raisoni EDUCATION

Power Plant Engineering

Course Code: 23BTMEL404

B. Tech - VII Semester

Prepared by:

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Teaching and Evaluation Scheme

Course Title: **POWER PLANT ENGINEERING**										
Semester	VII	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	Odd	Th	Tu	Pr	Credits	TAE	CAE	ESE	INT	EXT
Course Category	PEC 4	4 Hrs	-	-	04	10	15	50	-	-
Course Code	UNMEL404									
Teaching Mode	Offline	4 Hrs.			Total	75			-	
Duration of ESE	2.5 Hrs.					75				

Course Objectives and Outcomes

Course Objectives	1. To understand the importance of green energy in present energy crises.
	2. To understand solar energy, wind, biomass energy conversion techniques, fuel cell, MHD, geothermal, ocean wave energy, hydrogen, etc. & their applications.
	3. To understand the economics & green energy roles in sustainable development
Course Outcomes	Upon successful completion of this course, student shall be able to:
	CO 1. Analyze various solar applications and its components.
	CO 2. Apply Wind and ocean energy knowledge to generate electric power
	CO 3. Make use the concept of energy conversion system of biomass, biogas, fuel cell, MHD, thermoelectric, geothermal energy.
	CO 4. Understand the various concepts related to hydrogen, green fuel, green buildings and its applications
	CO 5. Apply the various green energy measurement techniques for energy economy

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

Following mapping is only for reference

Course Outcomes	Program Outcomes and Program Specific Outcomes													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	-	-	1	2	-	-	-	2	3	2	2
CO2	3	3	2	1	1	2	2	-	-	-	2	3	2	2
CO3	3	3	3	1	-	-	2	-	-	-	2	3	2	2
CO4	2	2	3	-	-	2	1	-	-	-	2	3	2	2
CO5	3	3	3	2	1	2	1	-	2	-	2	3	2	2

Syllabus

Unit	Contents
Unit 1	**Introduction to Nuclear Engineering:** Binding Energy, Energy release, Nuclear reactions & its initiation, Fission, Component of nuclear reactors & its material, Numerical based on energy release. Nuclear Reactors: Types of reactors, PWR, BWR, CANDU ,Gas cooled liquid metal cooled, Breeder reactor problems of operation , location of nuclear station, present & proposed nuclear plant in India. Nuclear Waste Disposal: Effects of nuclear waste on environment, its disposal to soil , water air, sea etc. Comparison with other power plants.
Unit 2	**Hydroelectric Power Plant Hydrology :** Rainfall , Runoff, Hydrograph , flow duration curve , mass curve. Hydroelectric power plant : Site selection ,classification of hydroelectric power plant, general arrangement, details of different components prime movers, governing, model & model testing advantages, comparison with other power plant, Micro hydal turbines.
	Steam Power Plant Introduction: Coal – its properties, handling & storage, fuel firing methods ash & dust handling boiler accessories, high pressure boiler, draught system, steam

Syllabus

Unit	Contents
Unit 3	**Steam Power Plant** Introduction: Coal – its properties, handling & storage, fuel firing methods ash & dust handling boiler accessories, high pressure boiler, draught system, steam turbine, condenser, cooling towers. Water treatment, steam pipes, power plant layouts, pollution from steam power plant.
Unit 4	**Gas Turbine Power Plant** Introduction, selection of various components, different arrangement, comparison with other power plant. Diesel Electric Power Plant: Introduction, Outline, type of engines, different components, performance, plant layout comparison with other power plant. Introduction to unconventional power sources – Solar, wind, Tidal, geothermal, MHD, Trigeneration.

Syllabus

Unit	Contents
Unit 5	**Peak load plants,** Automation & Instrumentation: Measurement of water purity, 02, C02 measurement, gas analysis, smoke & dust measurement, moisture measurement, nuclear measurement. Fluctuating Load: Load curves, various terms & definition, effect of fluctuating load. Economic Analysis: Tariffs, load division, and cost of electric energy. Combined Operation: Need, division, combination of different plant &, their coordination advantages. Advance topic on the subject

Study Material

Text Books	1.	1. Domkundwar 'Power Plant Engineering' Dhanpat Rai Publication, New Delhi
	2.	Non-conventional Energy Sources, G. D. Rai, 6th Edition, Khanna Publisher, New Delhi 2014.
	3.	Spera D.A., Wind Turbine Technology: Fundamental Concepts of Wind Turbine Engineering, ASME Press, NY 1994
	4.	Sustainable Building Design Manual. Vol 1 and 2, Teri, New Delhi, 2004. Hill, 2001.
E-Books	1.	Renewable Energy Sources and Emerging Technologies, K.C. Kothari, D. P. Ranjan, Rakesh Singal, 2nd Edition Kindle e-Textbook
	2.	Non-Conventional Energy Resources, SobhNath Singh, Kindle Edition e-Textbook.
Reference Books	1.	1. Vopal & Slortzki, 'Power Plant Engineering'
	2.	P.K. Nag, 'Power Plant Engineering'
	3.	. R.K. Rajput, 'Power Plant Engineering' Laxmi. Publications, New Delhi
	4.	M.M. Wakil, 'Power Plant Engineering' Tata Mc Graw Hills publication

Unit 1

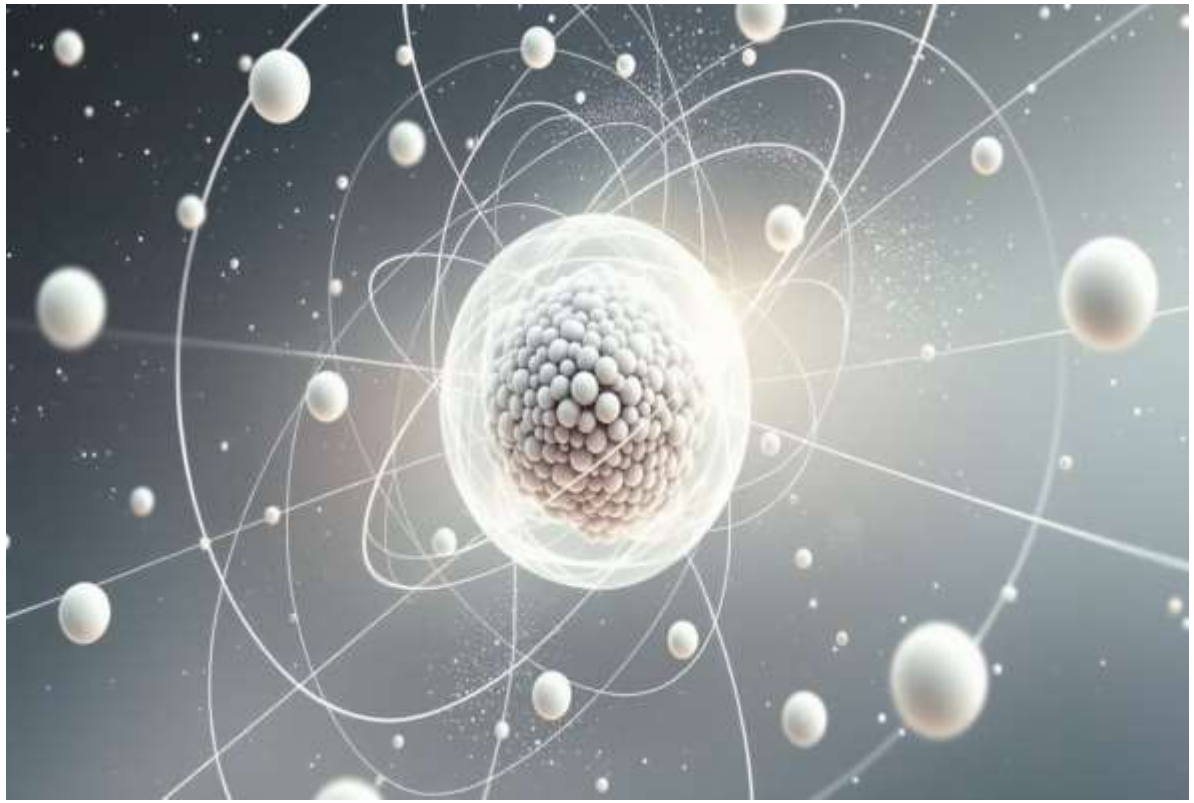
L-01



Introduction to Nuclear Engineering

- Binding Energy, Energy release, Nuclear reactions & its initiation, Fission,
- Component of nuclear reactors & its material, Numerical based on energy release.
- Nuclear Reactors: Types of reactors, PWR, BWR, CANDU ,Gas cooled liquid metal cooled, Breeder reactor problems of operation , location of nuclear station, present & proposed nuclear plant in India.
- Nuclear Waste Disposal: Effects of nuclear waste on environment, its disposal to soil , water air, sea etc. Comparison with other power plants.

The Atom's Core: A Dance of Forces



Within every atom's nucleus, nucleons—protons and neutrons—are held together by the strong nuclear force.

This force is the most powerful of nature's four fundamental forces, yet it operates only over extremely short distances, roughly 10^{-15} metres.

Understanding this force is key to unlocking nuclear energy.

Mass Defect & Energy Release: The He-4 Example

Helium-4, with its 2 protons and 2 neutrons, demonstrates the dramatic energy-mass relationship:

01

Total nucleon mass

Combined mass of separate nucleons: ~4.03188 atomic mass units (amu)

02

Measured He-4 mass

Actcual mass of bound nucleus: ~4.00c153 amu

03

Mass defect

Difference: ~0.03035 amu (missing mass converted to energy)

04

Binding Energy

Result: ~28.3 MeV (millions of electron volts)—approximately 2 million times greater than electron binding energies in atoms!

L-02

Binding Energy

Definition

The minimum energy required to break a nucleus apart into its individual nucleons.

Formation Energy

Equivalently, it's the energy released when nucleons combine to form a stable nucleus.

Mass Defect

This energy corresponds to the **mass defect**—the nucleus is measurably lighter than the sum of its parts, governed by Einstein's $E=mc^2$.



L-02

Binding Energy Per Nucleon: Stability's Curve

Peak at Iron

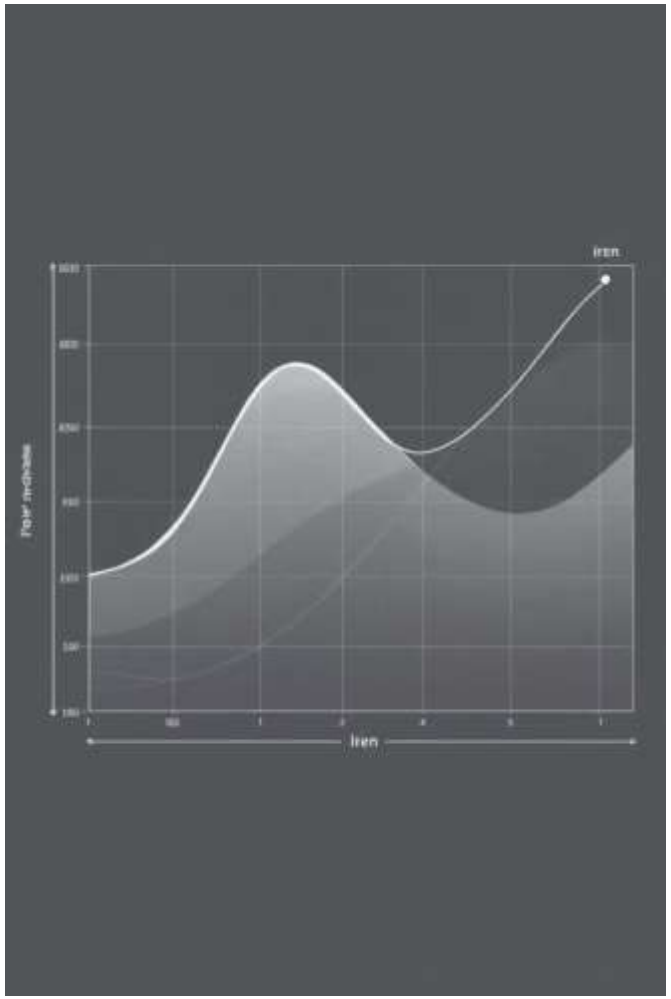
The BE/A curve reveals that nuclei around Iron-56 (A=56) represent the most stable configuration in nature.

Fusion Path

Lighter nuclei below iron release energy by **fusion**—joining together to form more stable, heavier nuclei.

Fission Path

Heavier nuclei beyond iron release energy through **fission**—splitting into lighter, more stable fragments.



L-02

Nuclear Reactions: Initiation and Energy Release

Nuclear Transformation

Changes occur within the atomic nucleus itself, unlike chemical reactions that involve electrons.

Particle Bombardment

Reactions initiate when a nucleus is struck by particles such as neutrons, protons, or alpha particles.

Energy Exchange

Exothermic reactions release tremendous energy; endothermic reactions require energy input to proceed.



L-03

Fission Products & Energy

Product Nuclei

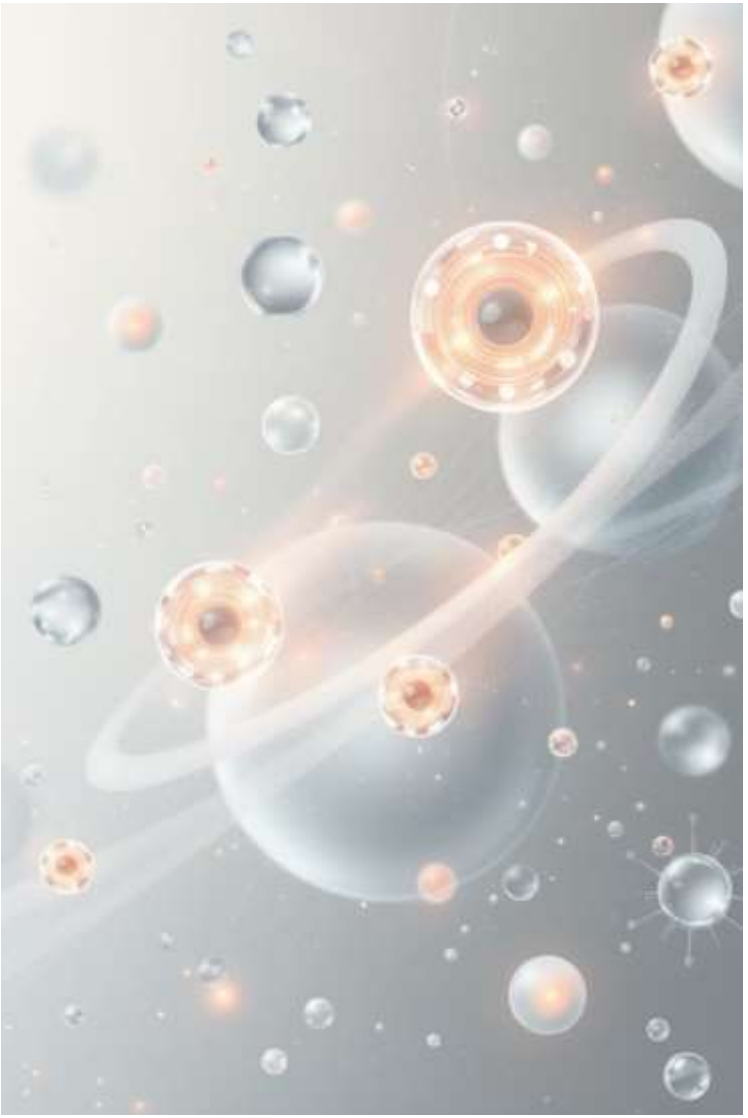
Lighter nuclei such as Barium-141 and Krypton-92 emerge from fission, called fission products.

Increased Binding

These products have greater total binding energy than the original heavy nucleus.

Energy Release

The binding energy difference converts to kinetic energy, heat, and radiation—harnessable power.



L-03

Nuclear Fission: Splitting the Atom

A heavy nucleus, such as Uranium-235, undergoes fission when it absorbs a neutron, splitting into two or more lighter nuclei.

- Triggered by neutron absorption (often "slow" or "thermal" neutrons)
- Releases enormous kinetic energy in the fragments
- Emits intense gamma rays
- Produces additional neutrons that can sustain chain reactions

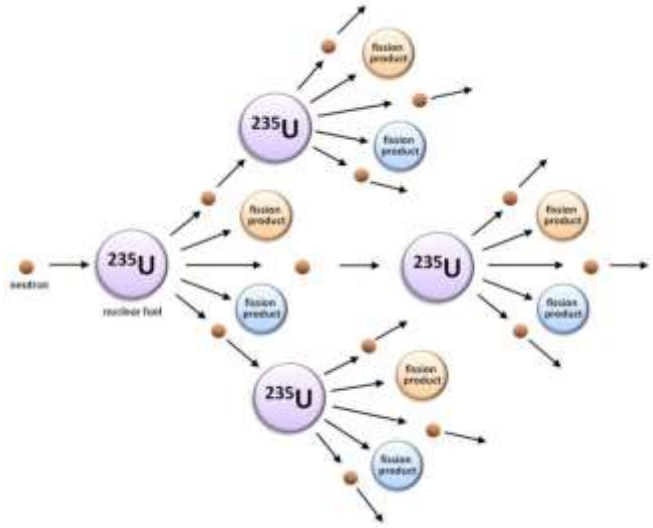


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The Fission of Uranium-235: A Chain Reaction

Neutron Capture

A U-235 nucleus absorbs a slow neutron, becoming unstable U-236.

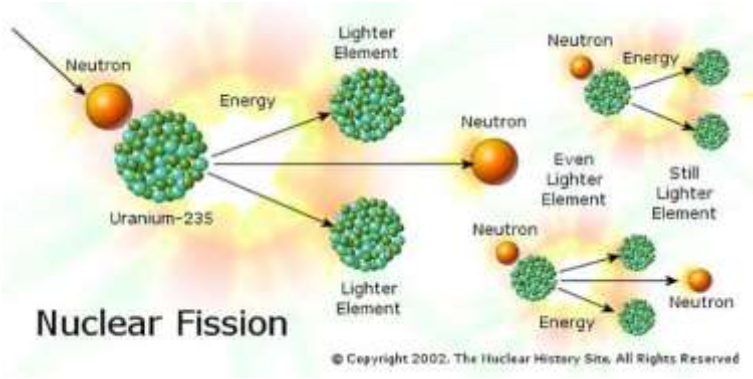


Fission Event

U-236 splits into lighter fragments, releasing over 200 MeV of energy—over 200 million times the energy of the triggering neutron.

Chain Reaction

Released neutrons trigger subsequent fissions in nearby U-235 nuclei, creating a self-sustaining chain reaction.



Energy Applications

Controlled chain reactions power nuclear reactors; uncontrolled reactions form the basis of nuclear weapons.

L-04

The Power of the Nucleus



Harnessing Immense Forces

Nuclear engineering transforms our understanding of binding energy and fission into practical energy generation.

From fundamental physics to controlled chain reactions, we unlock energy potential millions of times greater than chemical processes.

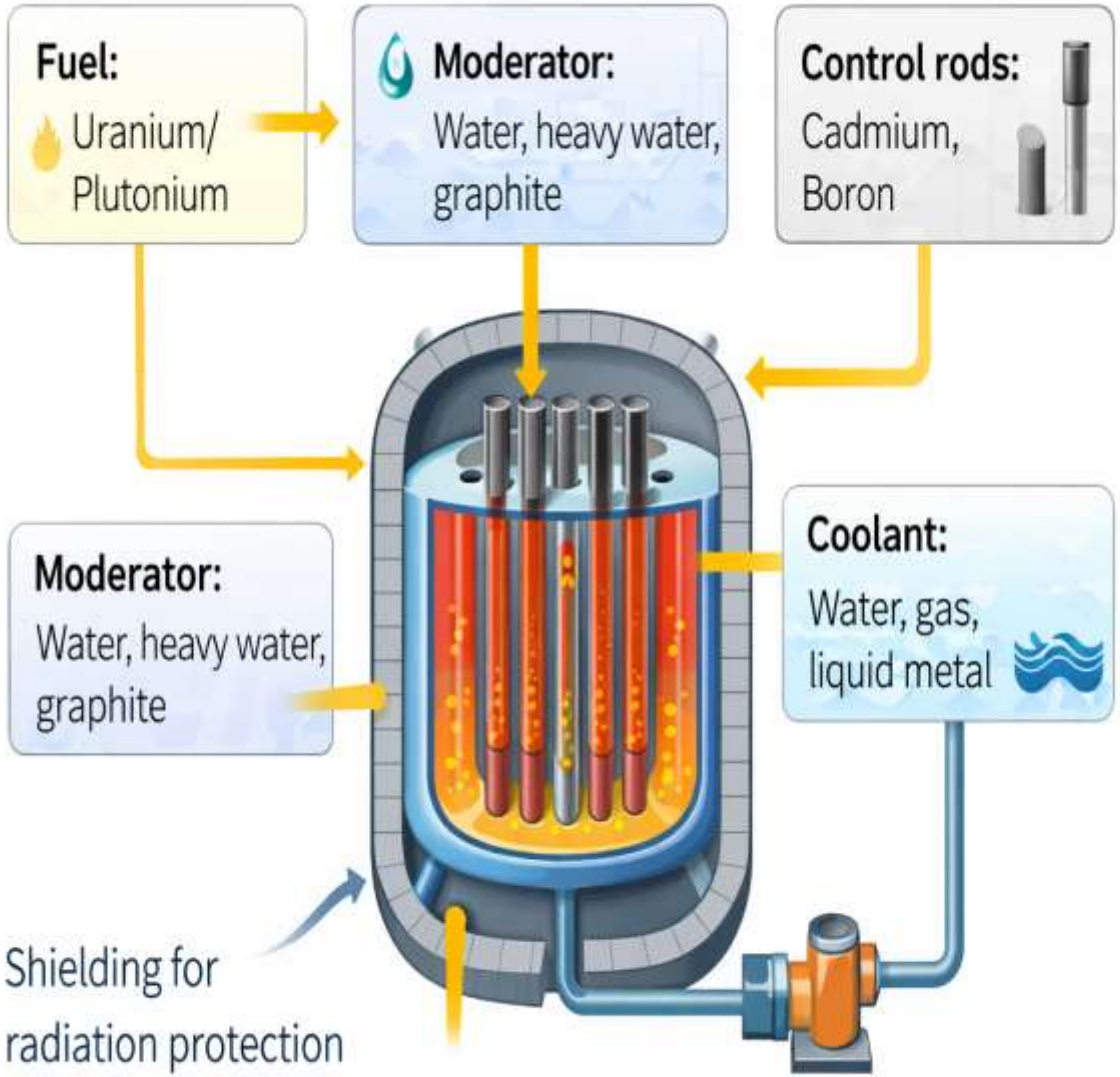
The atomic nucleus: where immense power awaits responsible stewardship.

Introduction to Nuclear Reactors

- Device to control nuclear chain reactions
- Produces heat from nuclear fission
- Steam drives turbines to generate electricity
- Fuel: Uranium-235, Plutonium-239

Basic Compone

- Fuel: Uranium/Plutonium
- Moderator: Water, heavy water, graphite
- Control rods: Cadmium, Boron
- Coolant: Water, gas, liquid metal
- Shielding for radiation protection



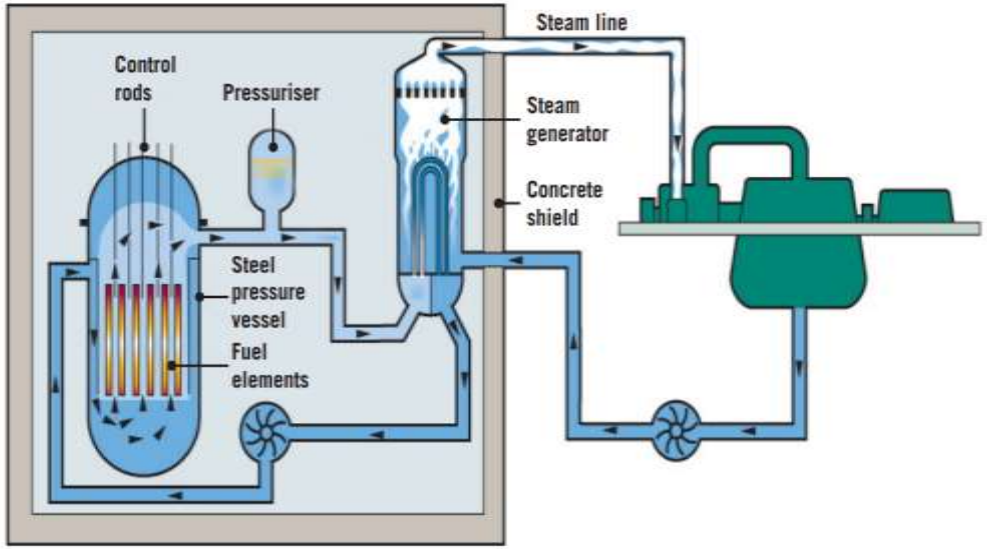
Types of Nuclear Reactors

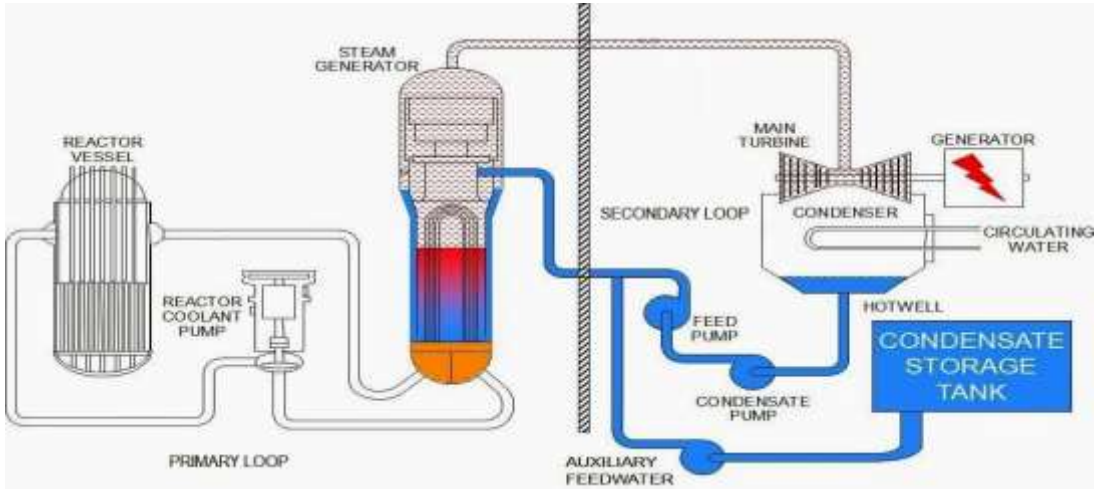
- Pressurized Water Reactor (PWR)
- Boiling Water Reactor (BWR)
- CANDU Reactor
- Gas-Cooled Reactor
- Liquid Metal Cooled Reactor
- Breeder Reactor

L-05

Pressurized Water Reactor (PWR)

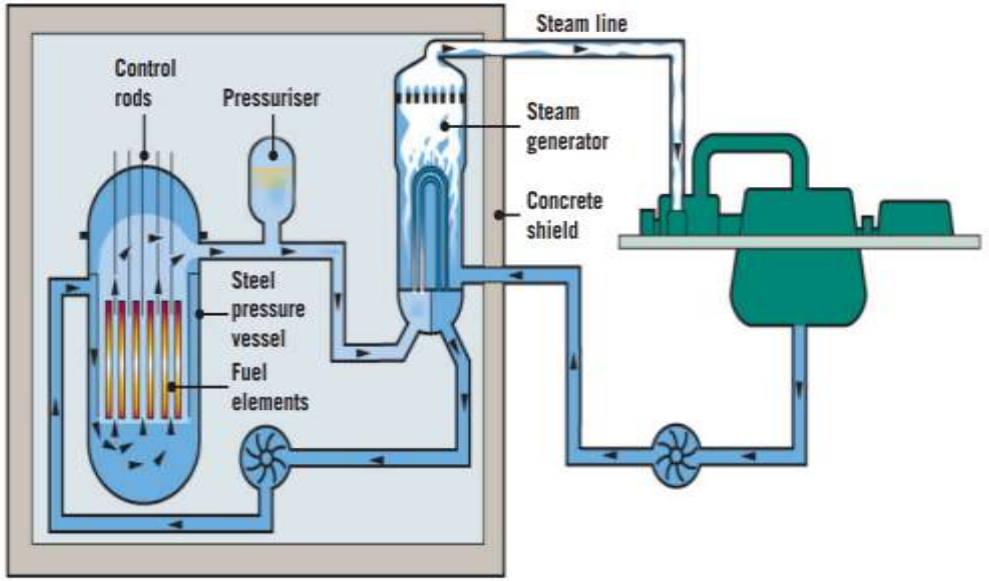
- Uses water as coolant and moderator
- Water under high pressure
- Heat transferred to secondary loop
- Advantages: Stable, safe
- Disadvantages: High pressure required





Pressurized Water Reactor (PWR)

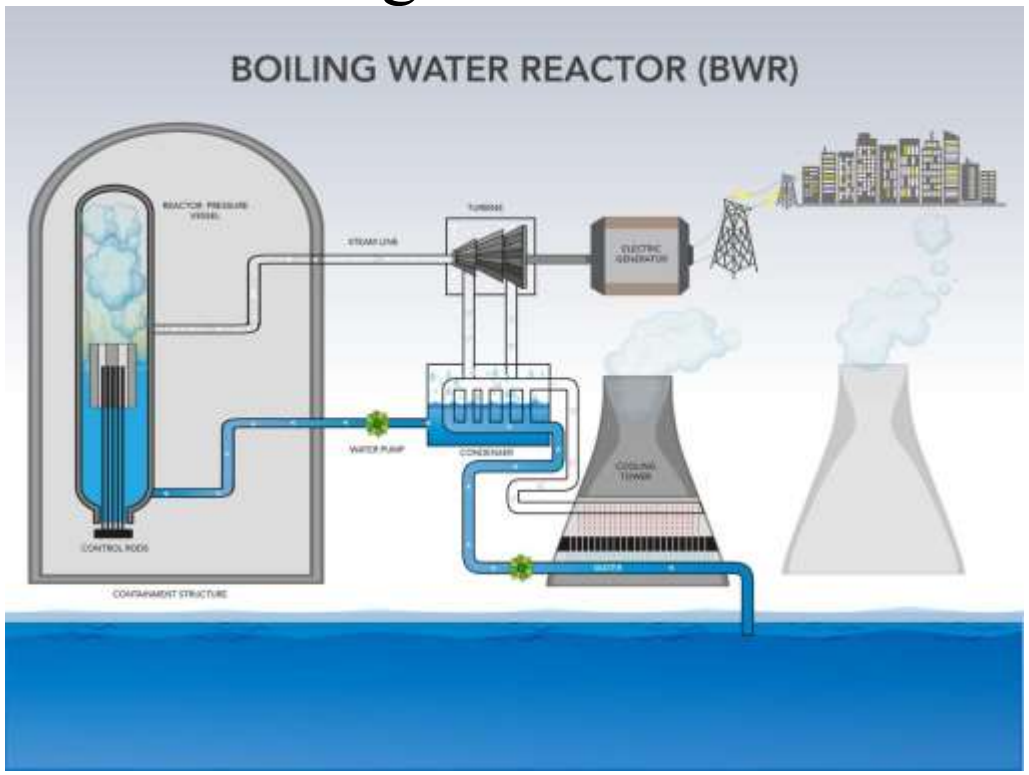
- By moving to greater levels of enrichment of U235, it is possible to tolerate a greater level of neutron absorption in the core (that is, absorption by non-fissile, non-fertile materials) and thus use ordinary water as both a moderator and a coolant.
- The two commercial reactor types based on this principle are both American designs, but are widely used in over 20 countries.

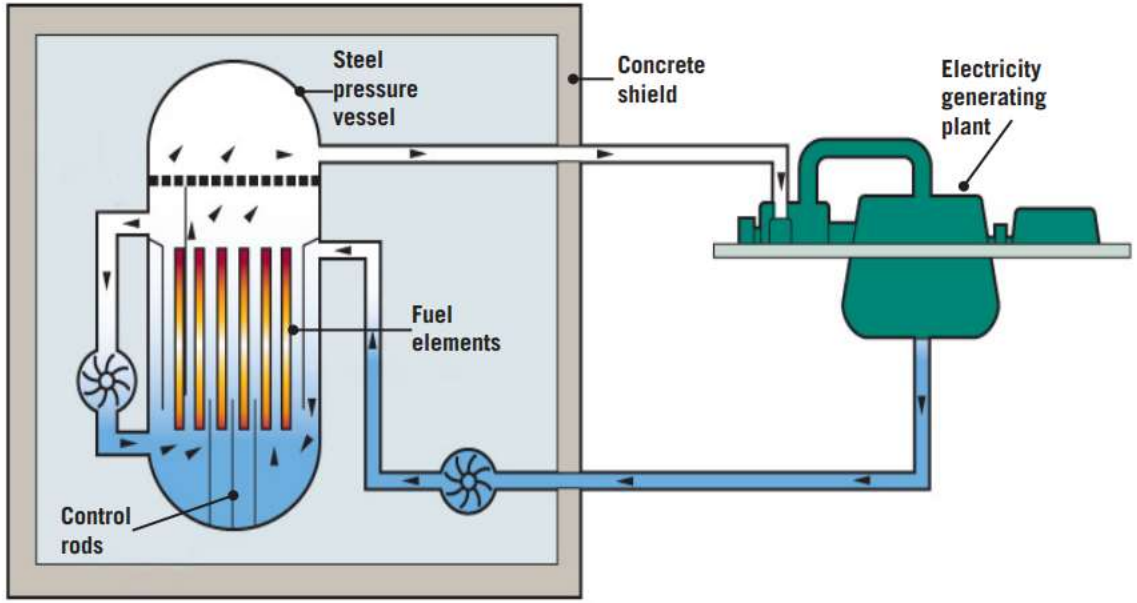


L-05

Boiling Water Reactor (BWR)

- Water boils inside reactor core
- Steam directly drives turbine
- Advantages: Simple design
- Disadvantages: Radioactive steam

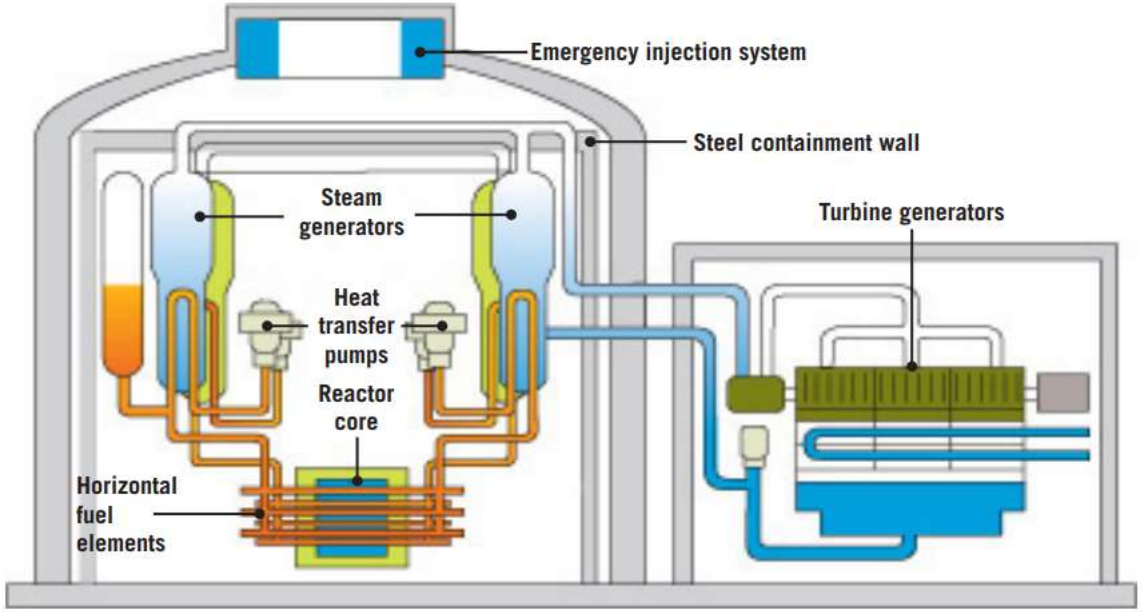


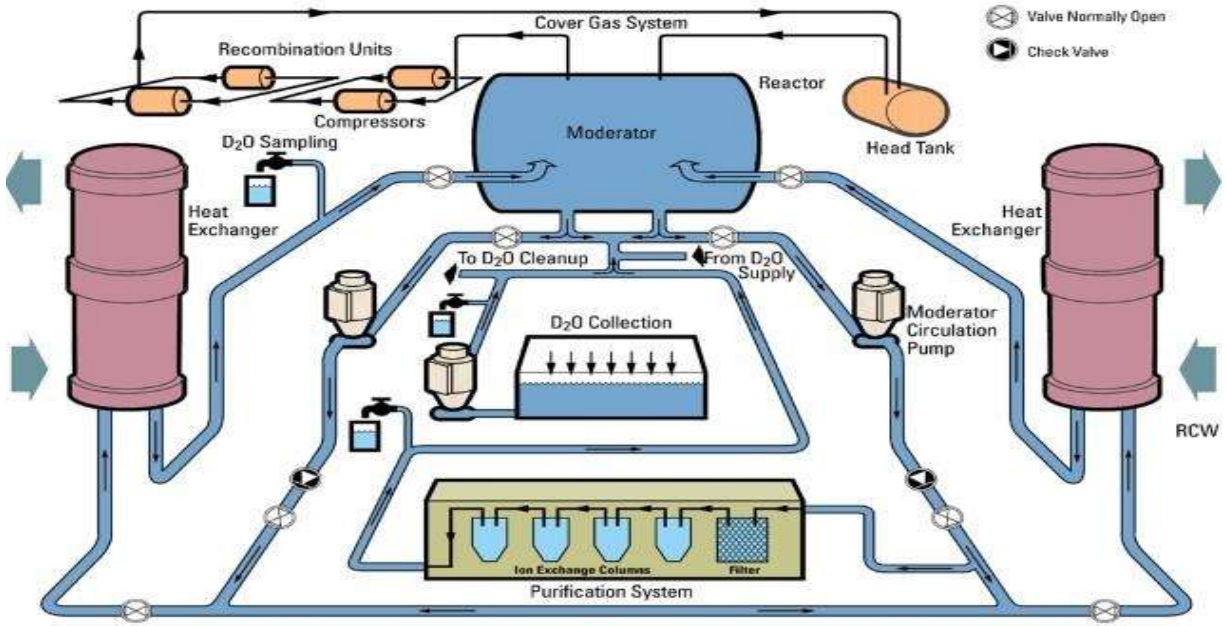


L-06

CANDU Reactor

- Uses heavy water (D2O)
- Uses natural uranium fuel
- Online refueling possible
- Advantages: No enrichment needed
- Disadvantages: Heavy water costly

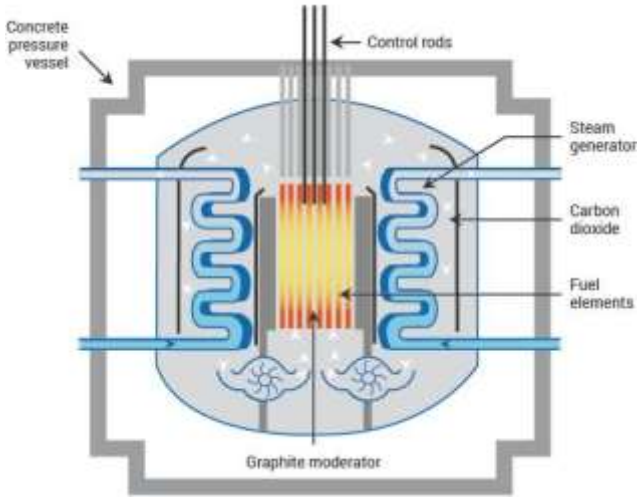




L-06

Gas & Liquid Metal Reactors

- Gas-cooled: CO2 or helium, graphite moderator
- High efficiency
- Liquid metal cooled: Sodium/lead coolant
- High heat transfer
- Used in fast reactors



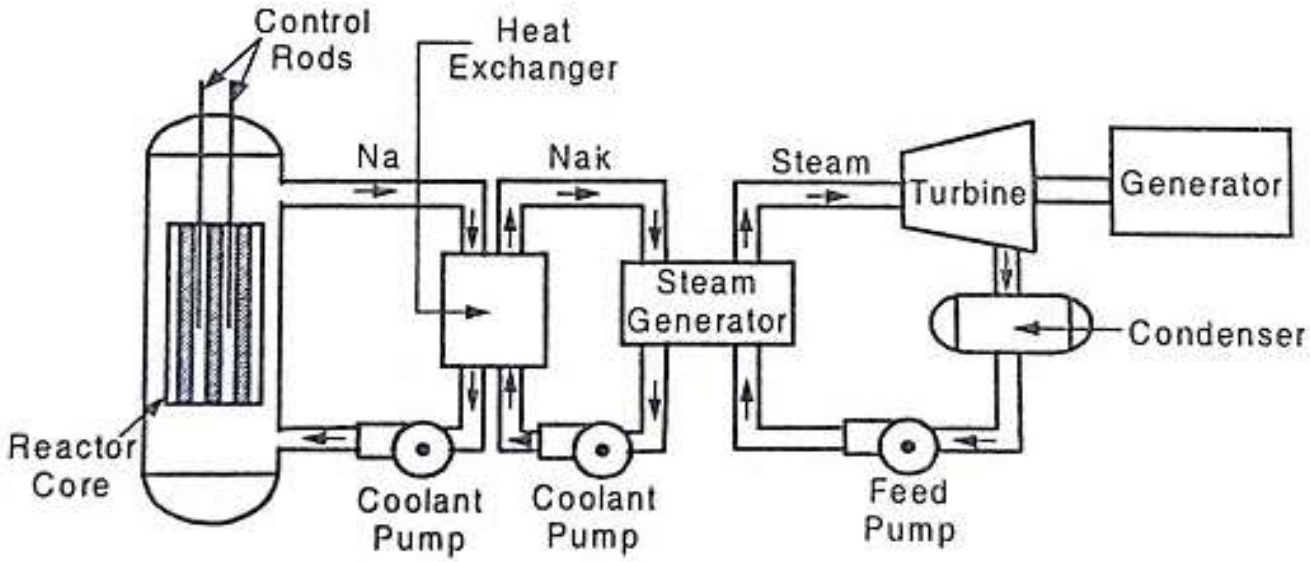
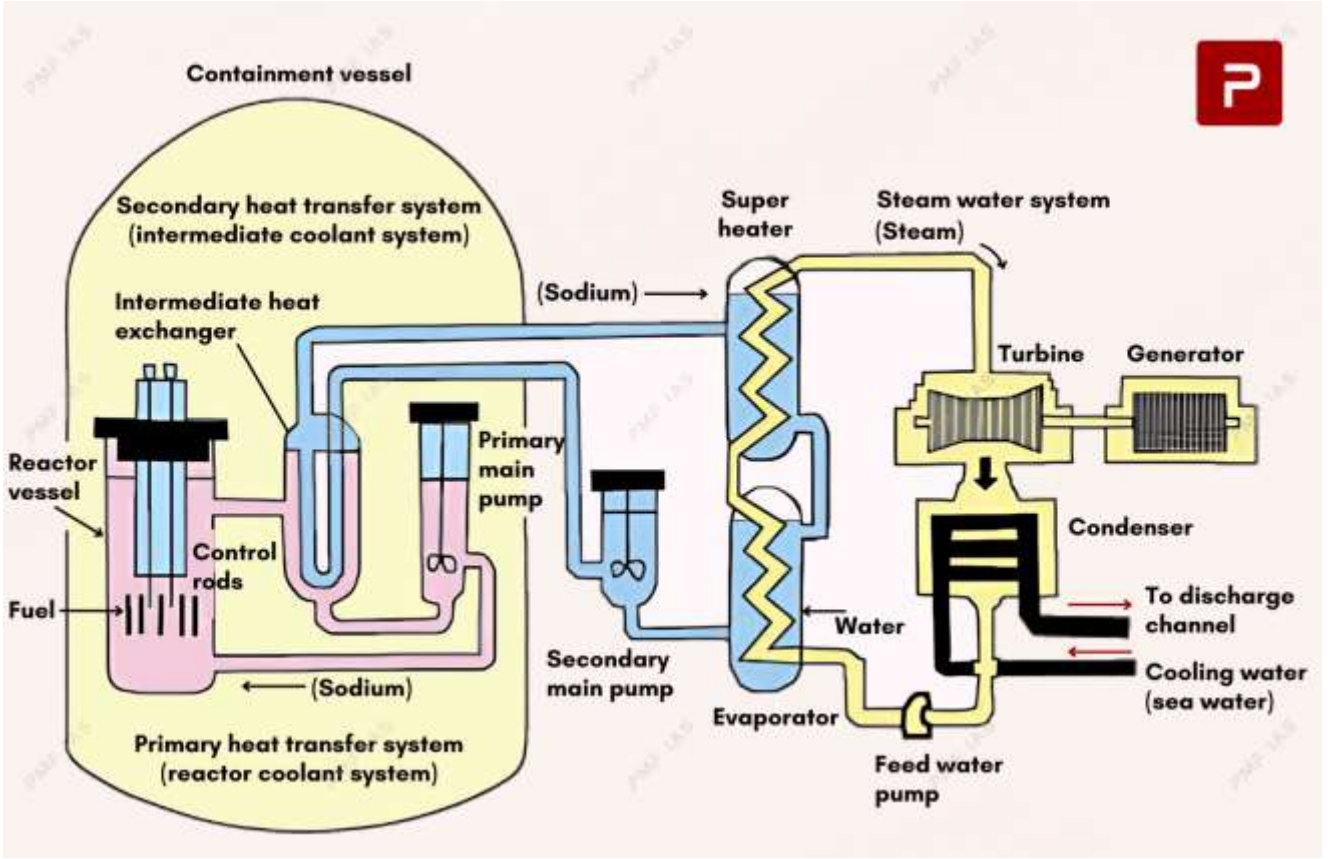


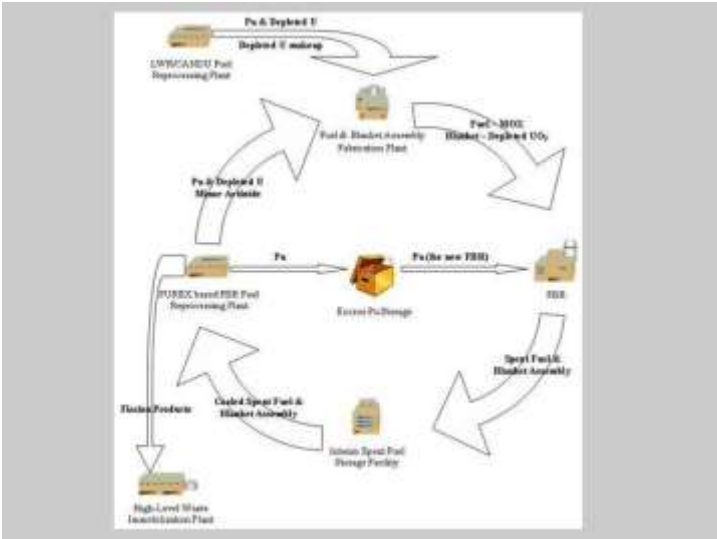
Fig:3.12 Liquid Metal Cooled Reactor

L-06

Breeder Reactor

- Produces more fuel than it consumes
- Converts U-238 to Pu-239
- Uses fast neutrons
- Efficient fuel use
- Complex and safety challenges

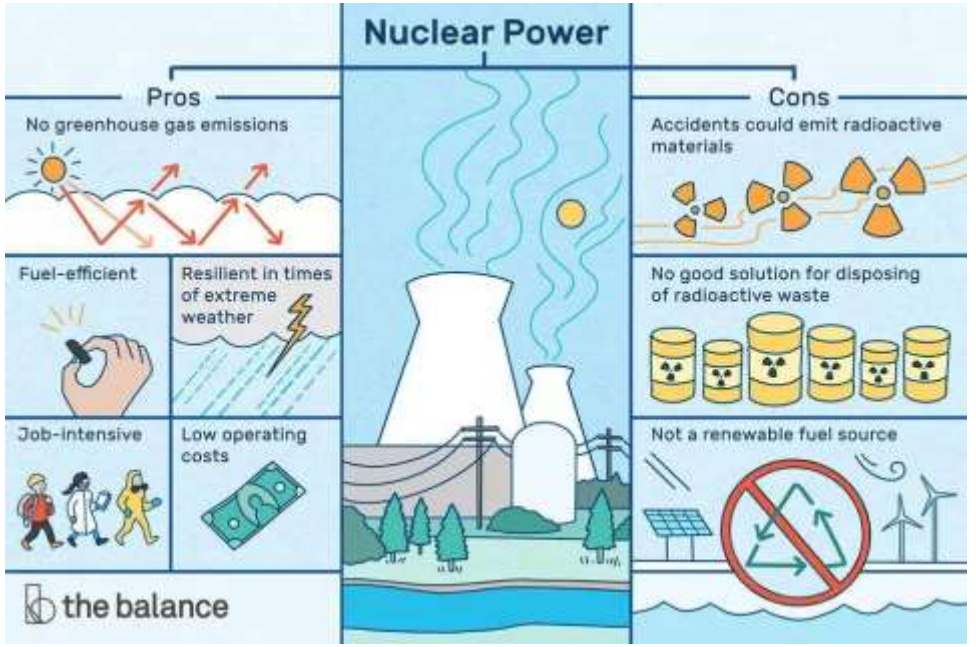


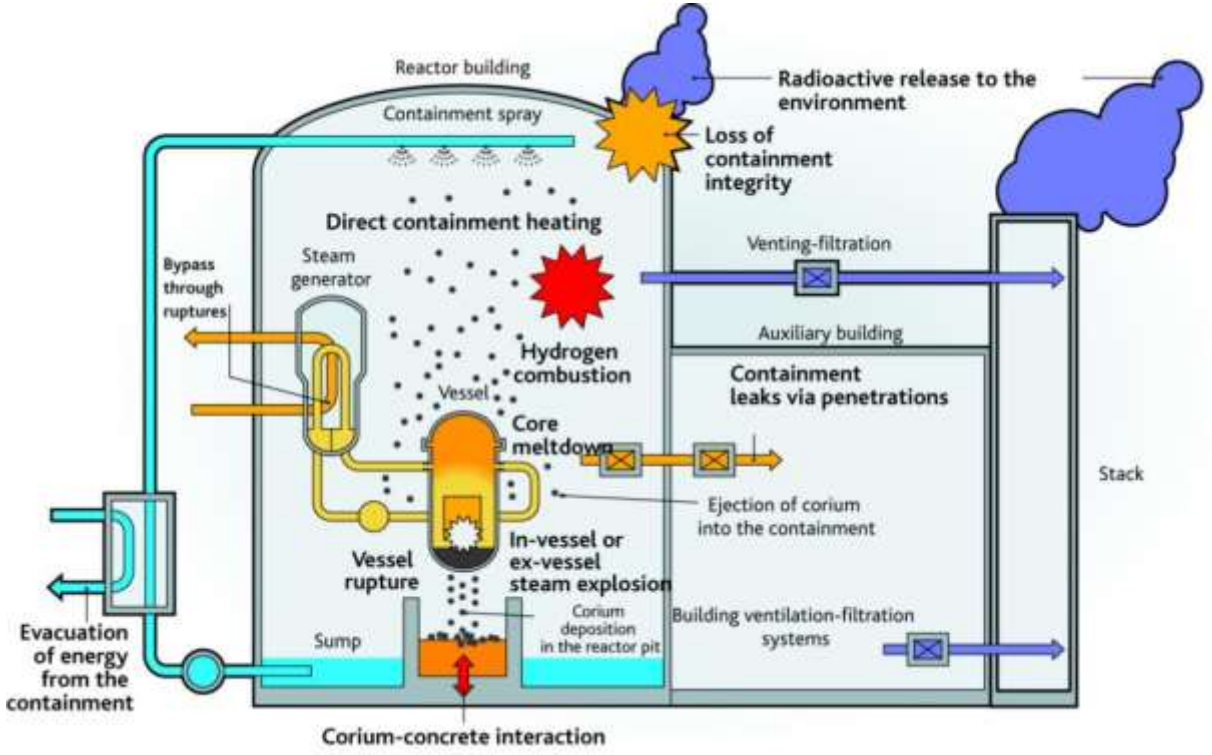


L-06

Operational Problems

- Radiation hazards
- Nuclear waste disposal
- High initial cost
- Risk of meltdown
- Material degradation
- Safety regulations





Unit 2

L-07

Introduction to Hydroelectric Power Plant

- Converts water energy into electrical energy
- Uses potential energy of stored water
- Clean and renewable source
- Main parts: Dam, turbine, generator



L-07

Hydrology in Hydropower

- Study of water availability
- Essential for plant design
- Helps in reservoir planning
- Predicts seasonal variations

L-07

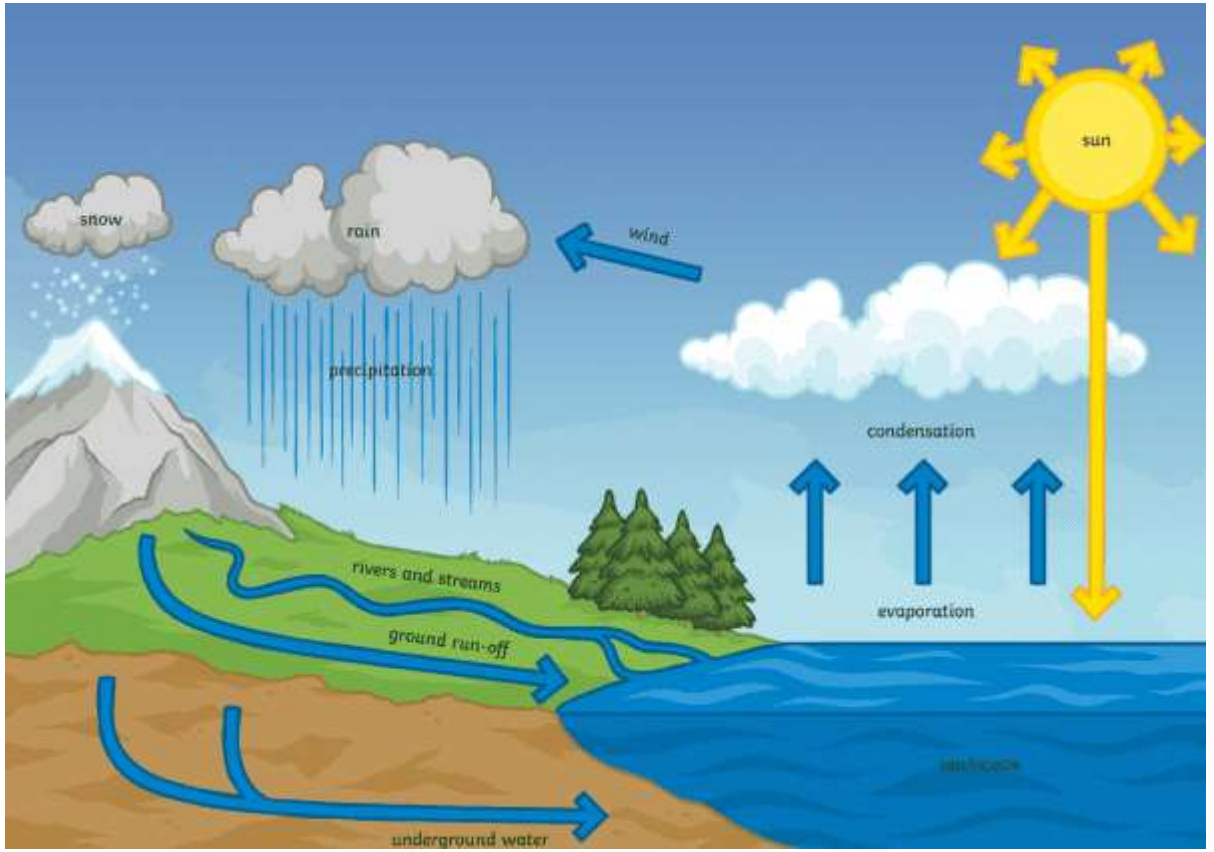
Rainfall

- Primary source of water
- Measured using rain gauges
- Types: Convective, Orographic, Cyclonic
- Affects water availability

L-08

Runoff

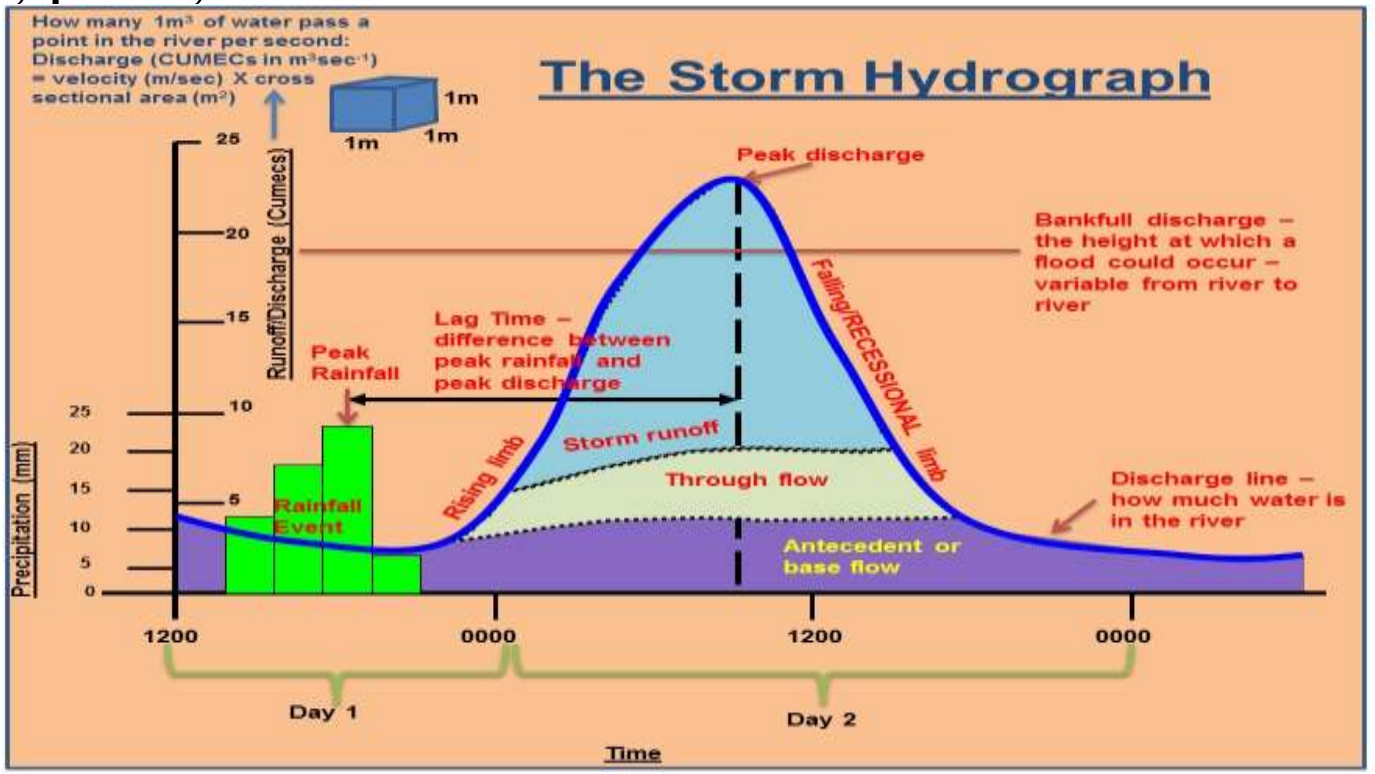
- Portion of rainfall flowing to rivers
- Depends on soil, slope, vegetation
- Types: Surface, subsurface
- Important for power estimation



L-08

Hydrograph

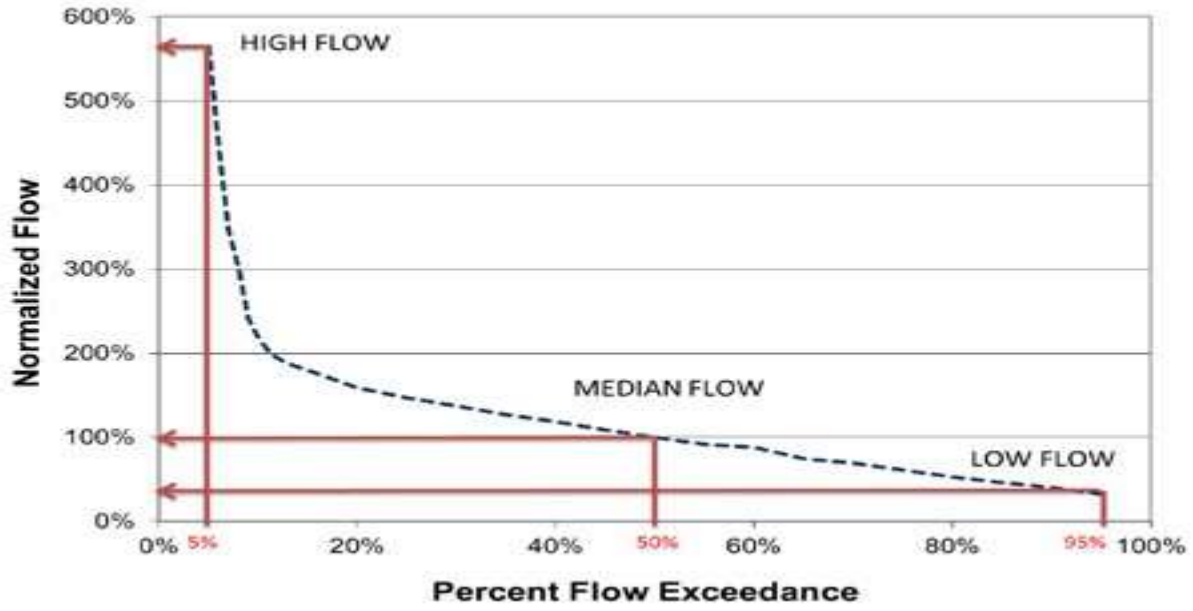
- Graph of discharge vs time
- Shows variation of river flow
- Key components: Rising limb, peak, recession
- Used for flood analysis



L-08

Flow Duration Curve

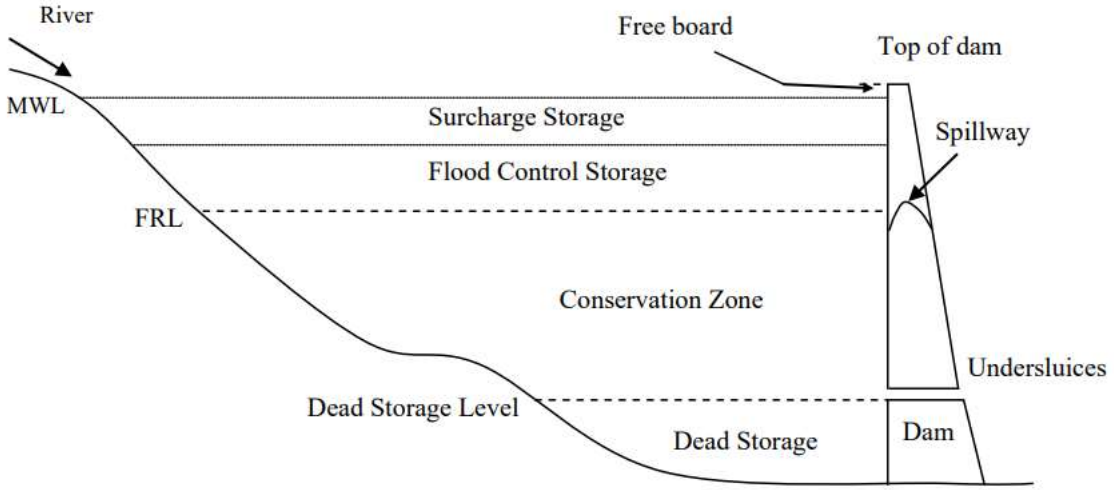
- Shows percentage of time flow is exceeded
- Used for power potential analysis
- Helps in turbine selection
- Indicates reliability of water supply



L-09

Mass Curve

- Cumulative flow vs time graph
- Used for reservoir capacity design
- Helps in storage estimation
- Important for dam planning

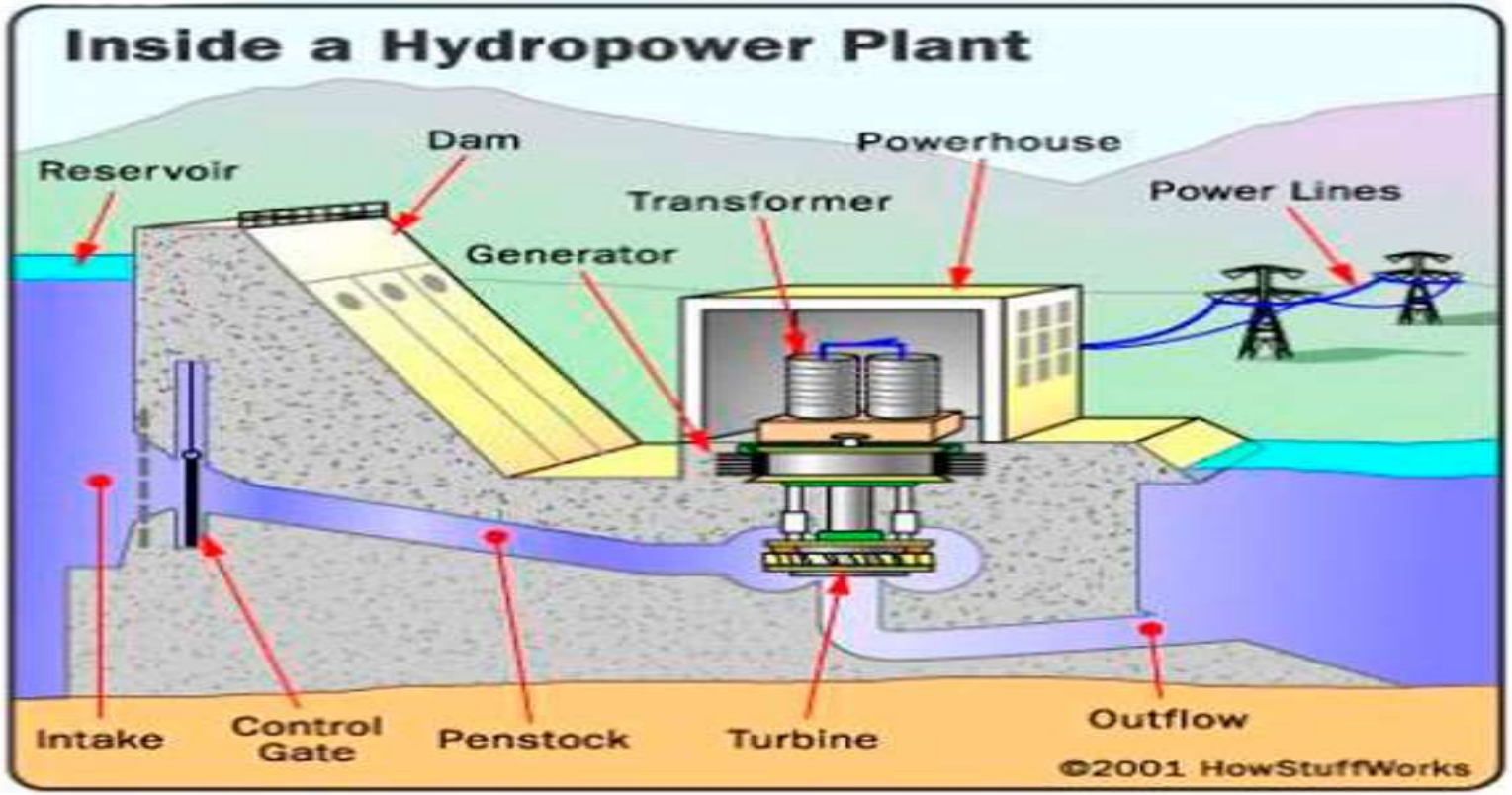


FRL: Full reservoir level
MWL: Maximum water level

Fig. 1.1 Schematic diagram of a reservoir showing the various storage zones.

Components of Hydroelectric Plant

- Dam and reservoir
- Penstock
- Turbine
- Generator
- Powerhouse



Advantages & Limitations

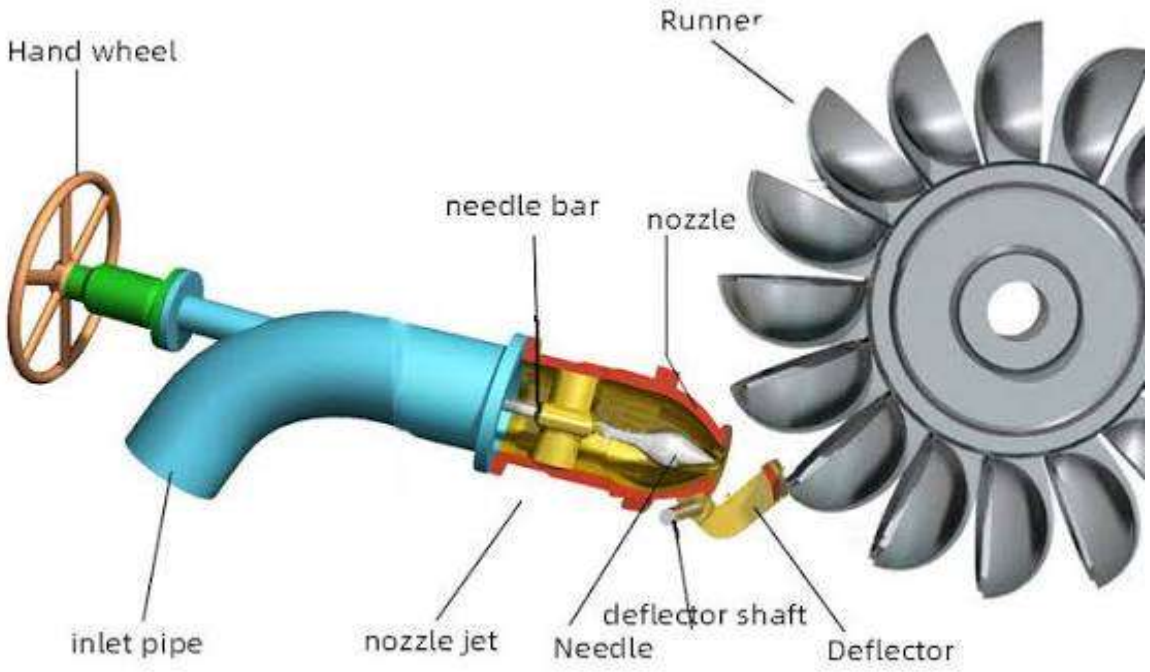
- Advantages: Renewable, low pollution, low operating cost
- Limitations: High initial cost
- Depends on rainfall
- Environmental and social impact

Impulse Turbines

- The impulse turbine generally uses the velocity of the water to move the runner – or turbine blades - and discharges to atmospheric pressure.
- The water stream hits each bucket on the runner.
- There is no suction on the down side of the turbine, and the water flows out the bottom of the turbine housing after hitting the runner.
- An impulse turbine is generally suitable for high head, low flow applications.
- Examples of impulse turbines include Pelton turbines, Turgo Turbines, and Cross-Flow Turbines.

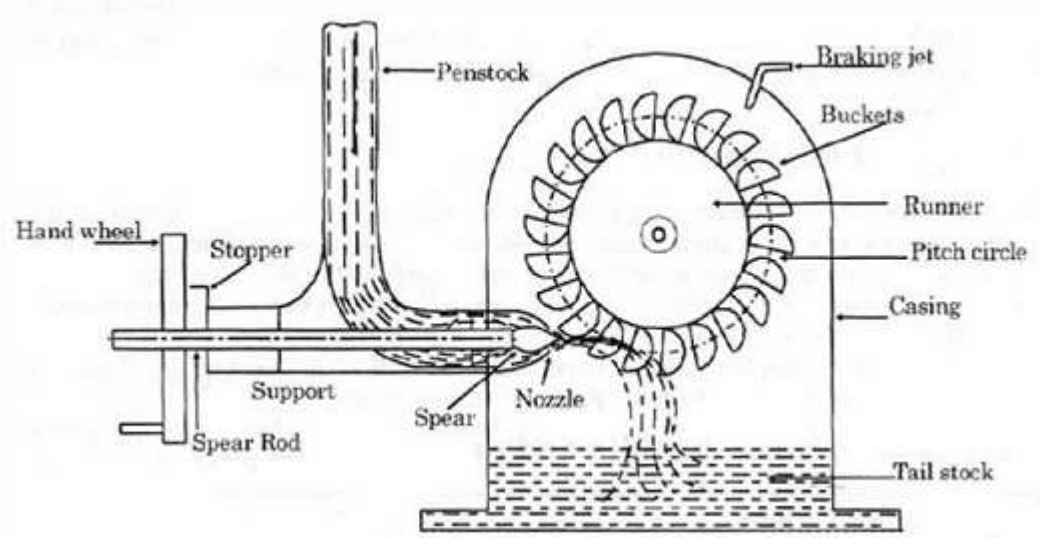
Pelton Turbine

- A Pelton wheel has one or more free jets discharging water into an aerated space and impinging on the buckets of a runner.
- Draft tubes are not required for impulse turbine since the runner must be located above the maximum tailwater to permit operation at atmospheric pressure.



Pelton Turbine

- With a Pelton turbine one or more jets impinge on a wheel carrying on its periphery a large number of buckets.
- Each jet issues through a nozzle with a needle valve to control the flow. They are only used for relatively high heads.
- The axes of the nozzles are in the plane of the runner



Pelton Turbine

- To stop the turbine - e.g. when the turbine approaches the runaway speed due to load rejection- the jet may be deflected by a plate so that it does not impinge on the buckets.
- In this way the needle valve can be closed very slowly, so that overpressure surge in the pipeline is kept to an acceptable minimum. Any kinetic energy leaving the runner is lost and so the buckets are designed to keep exit velocities to a minimum.
- The turbine casing only needs to protect the surroundings against water splashing and therefore can be very light.

Turgo Turbine

- Turgor Turbine A Turgo Wheel is a variation on the Pelton.
- The Turgo runner is a cast wheel whose shape generally resembles a fan blade that is closed on the outer edges.
- The water stream is applied on one side, goes across the blades and exits on the other side.

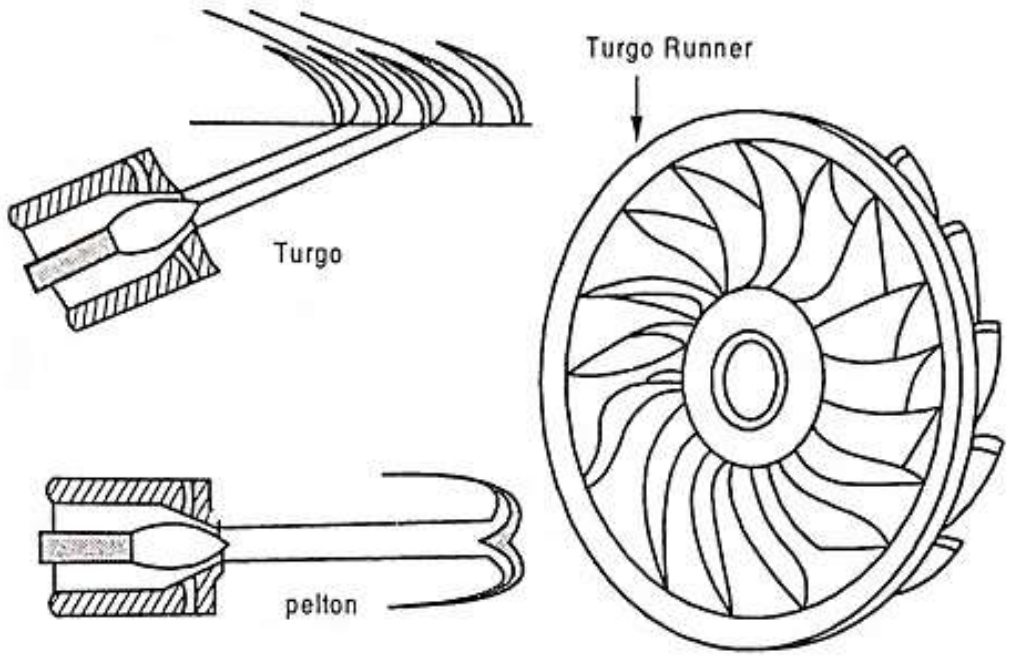
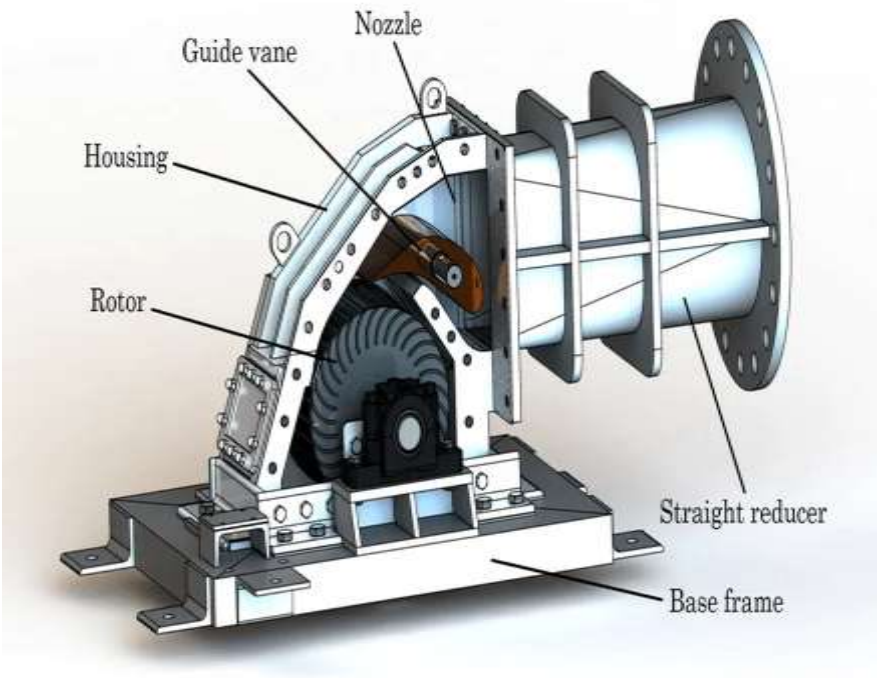


Fig. 4.27 Turgo turbines

Cross Flow

- Cross-Flow A cross-flow turbine is drum-shaped and uses an elongated, rectangular-section nozzle directed against curved vanes on a cylindrically shaped runner.
- It resembles a "squirrel cage" blower. The cross-flow turbine allows the water to flow through the blades twice.
- The first pass is when the water flows from the outside of the blades to the inside; the second pass is from the inside back out.
- A guide vane at the entrance to the turbine directs the flow to a limited portion of the runner



Reaction Turbines

- A reaction turbine develops power from the combined action of pressure and moving water.
- The runner is placed directly in the water stream flowing over the blades rather than striking each individually.
- Reaction turbines are generally used for sites with lower head and higher flows than compared with the impulse turbines.
- The three main types of reaction turbines are propellers, Francis, and Kinetic turbines.

Table 1
Turbine Selection

Turbine Style	Type	Head Range (Feet)
Reaction	Kaplan	6 – 125
Reaction	Francis	30 – 375
Impulse	Pelton	150 – 5,000
Impulse	Cross-Flow	9 – 750
Impulse	Turgo	50 – 750

Reaction Turbines

- Propeller: A propeller turbine generally has a runner with three to six blades in which the water contacts all of the blades constantly. Picture a boat propeller running in a pipe.
- Through the pipe, the pressure is constant; if it isn't, the runner would be out of balance.
- The pitch of the blades may be fixed or adjustable.
- The major components besides the runner are a scroll case, wicket gates, and a draft tube.
- There are several different types of propeller turbines:
- **Bulb turbine**. The turbine and generator are a sealed unit placed directly in the water stream. o Straflo. The generator is attached directly to the perimeter of the turbine. o Tube turbine. The penstock bends just before or after the runner, allowing a straight line connection to the generator turbi

Reaction Turbines

There are several different types of propeller turbines:

- **Bulb turbine**: The turbine and generator are a sealed unit placed directly in the water stream.
- **Straflo**: The generator is attached directly to the perimeter of the turbine.
- **Tube turbine :** The penstock bends just before or after the runner, allowing a straight line connection to the generator turbi



Reaction Turbines

Kaplan.

- Kaplan turbines are axialflow reaction turbines, generally used for low heads.
- Large Kaplan turbines have adjustable runner blades and may or may not have adjustable guide-vanes.
- If both blades and guide-vanes are adjustable it is described as "double-regulated".
- If the guide-vanes are fixed it is "single-regulated".
- Unregulated propeller turbines are used when both flow and head remain practically constant, and are most common in micro-hydro applications.

Reaction Turbines

Francis:

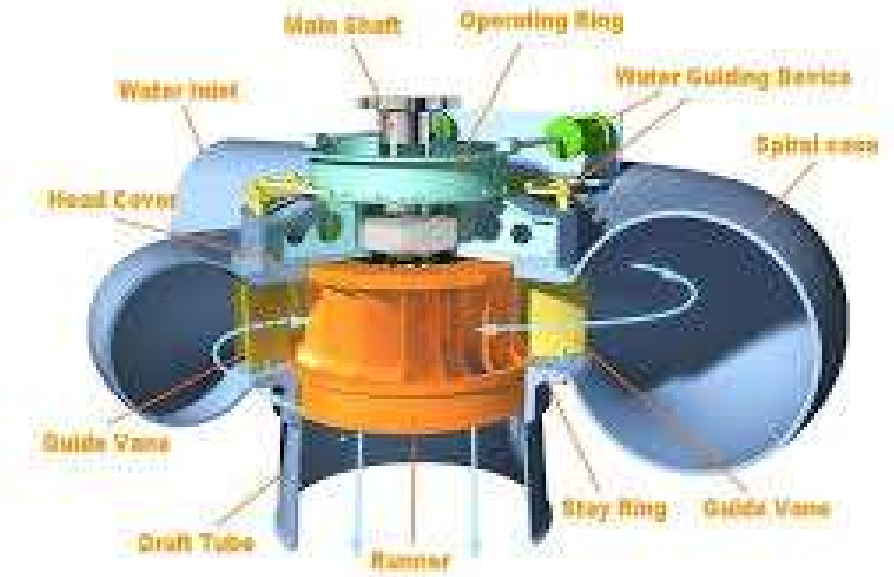
- A Francis turbine has a runner with fixed buckets or vanes.
- Water is introduced just above the runner and all around it and then falls through, causing it to spin.
- Francis turbines are radial flow reaction turbines, with fixed runner blades and adjustable guide vanes, used for medium heads.



Reaction Turbines

Francis:

- In the high speed Francis the admission is always radial but the outlet is axial.
- Francis turbines can be set in an open flume or attached to a penstock. For small heads and power open flumes are commonly employed. Steel spiral casings are used for higher heads, designing the



Francis Turbine

Reaction Turbines

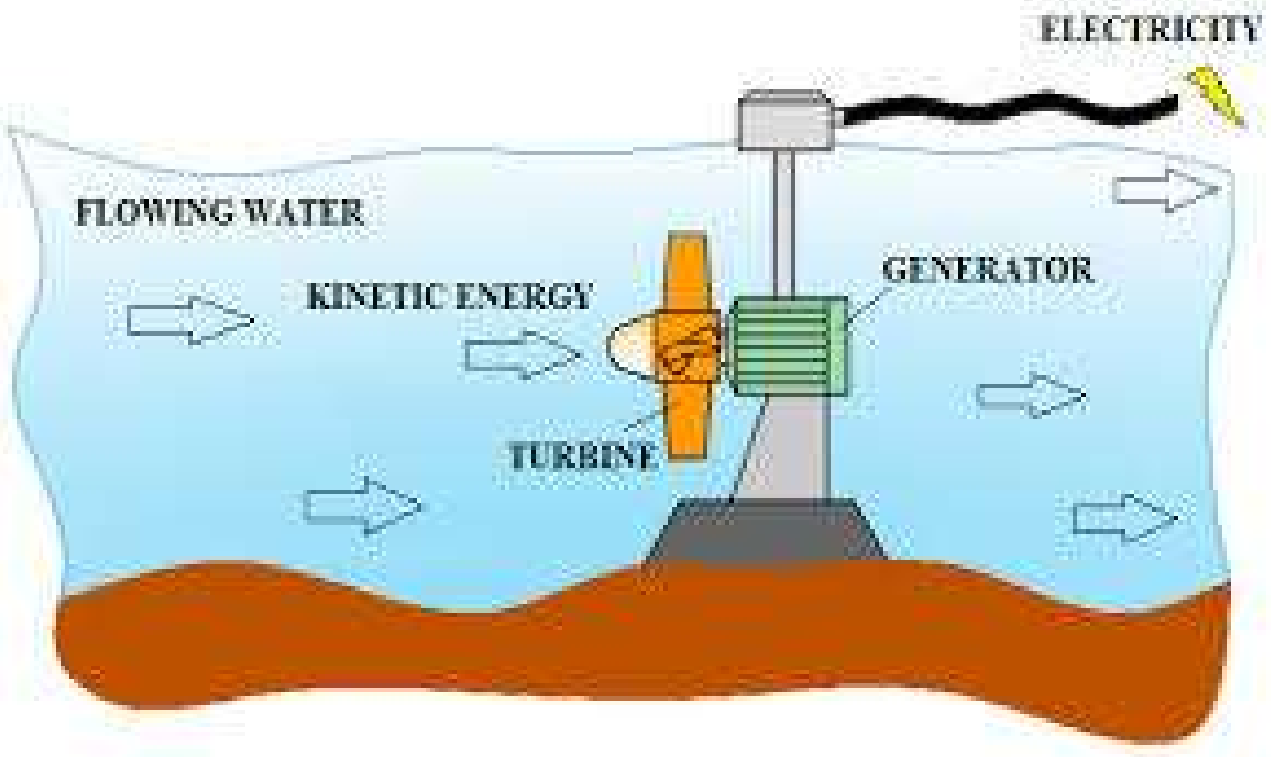
Francis:

- Francis turbines can be set in an open flume or attached to a penstock. For small heads and power open flumes are commonly employed.
- Steel spiral casings are used for higher heads, designing the casing so that the tangential velocity of the water is constant along the consecutive sections around the circumference.
- Small runners are usually made in aluminum bronze castings.
- Large runners are fabricated from curved stainless steel plates, welded to a cast steel hub.
- Besides the runner, the other major components are the scroll case, wicket gates, and draft tube.

Reaction Turbines

Kinetic Turbine :

- Kinetic energy turbines, also called free-flow turbines, generate electricity from the kinetic energy present in flowin water rather than the potential energy from the head.
- The systems may operate in rivers, man-made channels, tida waters, or ocean currents.

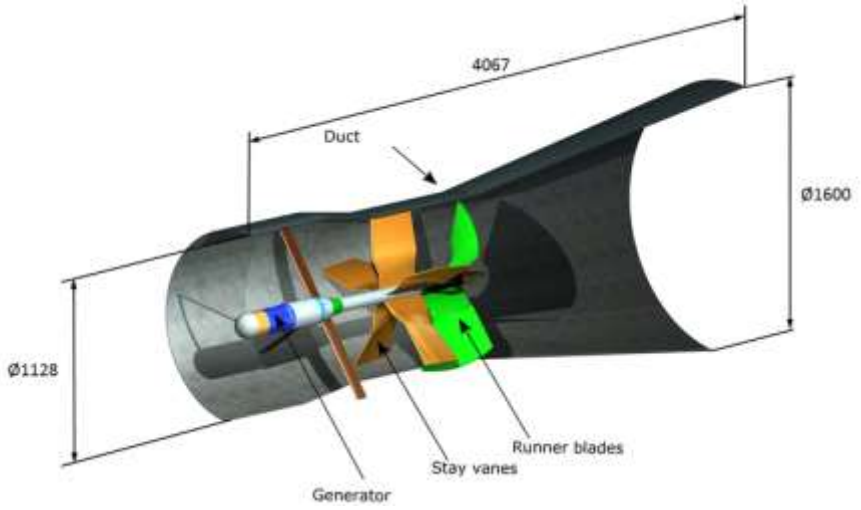


Reaction Turbines

Kinetic Turbine :

- Kinetic systems utilize the water stream's natural pathway. They do not require the diversion of water through manmade channels, riverbeds, or pipes, although they might have applications in such conduits.
- Kinetic systems do not require large civil works; however, they can use existing structures such as bridges, tailraces and channels

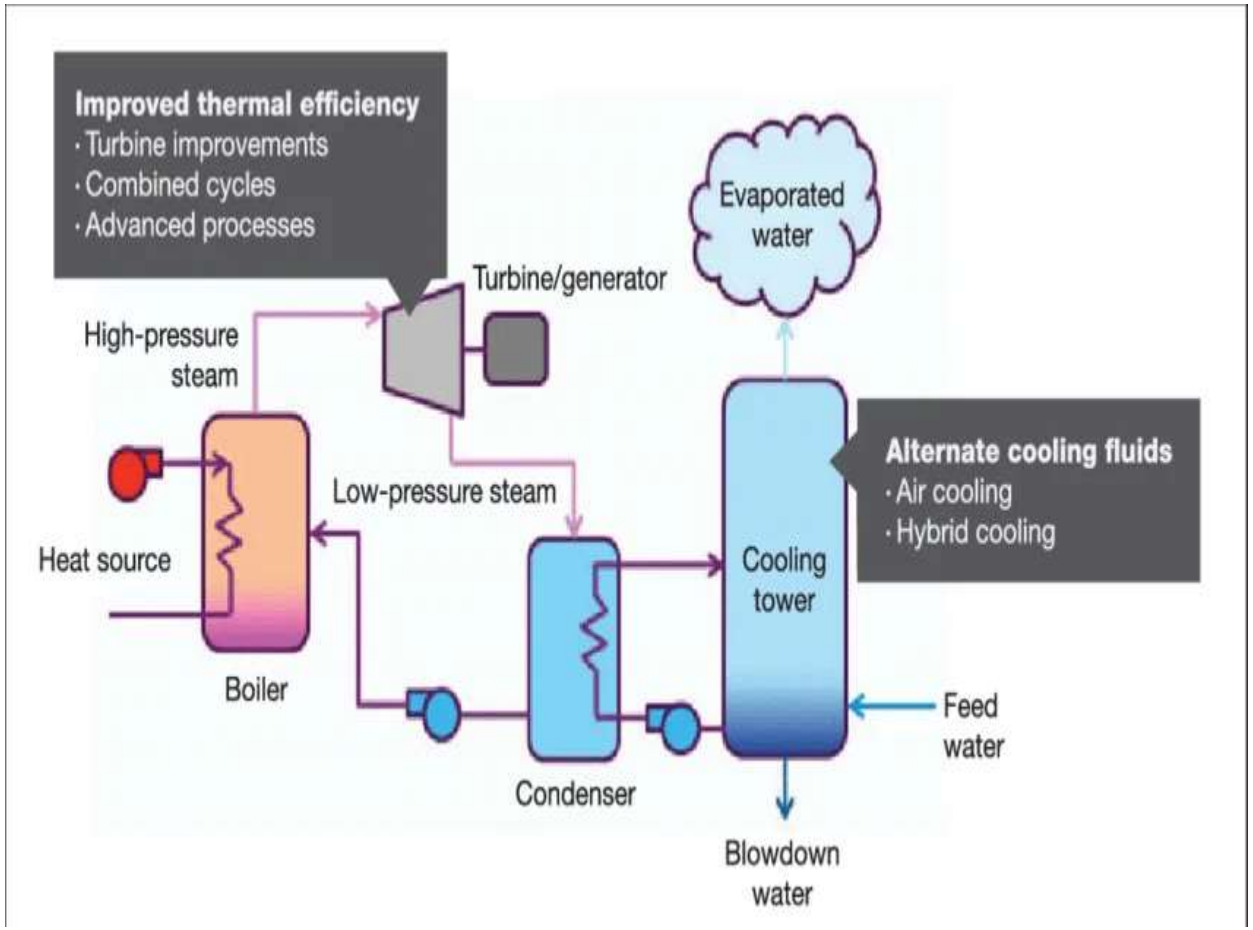




Unit 3

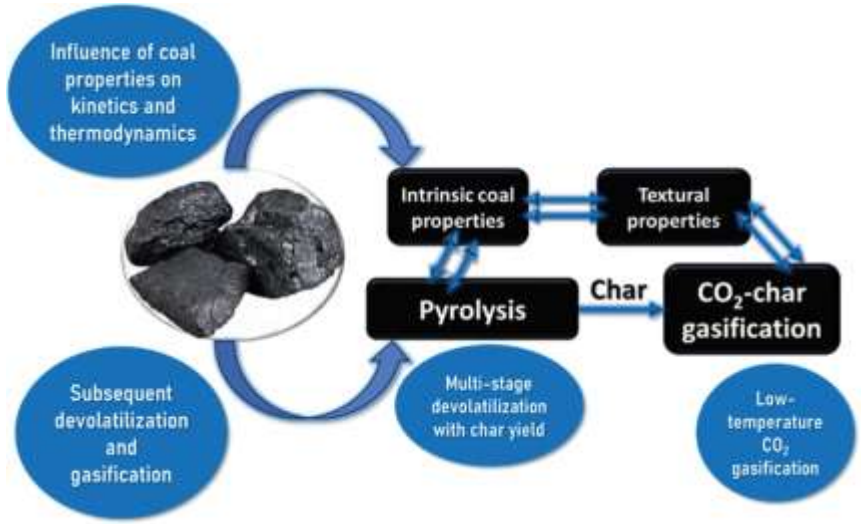
Introduction

- Thermal power plant using steam cycle
- Fuel: Coal mainly used
- Steam drives turbine to generate electricity
- Widely used power generation method



Coal – Properties

- Calorific value
- Moisture content
- Volatile matter
- Ash content
- Fixed carbon



Parameter	Coal	Manure
Moisture	10.8%	36.61%
Ash	5.68%	25.25%
Volatile Matter	52.8%	31.57%
Fixed Carbon	30.72%	6.57%
Heat Value(DAF) kJ/kg	26535	7865
Carbon	54.9%	19.24%
Hydrogen	4.33%	2.22%
Oxygen	23.2%	14.68%
Nitrogen	0.76%	1.47%
Sulfur	0.34%	0.53%

Coal Handling & Storage

- Coal transported by rail/road
- Stored in stockyards
- Crushing and pulverizing
- Conveyor belts used
- Protection from moisture and fire





Coal Handling & Storage

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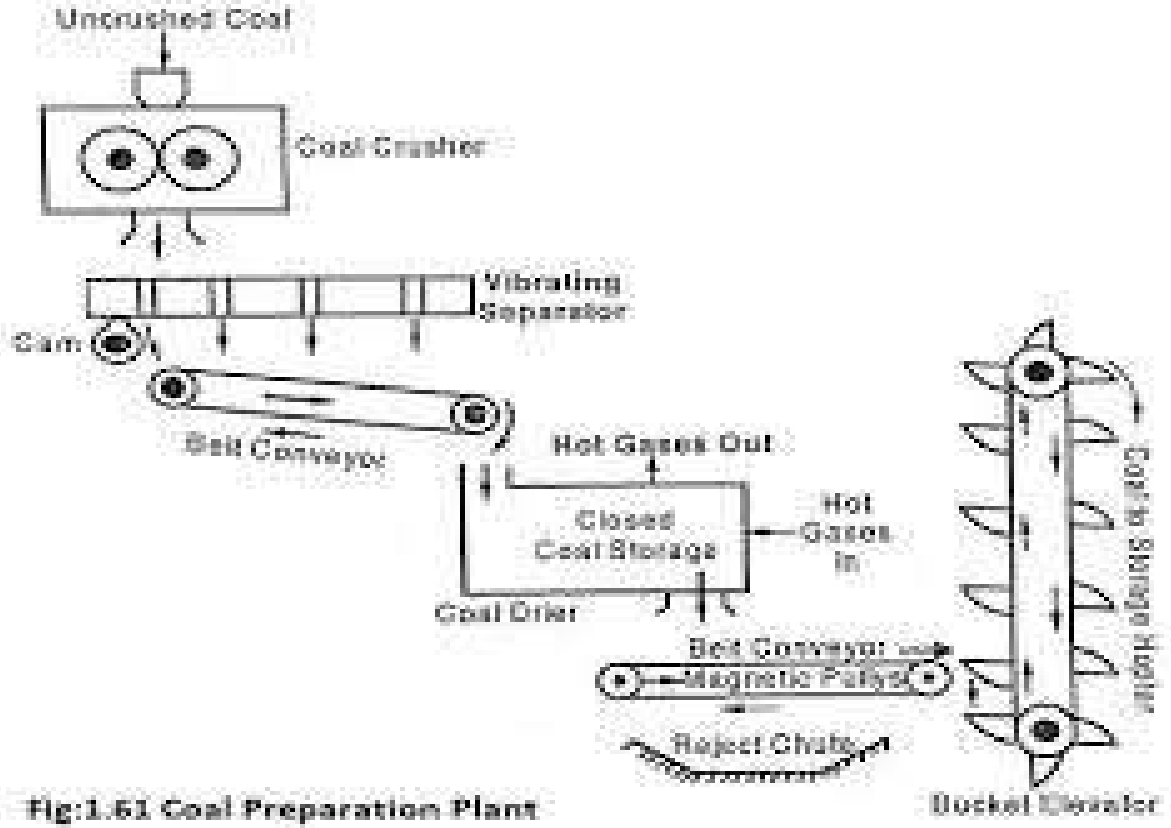
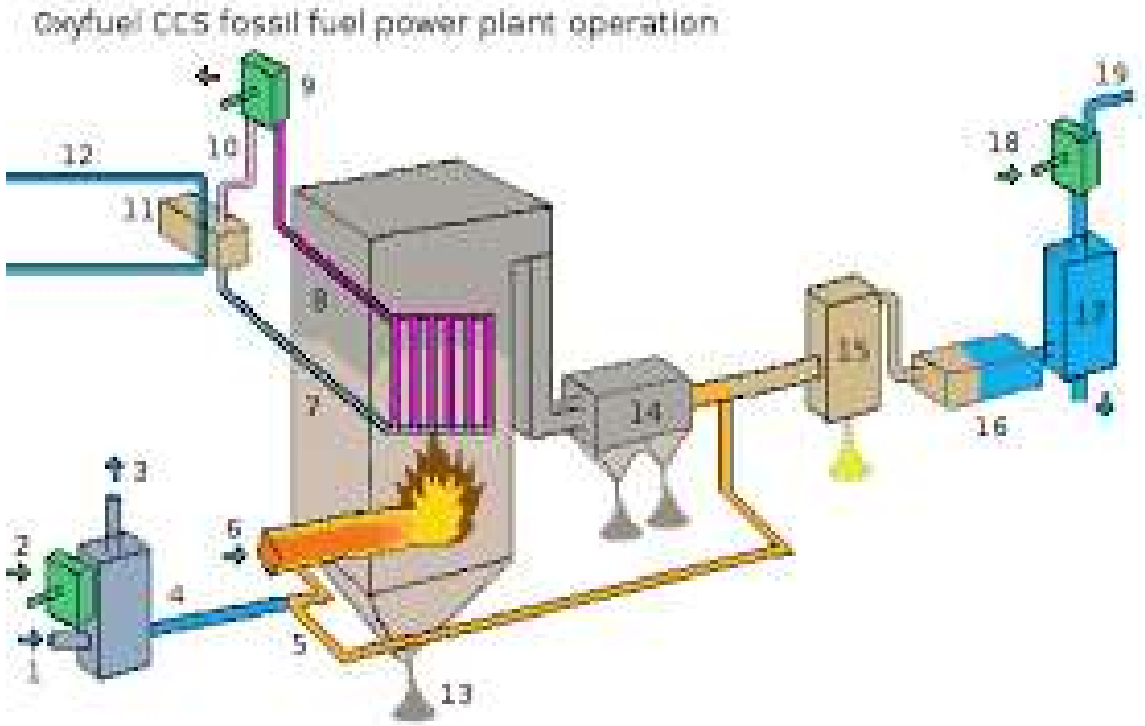


Fig:1.61 Coal Preparation Plant

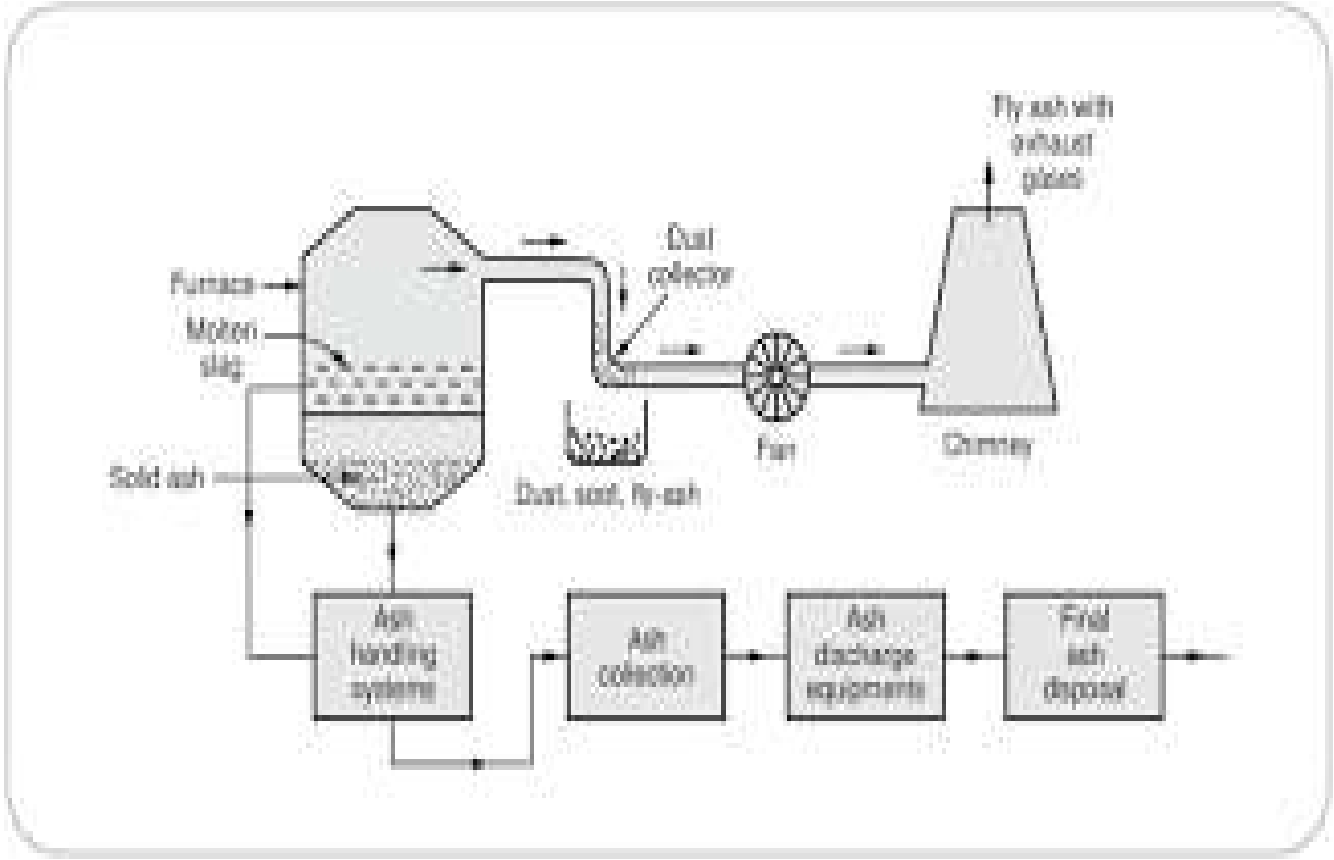
Fuel Firing Methods

- Hand firing
- Stoker firing
- Pulverized fuel firing
- Cyclone firing
- Choice depends on plant size



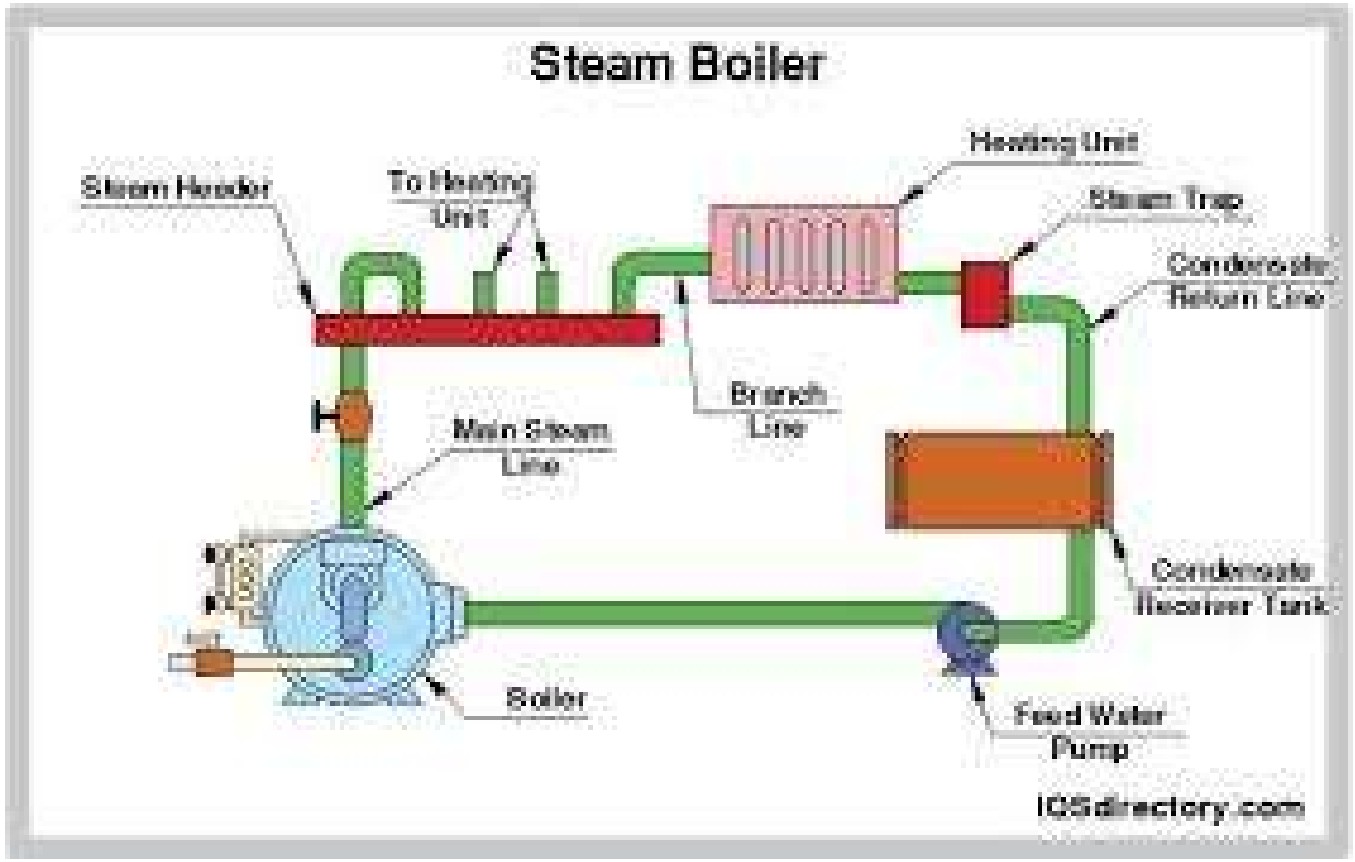
Ash & Dust Handling

- Bottom ash and fly ash
- Electrostatic precipitator (ESP)
- Mechanical collectors
- Ash disposal systems
- Environmental protection



Boiler Accessories

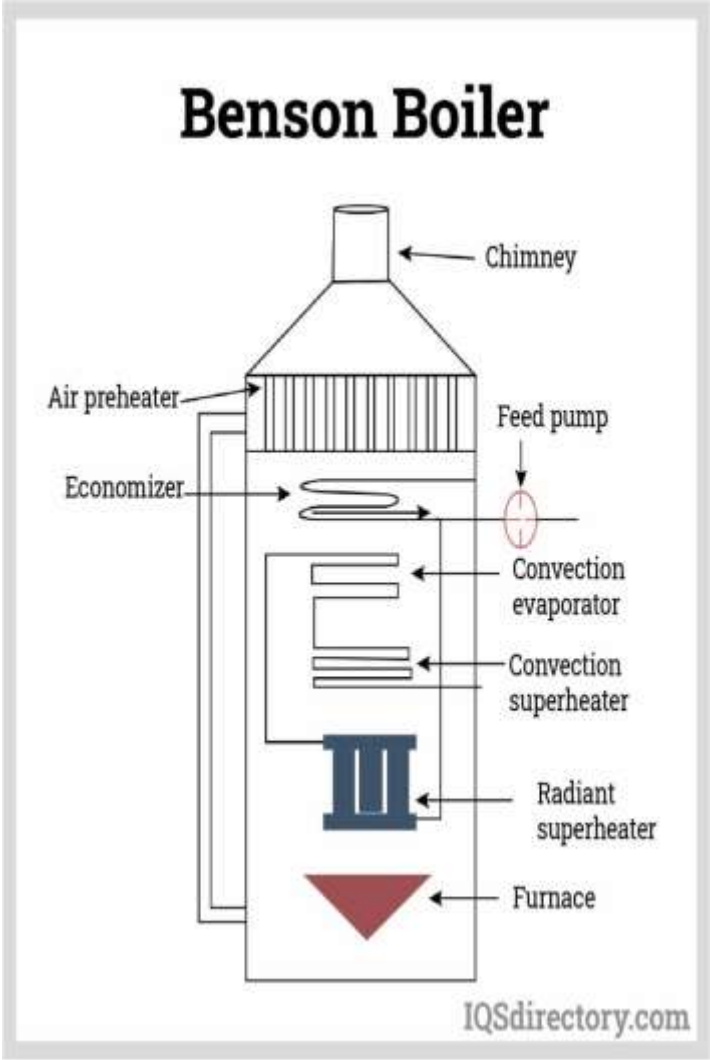
- Economizer
- Superheater
- Air preheater
- Feed pump
- Improves efficiency

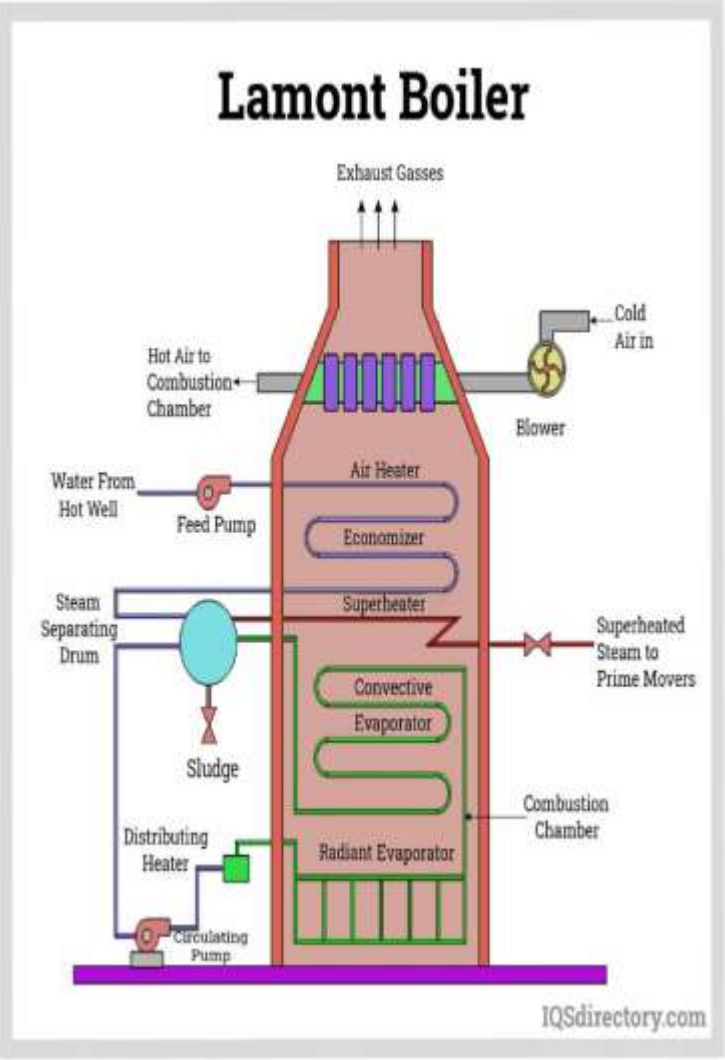


L-17

High Pressure Boiler

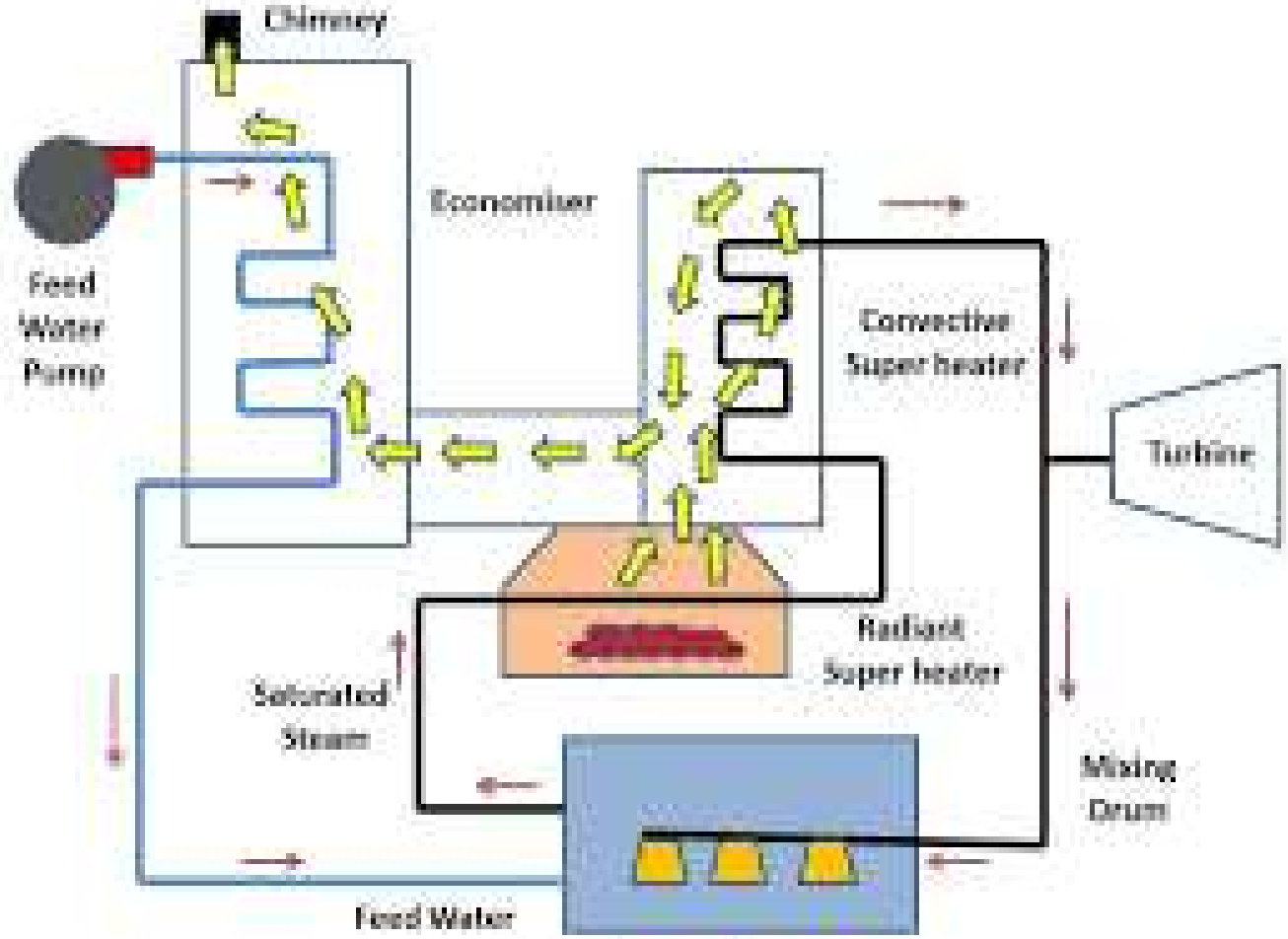
- Operates at high pressure and temperature
- Examples: Benson, Loeffler boiler
- Higher efficiency
- Compact design





High Pressure Boiler

- Operates at high pressure and temperature
- Examples: Benson, Loeffler boiler
- Higher efficiency
- Compact design

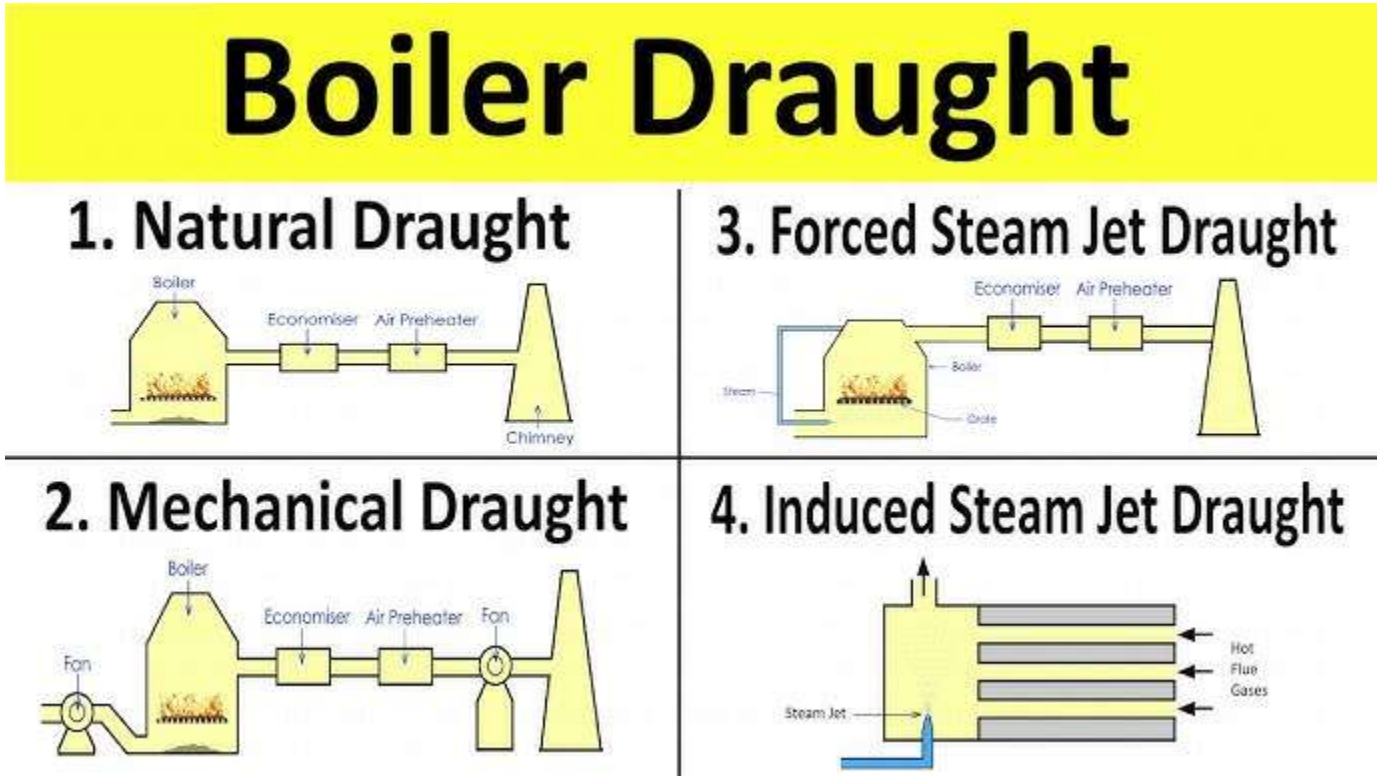


Loeffler Boiler

L-18

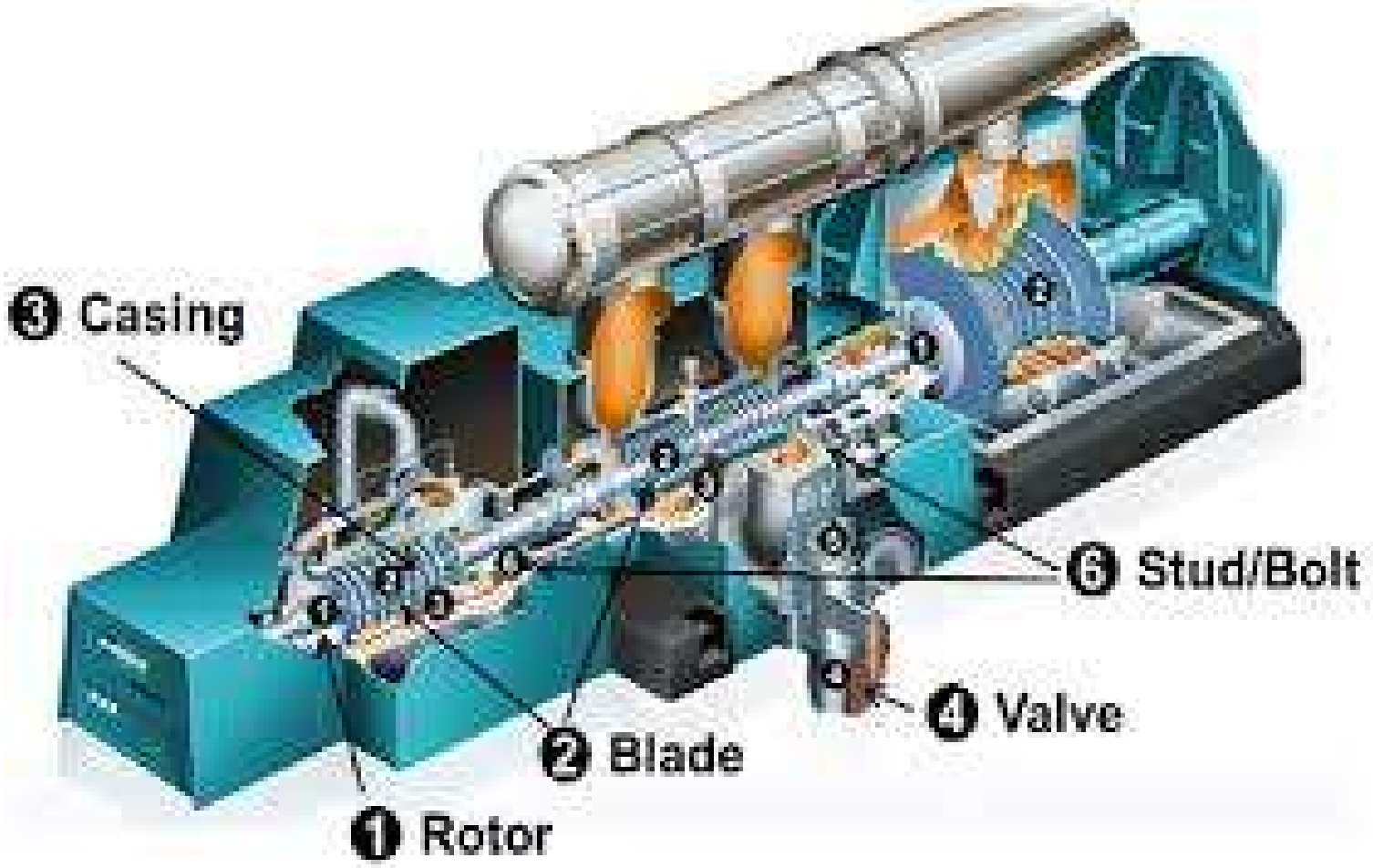
Draught System

- Natural draught
- Forced draught
- Induced draught
- Balanced draught
- Maintains air flow in furnace



Steam Turbine

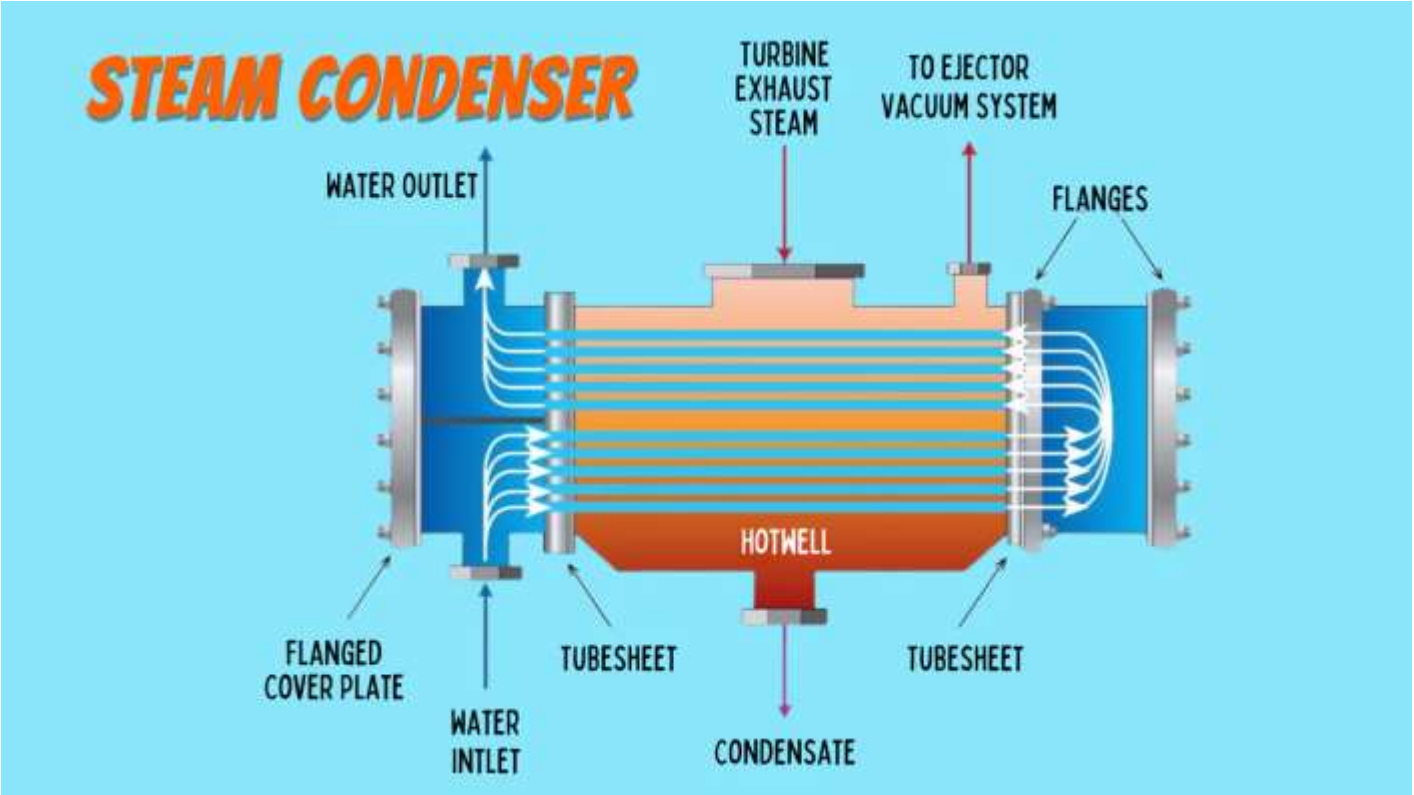
- Converts steam energy to mechanical energy
- Types: Impulse and Reaction
- Coupled with generator
- High efficiency device



L-18

Condenser

- Condenses exhaust steam
- Maintains vacuum
- Improves efficiency
- Types: Surface and Jet condenser



Cooling Towers

- Dissipates heat from condenser water
- Types: Natural draft, Mechanical draft
- Water recirculation
- Essential for large plants

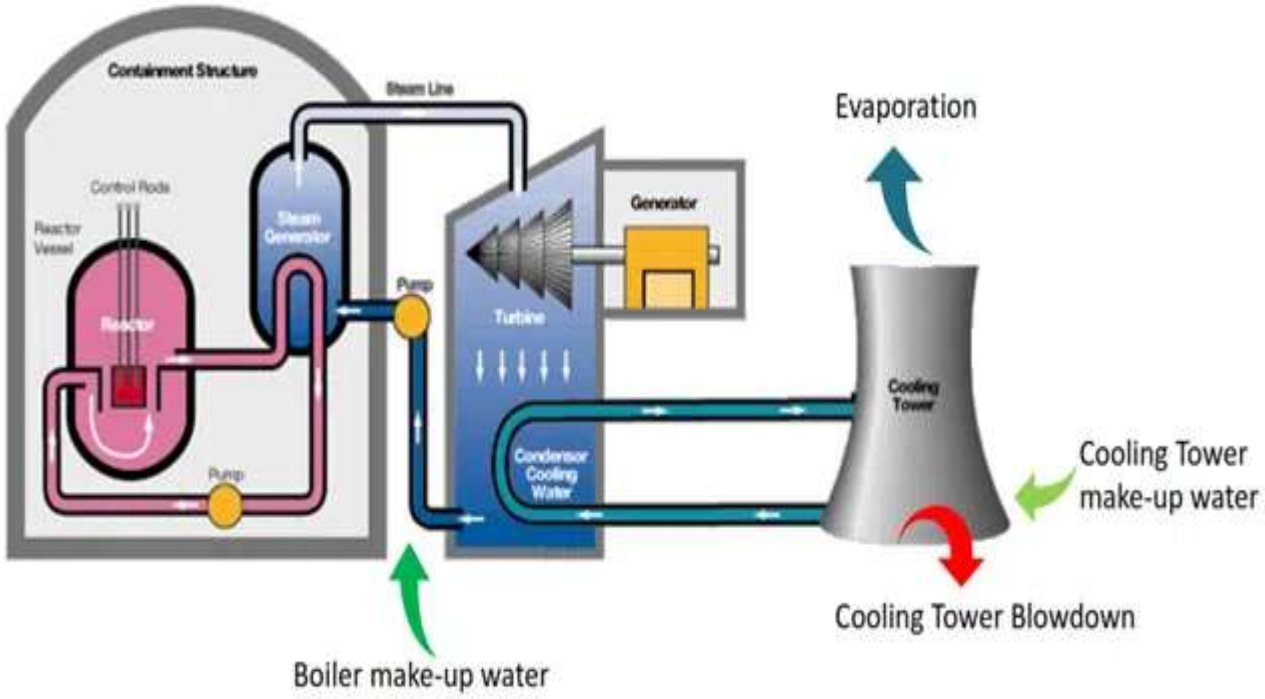




L-19

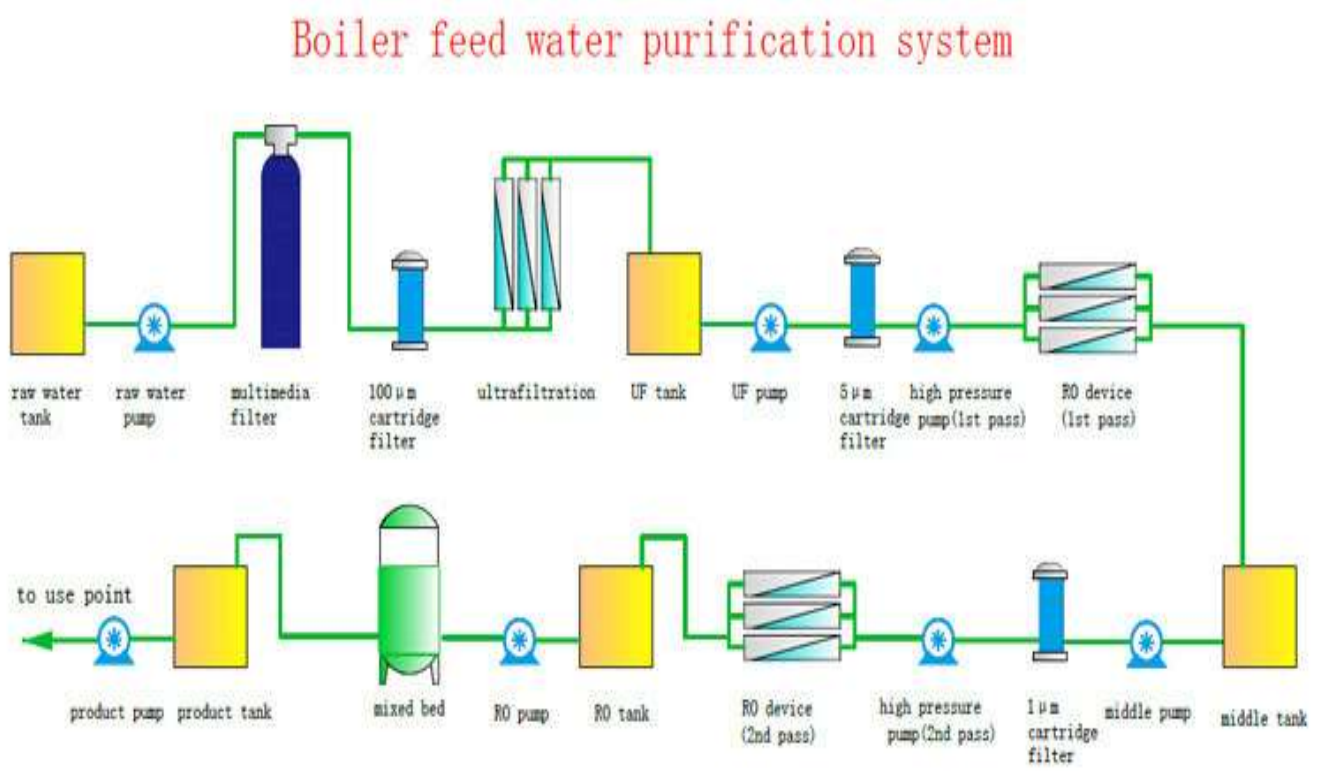
Water Treatment in Power Plant

- Removes impurities from water
- Prevents scaling and corrosion
- Processes: Filtration, softening, demineralization
- Use of chemical treatment
- Essential for boiler life



Boiler Feed Water Requirements

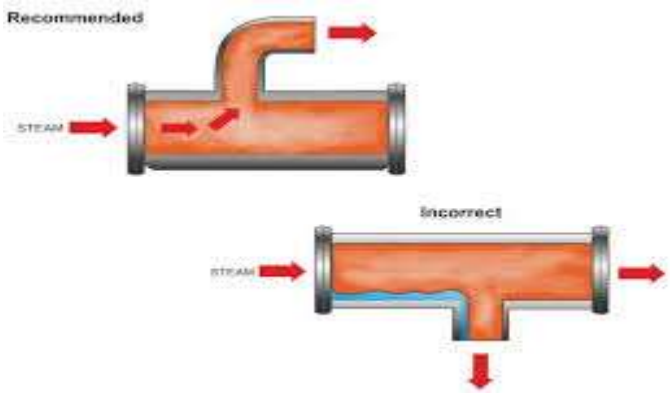
- Low hardness
- Low dissolved gases
- Controlled pH
- Free from suspended impurities
- Improves efficiency and safety



Steam Pipes

- Carries steam from boiler to turbine
- Must withstand high pressure & temperature
- Insulated to reduce heat loss
- Made of alloy steel
- Proper design avoids leakage





Steam Pipe Fittings

- Valves: Control steam flow
- Flanges and joints
- Steam traps
- Expansion joints
- Safety valves



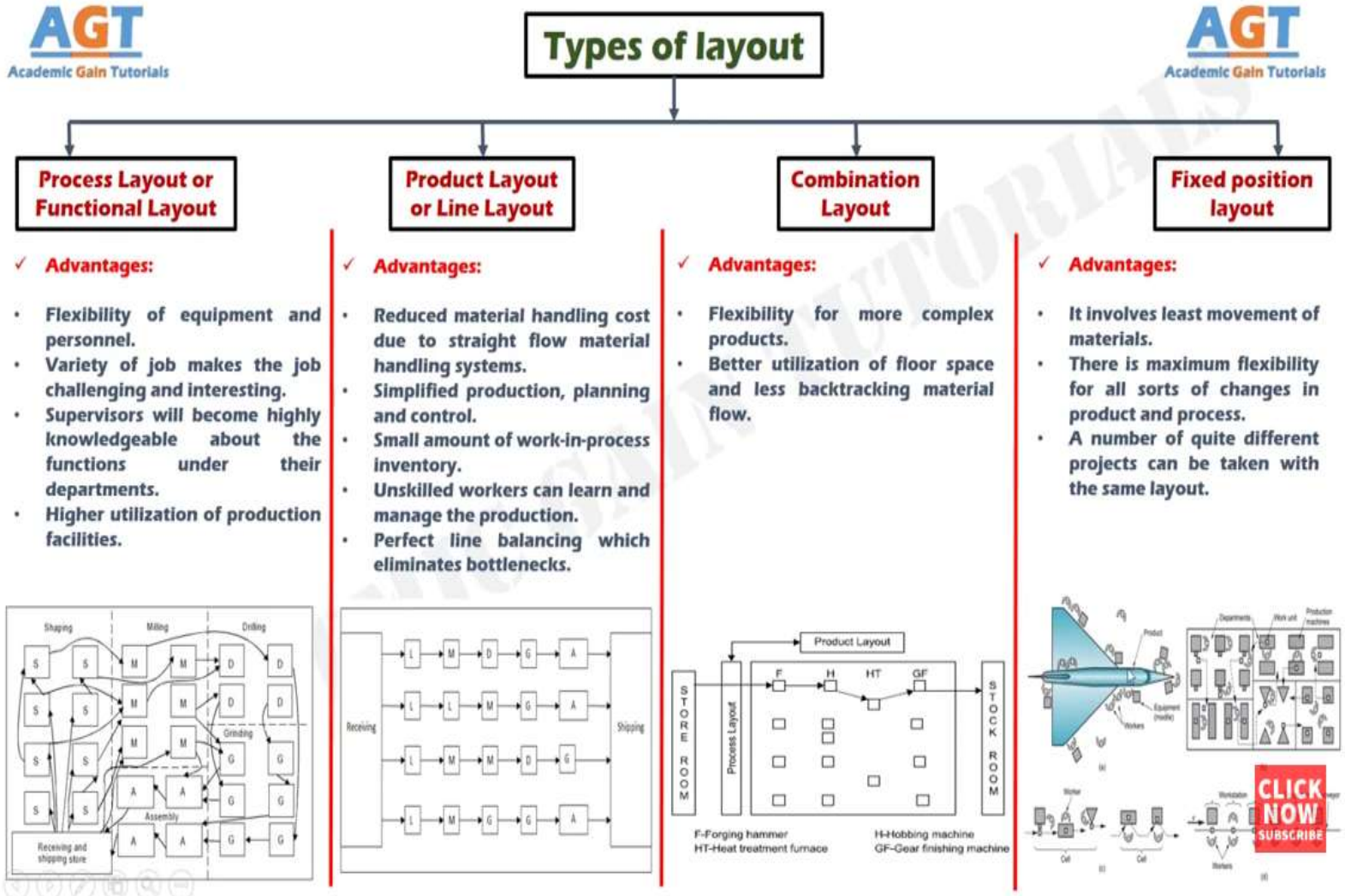
Power Plant Layout

- Coal handling system
- Boiler and furnace
- Turbine and generator
- Condenser and cooling system
- Ash handling system

L-20

Types of Layout

- Indoor layout
- Outdoor layout
- Unit system layout
- Central system layout



Pollution from Steam Power Plant

- Air pollution: CO2, SO2, NOx
- Water pollution from discharge
- Thermal pollution
- Ash disposal issues
- Noise pollution

Control of Pollution

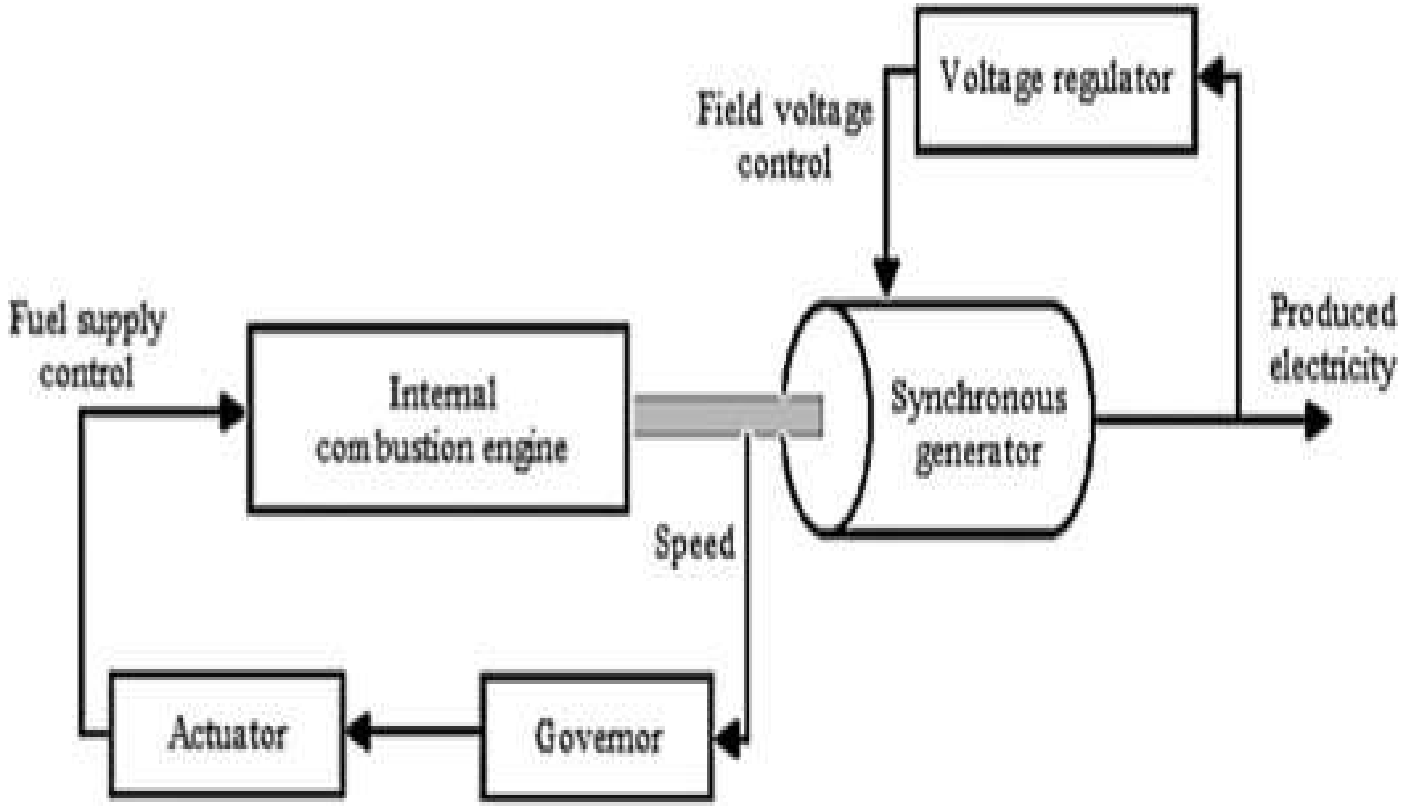
- Electrostatic precipitators
- Flue gas desulfurization
- Cooling towers
- Proper ash disposal
- Use of clean coal technology



Unit 4

Introduction

- Uses diesel engine to generate electricity
- Suitable for small power generation
- Used as standby or emergency power
- Quick starting plant



Selection of Components

- Engine capacity based on load
- Generator rating selection
- Fuel system design
- Cooling and lubrication systems
- Economic and efficiency considerations

Different Arrangements

- Single unit system
- Multiple unit system
- Centralized and decentralized systems
- Standby arrangements

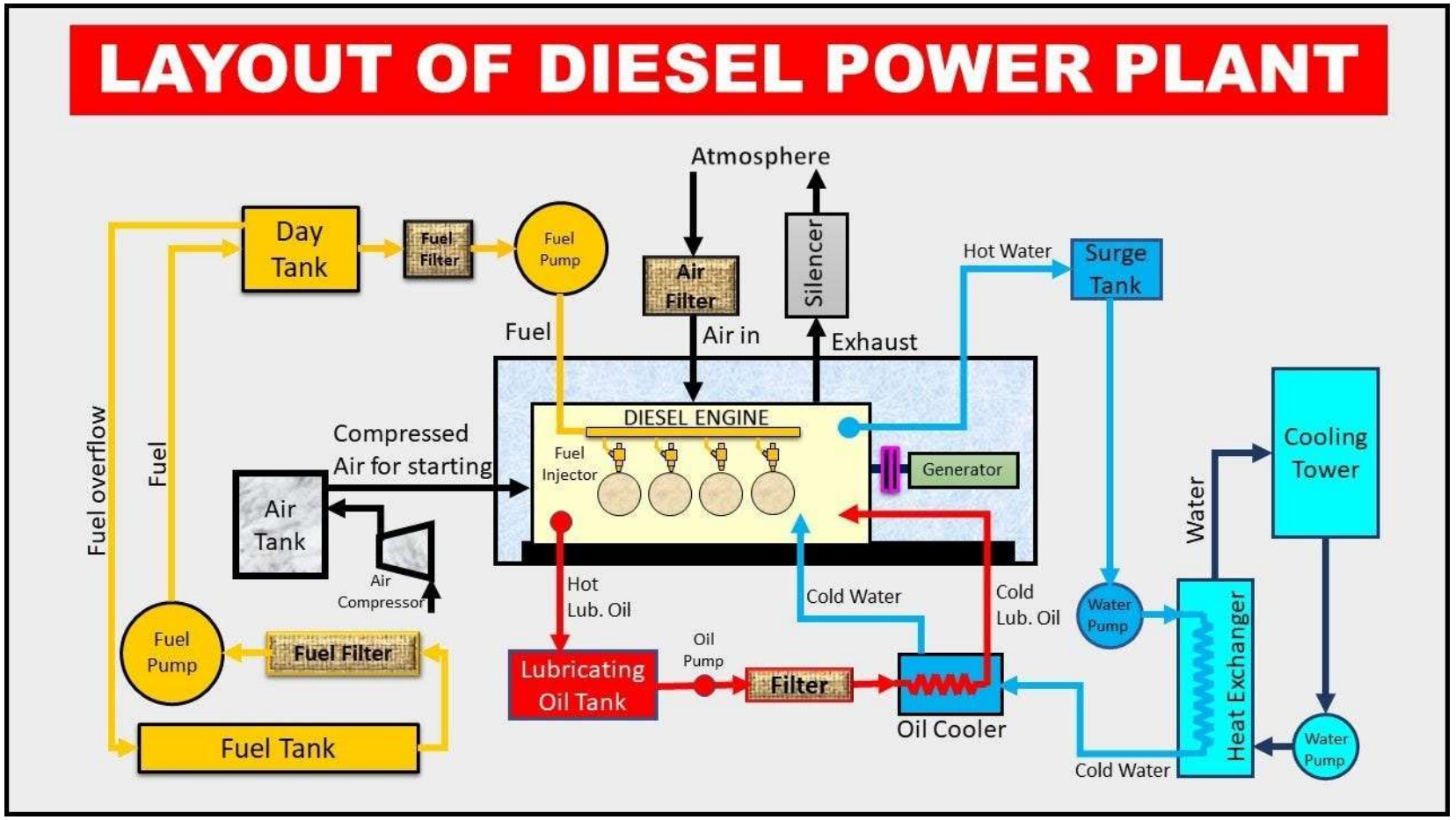
Comparison with Other Power Plants

- Diesel: Low capital cost, high running cost
- Thermal: High capacity, slower start
- Hydro: Clean but site dependent
- Nuclear: High cost, complex
- Diesel: Suitable for remote areas

L-22

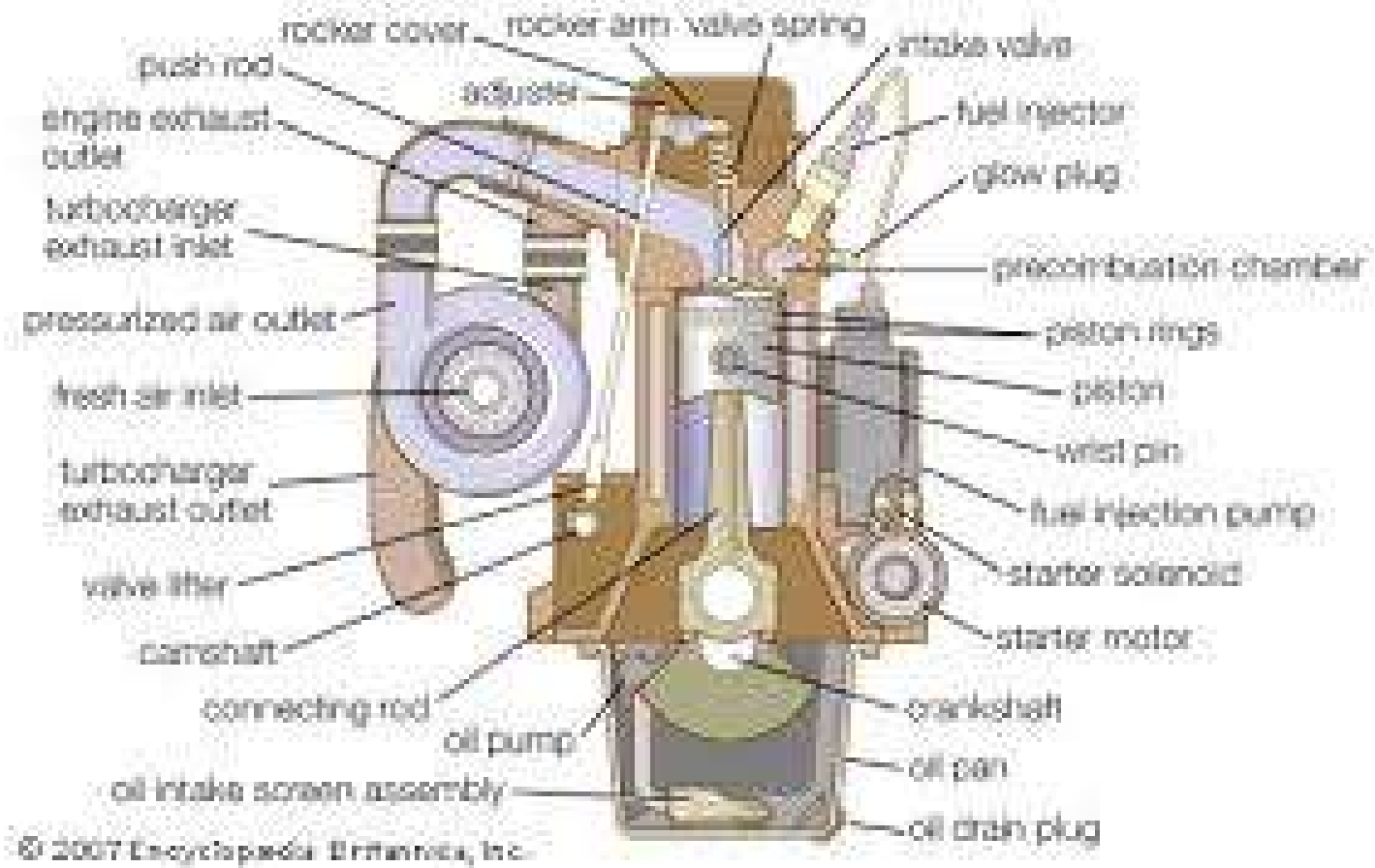
Outline of Diesel Power Plant

- Fuel supply system
- Air intake system
- Exhaust system
- Cooling system
- Lubrication system



Types of Diesel Engines

- Two-stroke engine
- Four-stroke engine
- Single cylinder and multi-cylinder
- High speed and low speed engines



Components of Diesel Power Plant

- Diesel engine (prime mover)
- Generator
- Fuel system
- Cooling system
- Lubrication system
- Control system

Fuel System

- Fuel storage tank
- Fuel pump
- Fuel injector
- Filters
- Ensures proper fuel supply

Cooling & Lubrication System

- Cooling prevents overheating
- Uses water or air cooling
- Lubrication reduces friction
- Oil pump and filters used
- Improves engine life

Performance of Diesel Power Plant

- Thermal efficiency
- Specific fuel consumption
- Mechanical efficiency
- Load factor and plant efficiency
- Performance depends on maintenance

Factors Affecting Performance

- Fuel quality
- Operating conditions
- Cooling efficiency
- Engine design
- Load variations

Plant Layout of Diesel Power Plant

- Fuel storage and supply system
- Engine and generator setup
- Cooling system
- Exhaust system
- Control room

Comparison with Other Power Plants

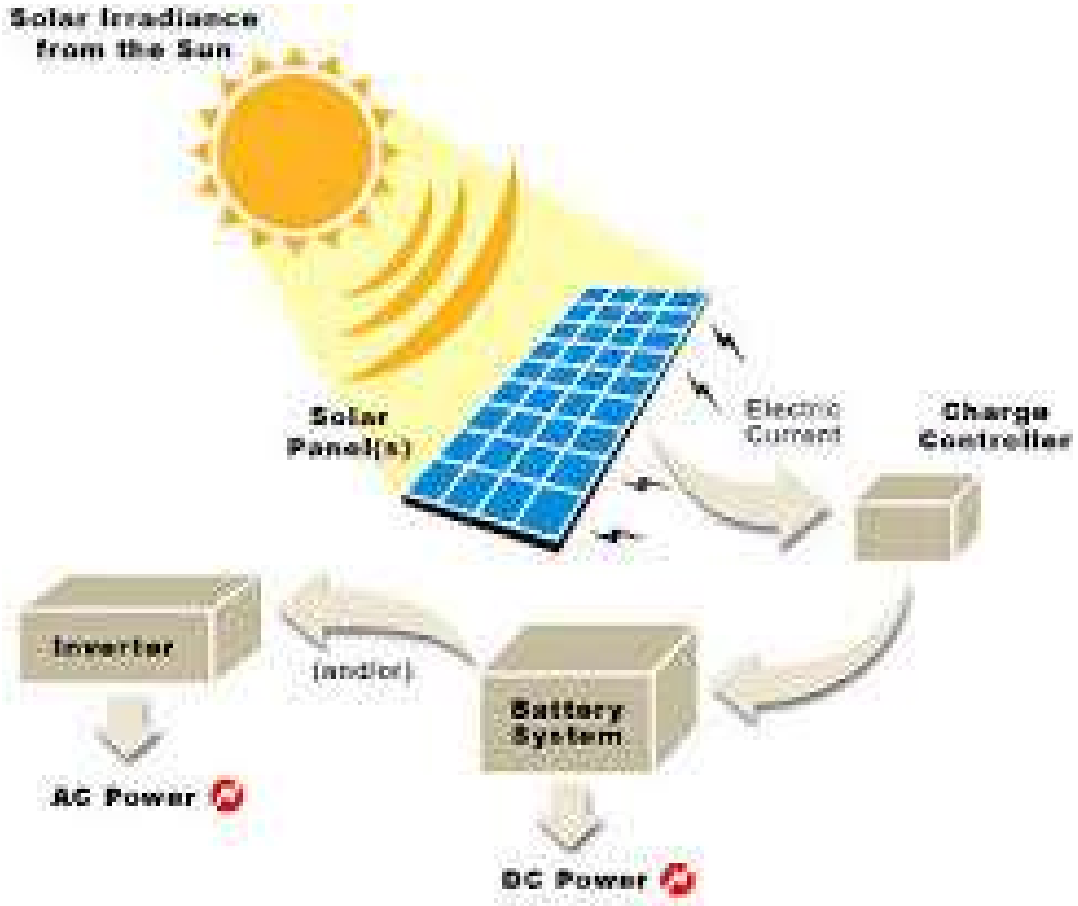
- Diesel: Quick start, high fuel cost
- Thermal: High capacity, pollution
- Hydro: Clean but location dependent
- Nuclear: High cost, complex
- Renewable: Clean but intermittent

Introduction to Unconventional Energy Sources

- Alternative to conventional energy
- Renewable and sustainable
- Environment friendly
- Includes solar, wind, tidal, etc.

Solar Energy

- Energy from sun
- Photovoltaic cells used
- Used in power generation and heating
- Clean and abundant



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Wind Energy

- Energy from wind turbines
- Used in large wind farms
- No pollution
- Depends on wind availability



Unit 5

L-29

Introduction

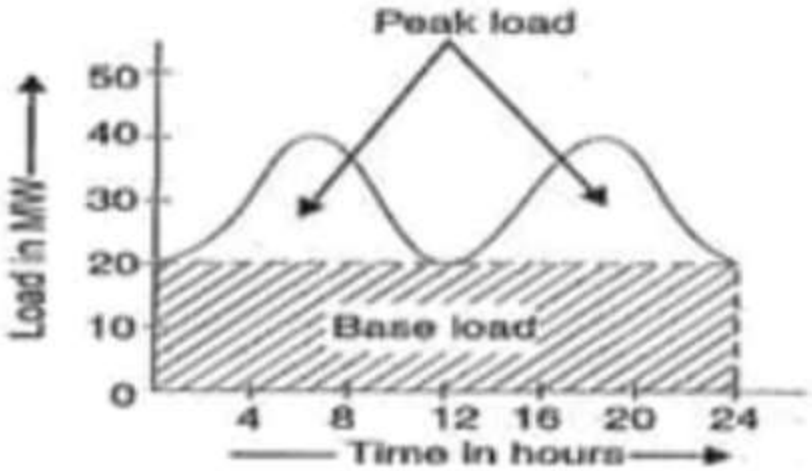
- Load varies with time
- Important for planning
- Ensures cost-effective generation

Base &Peak Load Power Station

- The changing load on the power station makes its load curve of variable nature.
- load on the power station can be considered in two parts, namely;

1.Base load

2.Peak load

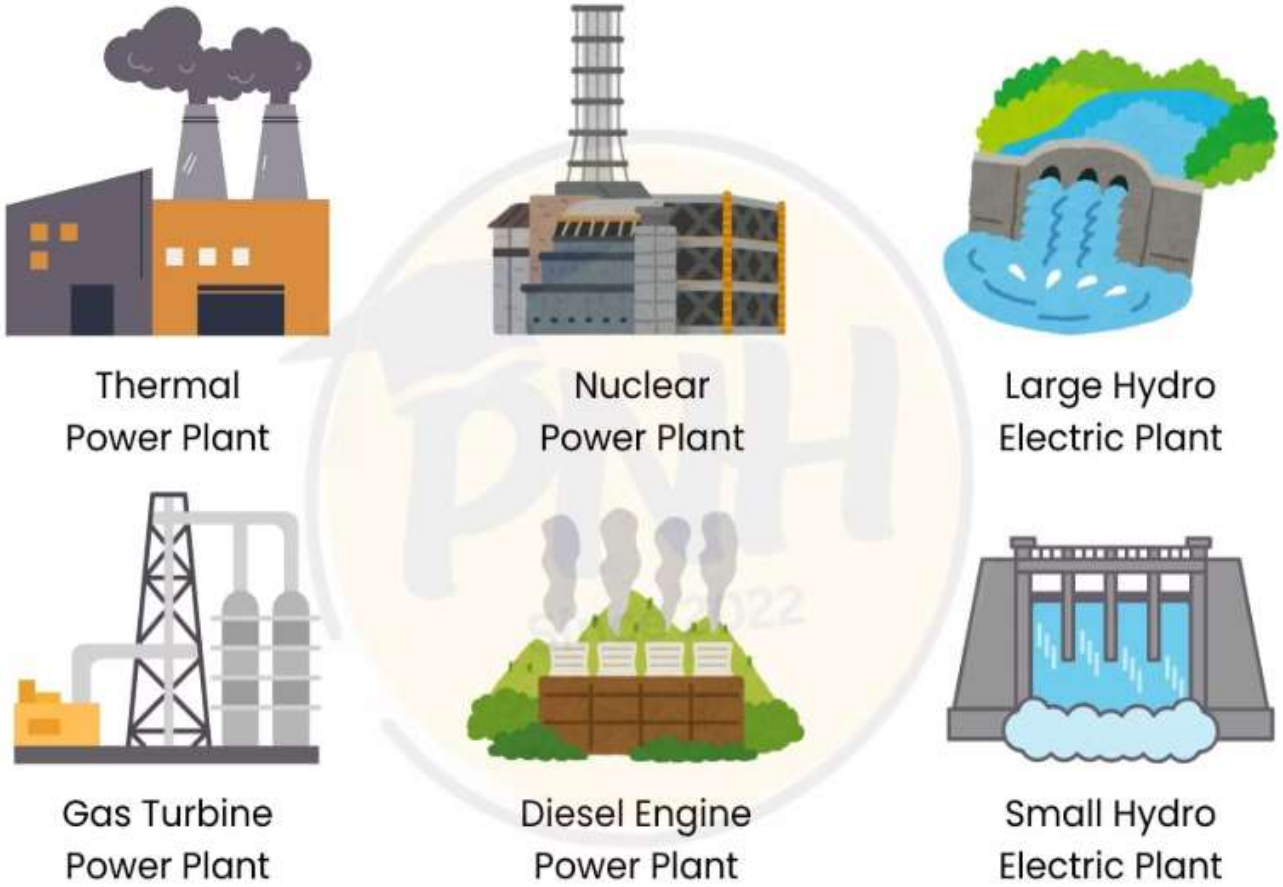


Prepared by: Prof. Taji S. G.

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Fluctuating Load

- Variation of load with time
- Caused by industrial, domestic, seasonal changes



Base Load Power Plants and Peak Load Power Plants

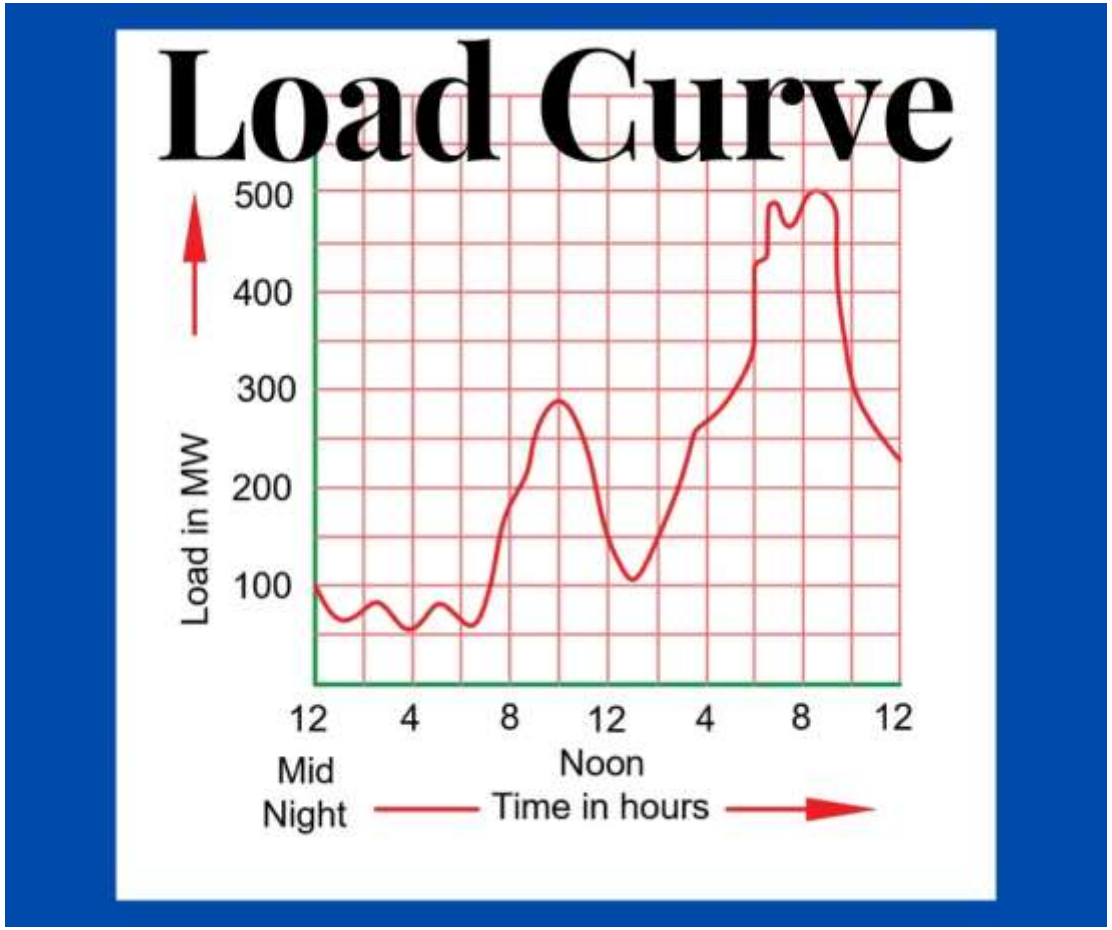
Load Curve

- Graph of load vs time
- Types: Daily, Weekly, Annual
- Used for planning

Feature	Base Load Plant	Peak Load Plant
Purpose	Supplies continuous minimum demand	Meets extra demand during peak times
Operation	Operates all the time	Operates only when needed
Operating Cost	Low	High
Start/Stop	Slow	Fast
Capacity	Large	Small
Examples	Coal, nuclear, large hydro	Gas turbines, diesel, small hydro

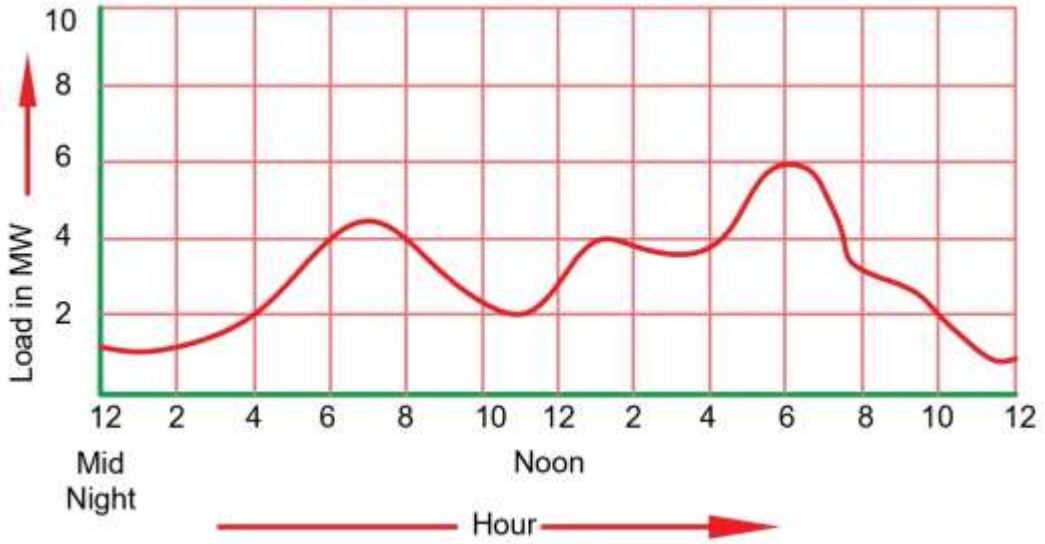
Daily Load Curve

- Load curves describe the variation in load demand from the consumer side on a power source over a period of time.
- A curve plotted over 24 hours are daily load curve.
- If plotted for a week, month or year then it is respectively called a weekly, monthly, **or yearly load curve.**



Important Terms

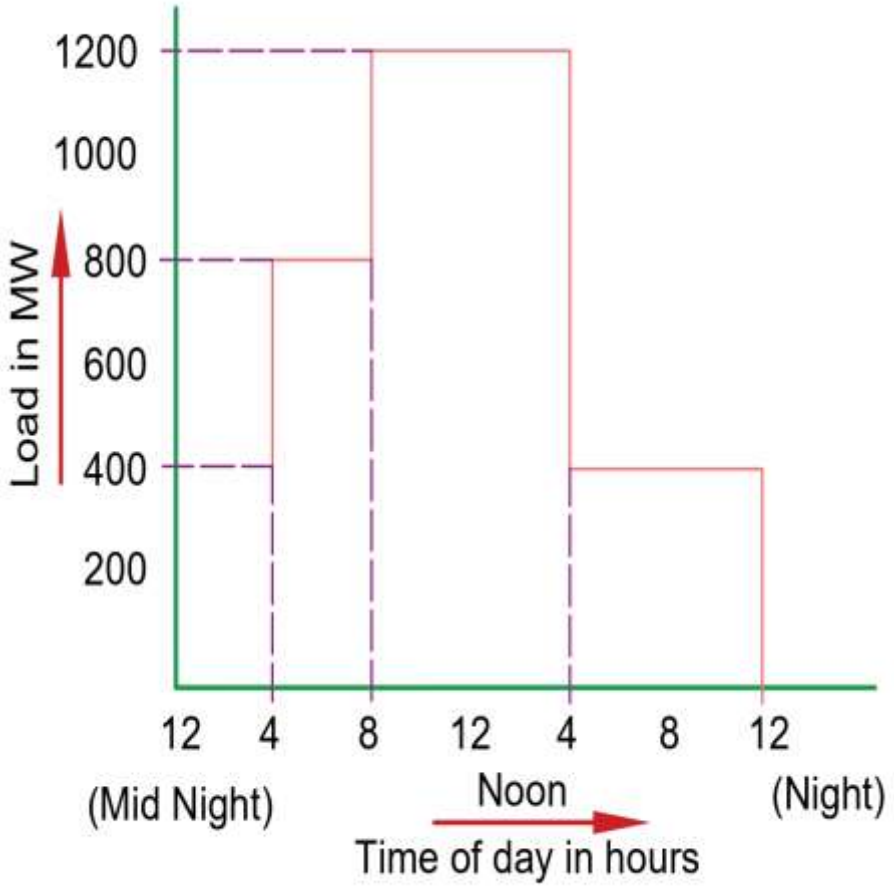
- The load duration curve depicts the consumer end load variation over a period of time.
- Whether it is plotted for an industrial or residential purpose, it serves the purpose of determining the power required to be generated by generating stations to meet consumer demand.



Important Terms

Daily Load Curve

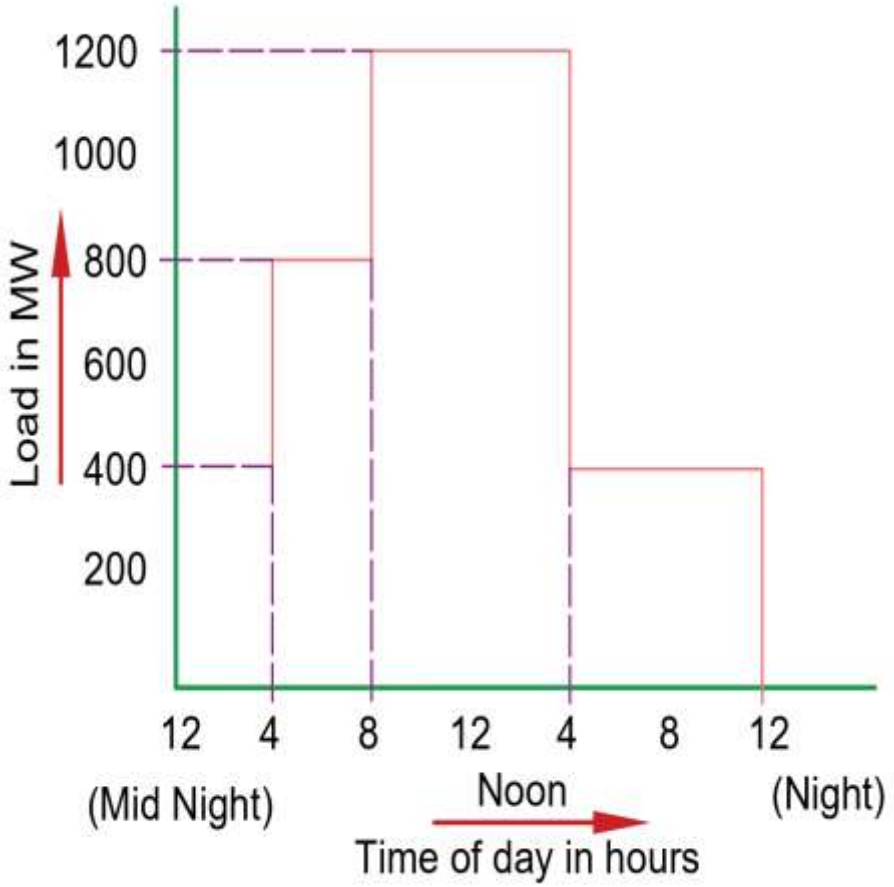
- The load demands from the consumer side vary and it does not remain constant. To know the peak demand on the generating station, the load on a power station during the whole day (i.e. for 24 hours) is recorded half-hourly or hourly.
- Then the graph is plotted with respect to time to obtain the **daily load curve** of the power plant.



Important Terms

Monthly Load Curve

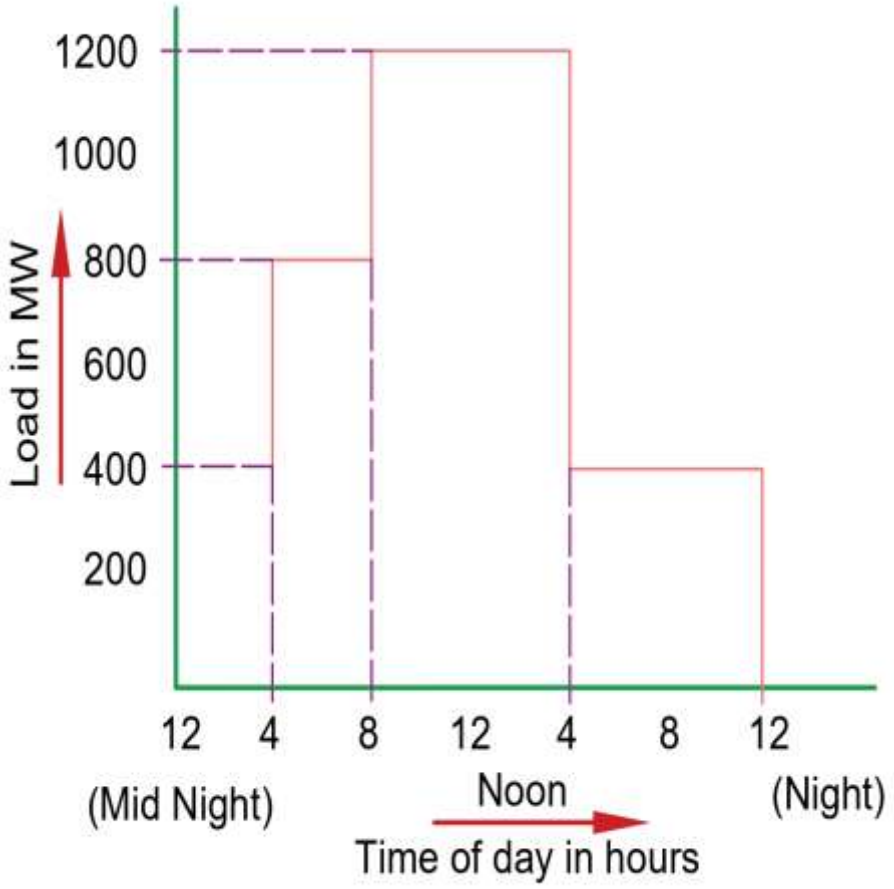
- We can plot the **monthly load curve** of the power station from the daily load curves for a particular month.
- The average values of the load over a month at different times are first calculated and then the graph is plotted,
- The purpose of the monthly load curve is to fix the rate of the energy.



Important Terms

Yearly Load Curve

- We can plot the yearly load curve from the monthly load curves of that year.
- The average values of the load over the year are first calculated to draw the yearly load curve.
- The load factor is very important data for a power-generating station.
- The annual load factor can be determined by the yearly load curve.



Additional Terms

- Plant Capacity Factor
- Utilization Factor
- Diversity Factor

Importance of Load Curves

Importance of Load Curves

- The Load curves provide the following important information of generating station.
- The load demand from the consumer side varies depending on the time of loading, season, and other factors. Therefore, the load on the generating station can not be practically constant. When we plot the graph between the load and time of the day, we will find the load variation with respect to time. Thus, a daily load curve shows the dissimilarity in the load on the power plant during the different hours of the day.

Importance of Load Curves

Importance of Load Curves

- If we observe the daily load curve, we will find that the load at a particular time is maximum.
- The maximum demand at a particular time on the daily load curve is called the peak load.
- The peak point on the curve shows the maximum demand for the power station on that day.
- Thus, the peak point on the curve shows the highest demand for the Power Station for that day.

Importance of Load Curves

- After knowing the maximum demand by a daily load curve, it is possible to determine the size of the generating station and the number of generating stations.
- It shows the load demand for different times of the day. Suppose, for a particular day, in the morning at 10 A.M. load demand is 100 MW and 200 MW at 7 P.M.
- We can run a single generator to meet the load demand in the morning and parallel one more generator in the evening to meet the load demand. Thus, it is possible to economically dispatch the power by power scheduling for the different times of the day on the basis of curve data. The sequence and time to shut off or to start smaller units at a certain time are made clear by anticipating the load curve.

Importance of Load Curves

- It provides data on the number of units and size of generating stations required to meet the power demand.
- Thus, the generating stations can thereby plan a specific schedule to generate power in the most economical manner.
- The number of kWh(Units) generated on the day can be calculated by the area under the daily load curve. Electrical energy(kWh) generated per day = Area (in kWh) under the daily load curve

Importance of Load Curves

- We can calculate the average load using this daily load curve.
- The average load is equal to the ratio of area under the daily load curve and the total number of hours of that day.
- Mathematically, the area under the curve provides the units consumed for that duration, and units consumed divided by time gives the average load.

We can also calculate the load factor of the generating station by dividing the area under the load curve by the total area of the rectangle.

$$\text{Average Load Per day} = \frac{\text{Area under daily Curve(24Hrs.)}}{24\ Hrs}$$

$$\text{Load Factor} = \frac{\text{Average Load}}{\text{Maximum Load Demand}}\ X\frac{24\ Hours}{24\ Hous}$$

$$\text{Load Factor} = \frac{\text{Area under Daily curve}}{\text{Area of rectangle in which load curve is contained}}$$