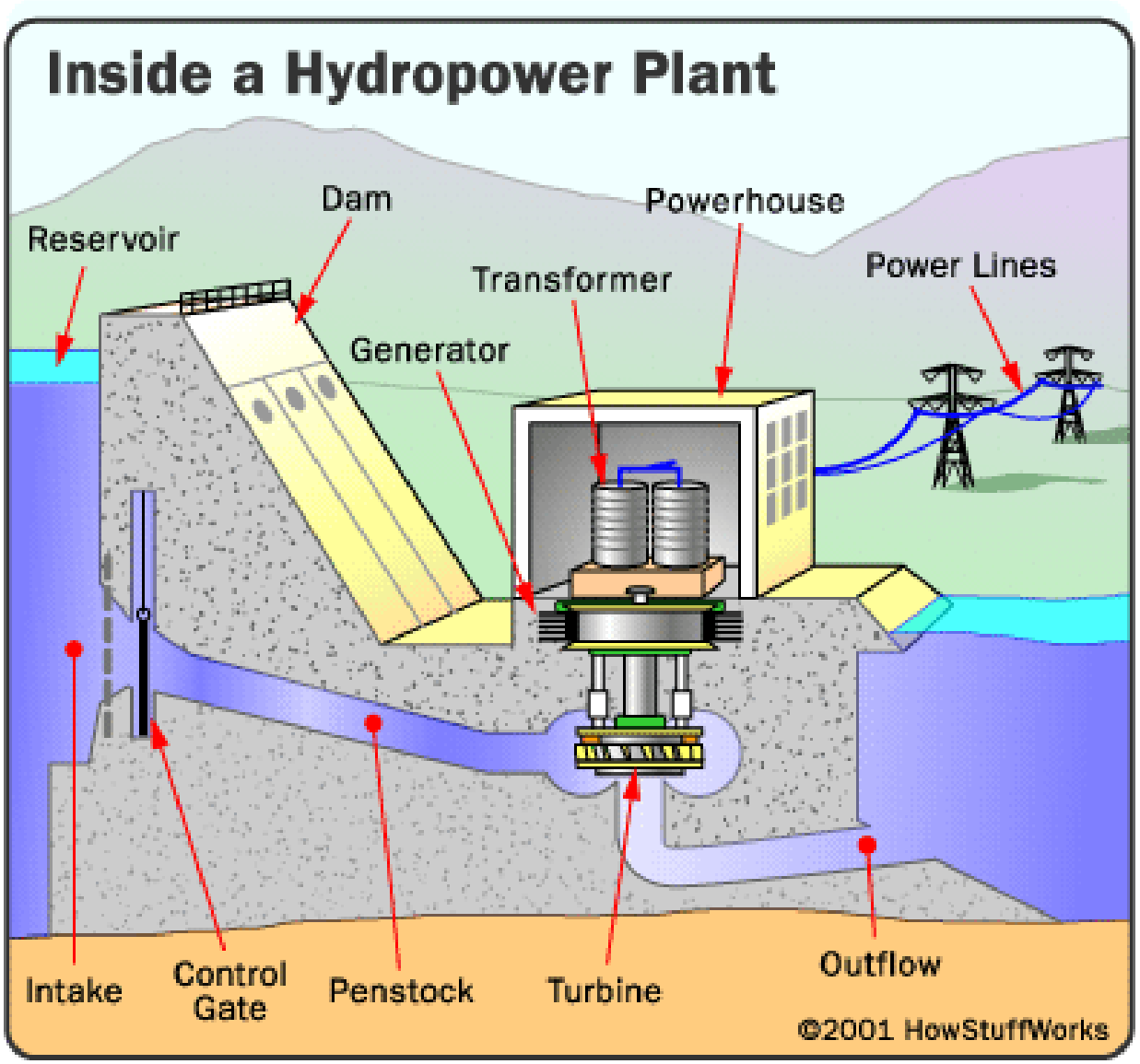
1. *The system is dependent on external means as considerable quantity of cooling water is required in the pre-cooler.*

2. Higher internal pressures involve complicated design of all components and high quality material is required which increases the cost of the plant.

3. The response to the load variations is poor compared to the open-cycle plant.

4. It requires very big heat-exchangers as the heating of workings fluid is done indirectly. The space required for the heat exchanger is considerably large. The full heat of the fuel is also not used in this plant.

4. Hydro-electric Power Plant



Hydro projects are developed for the following purposes:

1. *To control the floods in the rivers.*

2. *Generation of power.*

3. *Storage of irrigation water.*

4. *Storage of the drinking water supply.*

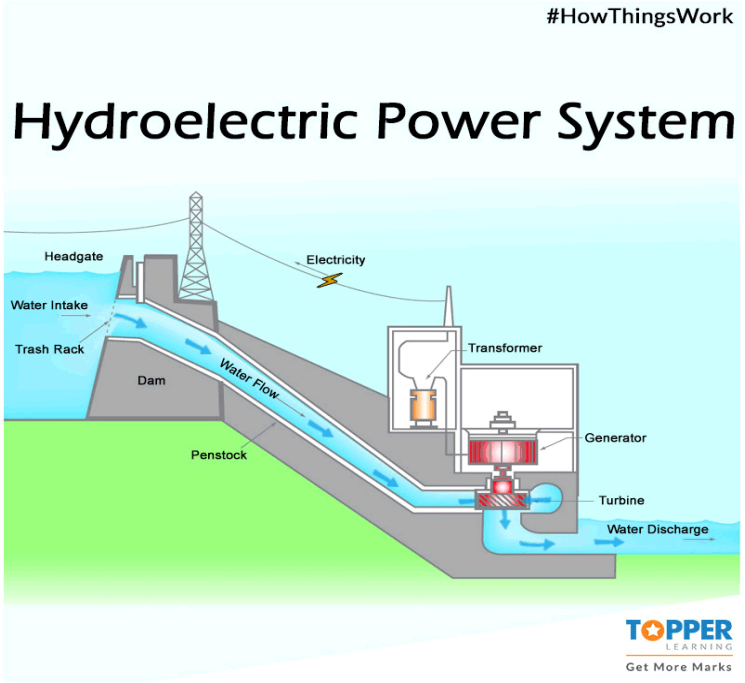
Working Principle of Hydro-electric power plant

When rain water falls over the earth's surface, it possesses potential energy relative to sea or ocean towards which it flows.

The water falls through an appreciable vertical height, this energy can be converted into shaft work.

As the water falls through a certain height, its potential energy is converted into kinetic energy and this kinetic energy is converted to the mechanical energy by allowing the water to flow through the hydraulic turbine runner.

This mechanical energy is utilized to run an electric generator which is coupled to the turbine shaft.



The power developed in this manner is given as:

Power = W.Q.H.η watts

where, W = Specific weight of water, N/m^3

Q = rate of water flow, m^3/sec.

H = Height of fall or head, m

η = efficiency of conversion of potential energy into mechanical energy.

Advantages of Hydro power plant

1. The plant is highly reliable and its maintenance and operation charges are very low.
2. The plant can be run up and synchronized in a few minutes.
3. The load can be varied quickly and the rapidly changing load demands can be met without any difficulty.
4. The plant has no stand by losses.
5. No fuel charges.
6. The efficiency of the plant does not change with age.
7. The cost of generation of electricity varies little with the passage of time.

Disadvantages of hydro power plant

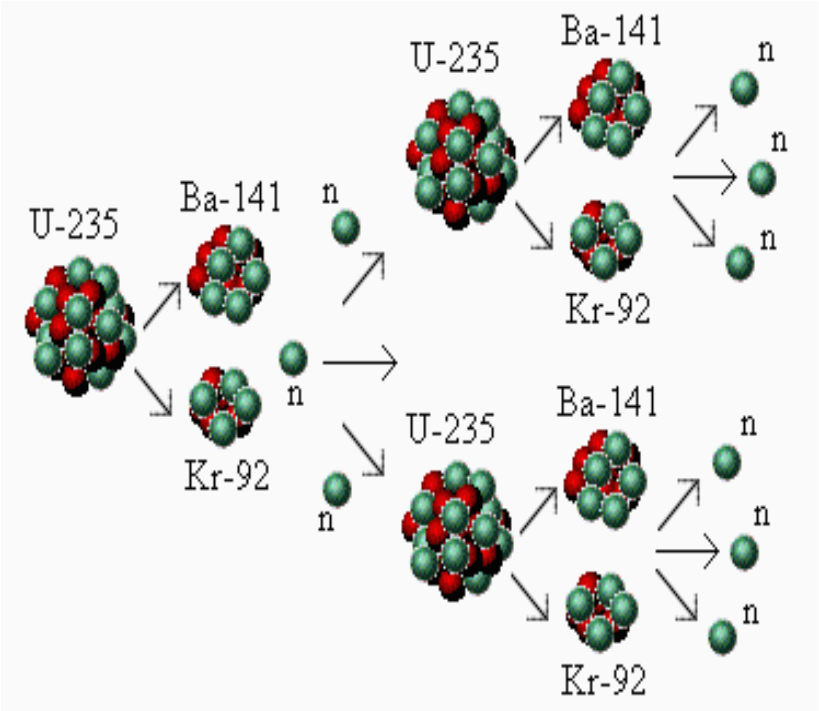
1. The capital cost of the plant is very high.
2. The hydro-electric plant takes much longer in design and execution.
3. These plants are usually located in hilly areas far away from the load center.
4. Transformation and transmission costs are very high.
5. The output of a hydro-electric plant is never constant due to vagaries of monsoons and their dependence on the rate of water flow in a river.

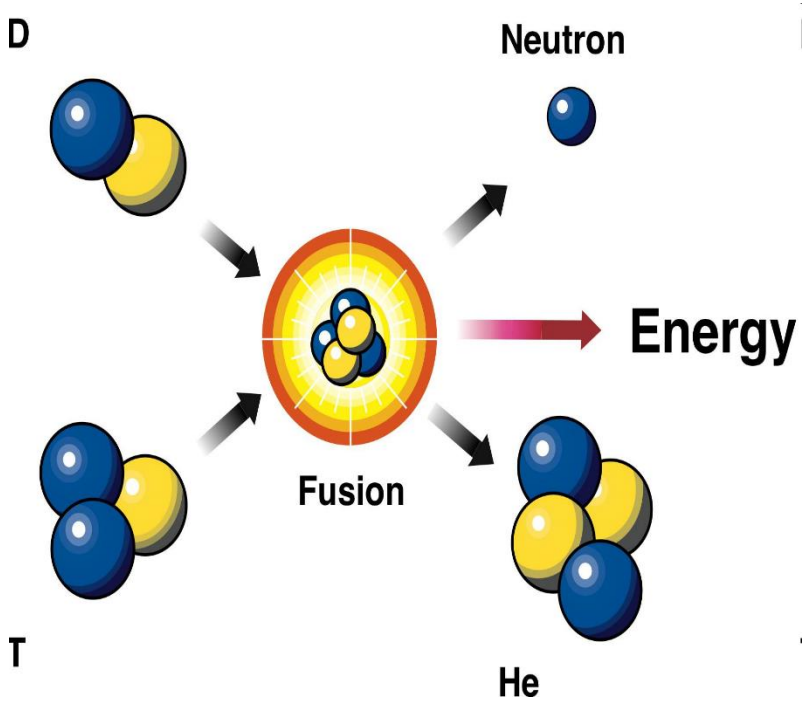
5. Nuclear Power Plant

- *Uranium was discovered in 1789 by Martin Klaproth, a German chemist, and named after the planet Uranus.*
- *The science of atomic radiation, atomic change and nuclear fission was developed from 1895 to 1945, much of it in the last six of those years.*
- *Over 1939-45, most development was focused on the atomic bomb.*
- *From 1945 attention was given to harnessing this energy in a controlled fashion for naval propulsion and for making electricity*
- *Since 1956 the prime focus has been on the technological evolution of reliable nuclear power plants.*
- *The energy in one pound of highly enriched Uranium is comparable to that of one million gallons of gasoline.*
- *One million times as much energy in one pound of Uranium as in one pound of coal.*
- *Nuclear energy annually prevents 5.1 million tons of sulfur 2.4 million tons of nitrogen oxide 164 metric tons of carbon.*
- *First commercial power plant, England 1956.*
- *17% of world's electricity is from nuclear power.*

Nuclear Reactions

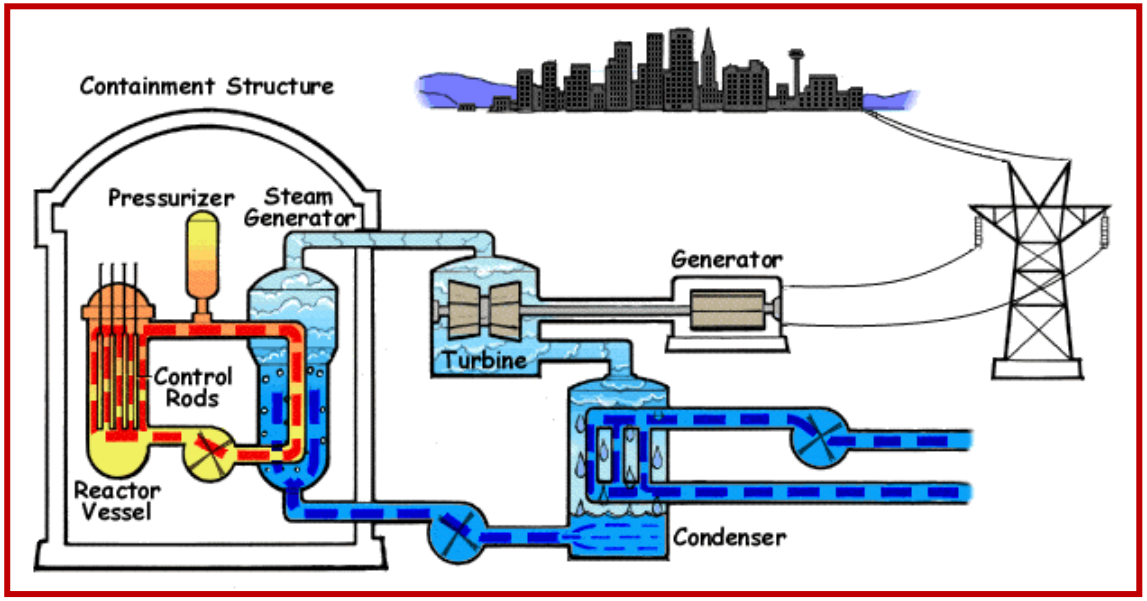
- *Nuclear reactions deal with interactions between the nuclei of atoms including of nuclear fission and nuclear fusion*
- *Both fission and fusion processes deal with matter and energy*
- *Fission is the process of splitting of a nucleus into two "daughter" nuclei leading to energy being released*
- *Fusion is the process of two "parent" nuclei fuse into one daughter nucleus leading to energy being released*





Nuclear Reactors

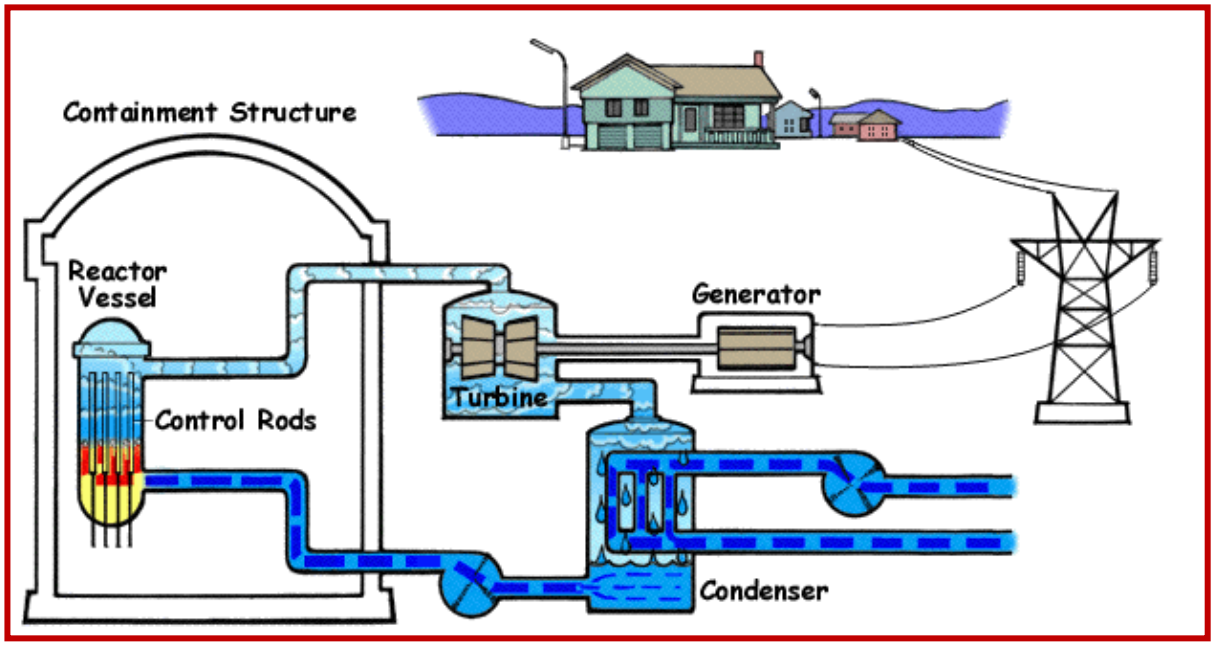
The pressurized water reactor overcomes the problem of a slightly radioactive steam circuit by having an intermediate heat exchanger to separate the reactor coolant circuit from the turbine steam circuit. Steam is generated in this steam generator and is sent to the turbine as saturated steam under conditions similar to those in the boiling water reactor. The reactor coolant circuit is maintained at high pressure to prevent any boiling in the reactor and operates at a slightly higher temperature than the BWR to promote heat transfer to the secondary steam circuit. Because no boiling occurs in the reactor core, it is more compact and does not require channels. The fuel rods of the individual elements form a continuous vertical matrix in the core. This is flooded with an upward flow of circulating light water which serves as coolant and moderator.



The Pressurized Water Reactor (PWR)

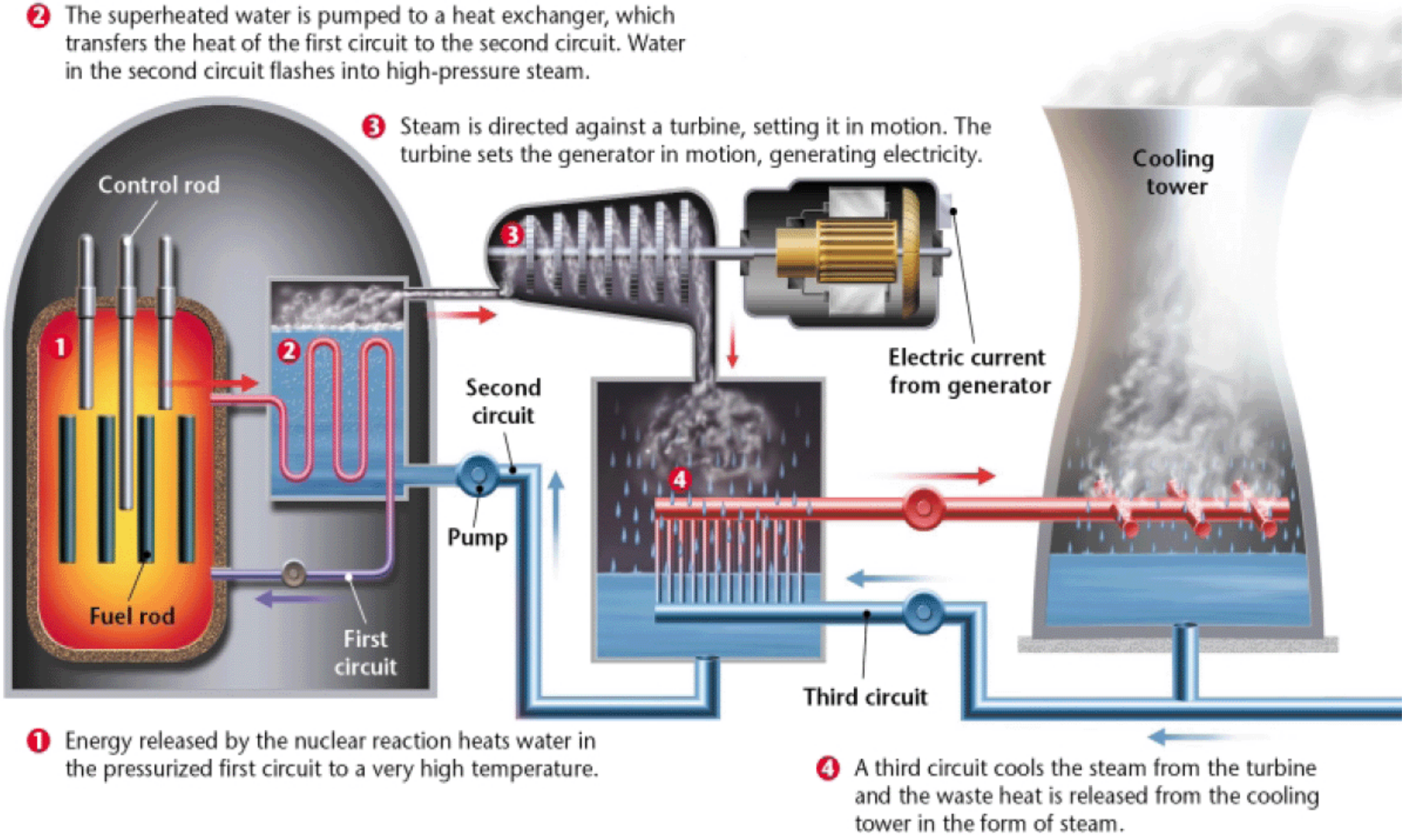
Nuclear Reactors

The boiling water reactor consists of a pressure vessel containing the fuel rods in vertical elements, with each element surrounded by a channel. The channels are flooded with light water which serves as the moderator and coolant. Pumps circulate water upwards through the channels, and steam is generated within the channels. The exit steam quality is about 13%, and the steam is separated from the water in cyclone separators above the reactor core. This saturated steam is sent directly to the steam turbines.



Boiling Water Reactor (BWR)

Working of Nuclear Power Plant



Nuclear power stations in India

(i) Tarapur Nuclear Power Station. *It is India's first nuclear power plant. It has been built at Tarapur 60 miles north of Bombay with American collaboration. It has two boiling water reactors each of 200 mW capacity and uses enriched uranium as its fuel. It supplies power to Gujarat and Maharashtra.*

(ii) Rana Pratap Sagar (Rajasthan) Nuclear Station. *It has been built at 42 miles south west of Kota in Rajasthan with Canadian collaboration. It has two reactors each of 200 mW capacity and uses natural uranium in the form of oxide as fuel and heavy water as moderator.*

(iii) Kalpakkam Nuclear Power Station. *It is the third nuclear power station in India and is being built at about 40 miles from Madras City. It will be wholly designed and constructed by Indian scientists and engineers. It has two fast reactors each of 235 mW capacity and will use natural uranium as its fuel.*

(iv) Narora Nuclear Power Station. *It is India's fourth nuclear power station and is being built at Narora in Bullandshahar District of Uttar Pradesh. This plant will initially have two units of 235 mW each and provision has been made to expand its capacity of 500 mW. It is expected to be completed by 1991.*

(v) Kakarpar Nuclear Power Plant. *This fifth nuclear power plant of India is to be located at Kakarpar near Surat in Gujarat. This power station will have four reactors each of 235 mW capacity.*

Nuclear power site selection

1. Availability of water. *At the power plant site an ample quantity of water should be available for condenser cooling and made up water required for steam generation. Therefore the site should be nearer to a river, reservoir or sea.*

2. Distance from load center. *The plant should be located near the load center. This will minimize the power losses in transmission lines.*

3. Distance from populated area. *The power plant should be located far away from populated area to avoid the radioactive hazard.*

4. Accessibility to site. *The power plant should have rail and road transportation facilities.*

5. Waste disposal. *The wastes of a nuclear power plant are radioactive and there should be sufficient space near the plant site for the disposal of wastes.*

Advantages of Nuclear power plant

***1**. Space requirement of a nuclear power plant is less as compared to other conventional power plants are of equal size.*

***2**. A nuclear power plant consumes very small quantity of fuel. Thus fuel transportation cost is less and large fuel storage facilities are not needed. Further the nuclear power plants will conserve the fossil fuels (coal, oil, gas etc.) for other energy need.*

***3**. There is increased reliability of operation.*

***4**. Nuclear power plants are not effected by adverse weather conditions.*

***5**. Nuclear power plants are well suited to meet large power demands. They give better performance at higher load factors (80 to 90%).*

***6**. Materials expenditure on metal structures, piping, storage mechanisms are much lower for a nuclear power plant than a coal burning power plant.*

***7**. It does not require large quantity of water.*

Disadvantages of Nuclear power plant

***1**. Initial cost of nuclear power plant is higher as compared to hydro or steam power plant.*

***2**. Nuclear power plants are not well suited for varying load conditions.*

***3**. Radioactive wastes if not disposed carefully may have bad effect on the health of workers and other population. In a nuclear power plant the major problem faced is the disposal of highly radioactive waste in form of liquid, solid and gas without any injury to the atmosphere. The preservation of waste for a long time creates lot of difficulties and requires huge capital.*

***4**. Maintenance cost of the plant is high.*

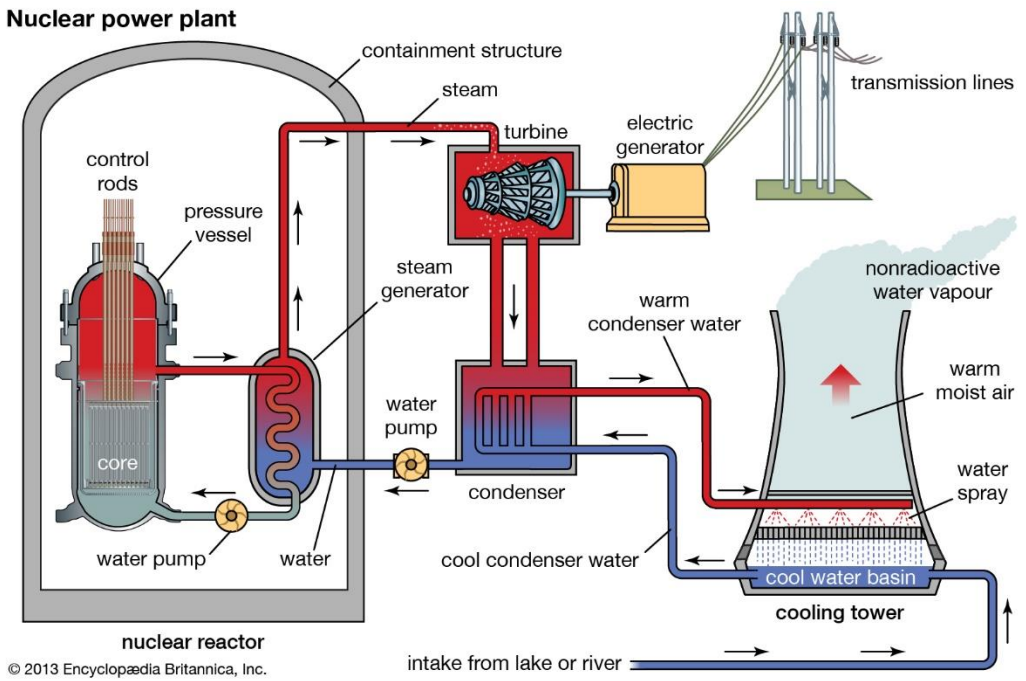
***5**. It requires trained personnel to handle nuclear power plants.*

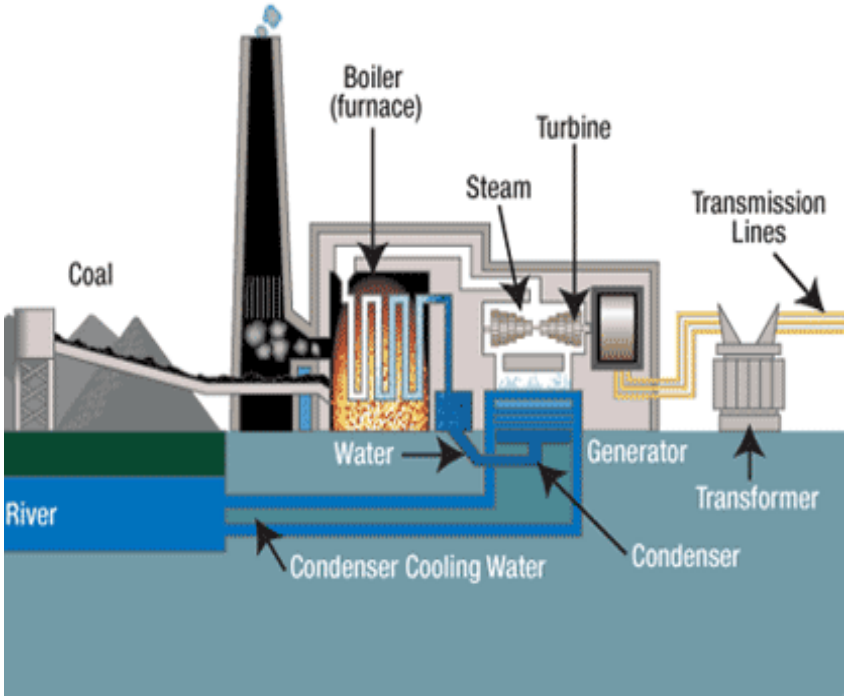
Comparison of Nuclear power plant with steam power plant

(i) *The number of workman required for the operation of nuclear power plant is much less than a steam power plant. This reduces the cost of operation.*

(ii) *The capital cost of nuclear power plant falls sharply if the size of plant is increased. The capital cost as structural materials, piping, storage mechanism etc. much less in nuclear power plant than similar expenditure of steam power plant. However, the expenditure of nuclear reactor and building complex is much higher.*

(iii) *The cost of power generation by nuclear power plant becomes competitive with cost of steam power plant above the unit size of about 500 mW.*





Safety Measures for Nuclear Power Plants

Nuclear power plants should be located far away from the populated area to avoid the radioactive hazard. A nuclear reactor produces α and (β particles, neutrons and ϒ-quanta which can disturb the normal functioning of living organisms. Nuclear power plants involve radiation leaks, health hazard to workers and community, and negative effect on surrounding forests.

At nuclear power plants there are three main sources of radioactive contamination of air:

(i) *Fission of nuclei of nuclear fuels.*

(ii) *The second source is due to the effect of neutron fluxes on the heat carrier in the primary cooling system and on the ambient air.*

(iii) *Third source of air contamination is damage of shells of fuel elements.*

Safety Measures for Nuclear Power Plants contd….

(i) *Nuclear power plant should be located away from human habitation.*
(ii) *Quality of construction should be of required standards.*
(iii) *Waste water from nuclear power plant should be purified. The water purification plants must have a high efficiency of water purification and satisfy rigid requirements as regards the volume of radioactive wastes disposed to burial.*
(iv) *An atomic power plant should have an extensive ventilation system. The main purpose of this ventilation system is to maintain the concentration of all radioactive impurities in the air below the permissible concentrations.*
(v) *An exclusion zone of 1.6 km radius around the plant should be provided where no public habitation is permitted.*
(vi) *The safety system of the plant should be such as to enable safe shut down of the reactor whenever required.*
(vii) *Periodical checks be carried out to check that there is no increase in radioactivity than permissible in the environment.*
(viii) *Wastes from nuclear power plant should be carefully disposed off. There should be no danger of pollution of water of river or sea where the wastes are disposed.*