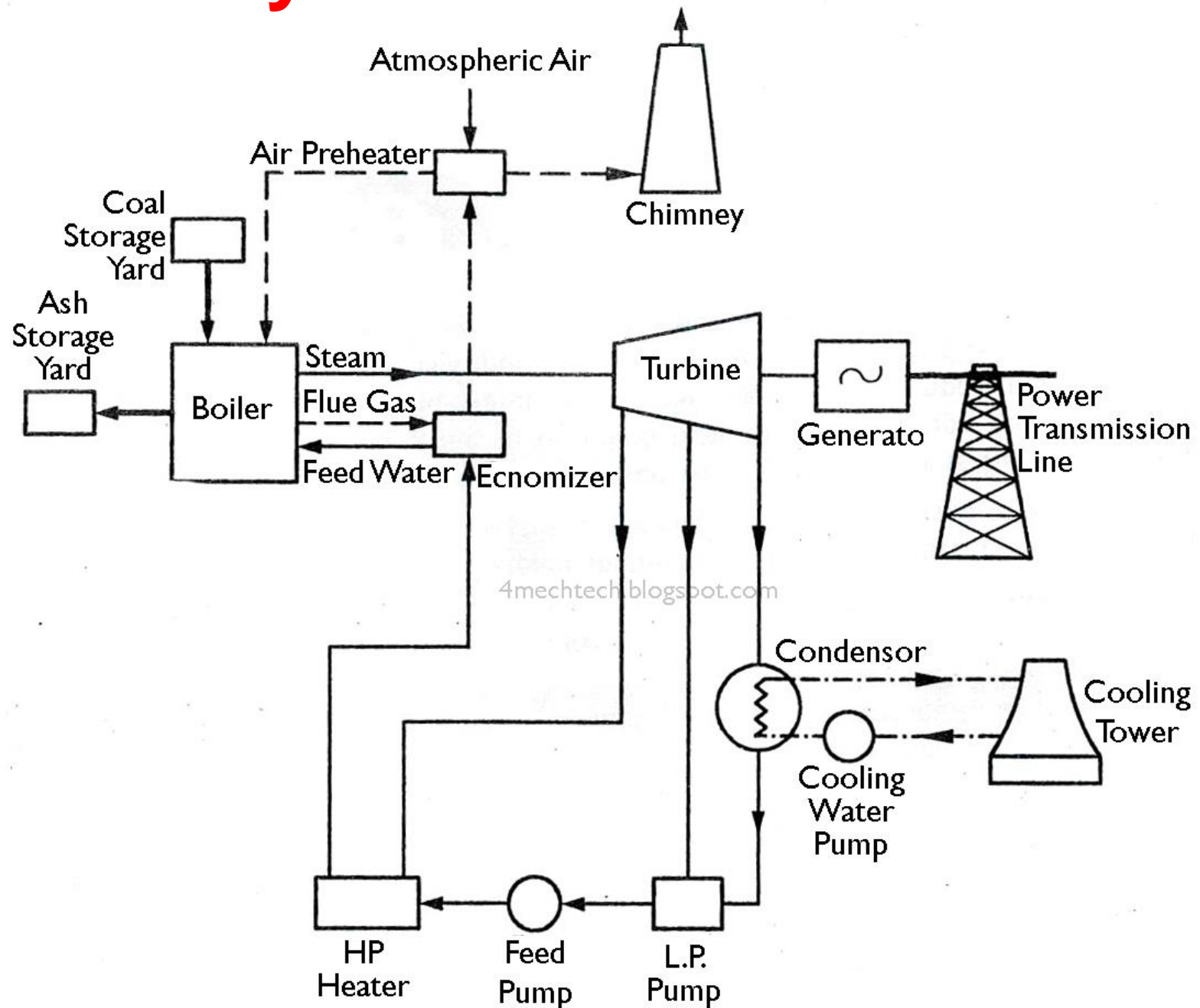


PRESENTATION ON THERMAL POWER PLANT (STEAM POWER PLANT)

Thermal Power Plant



Basic Layout of Steam Power Plant



THERMAL POWER STATION

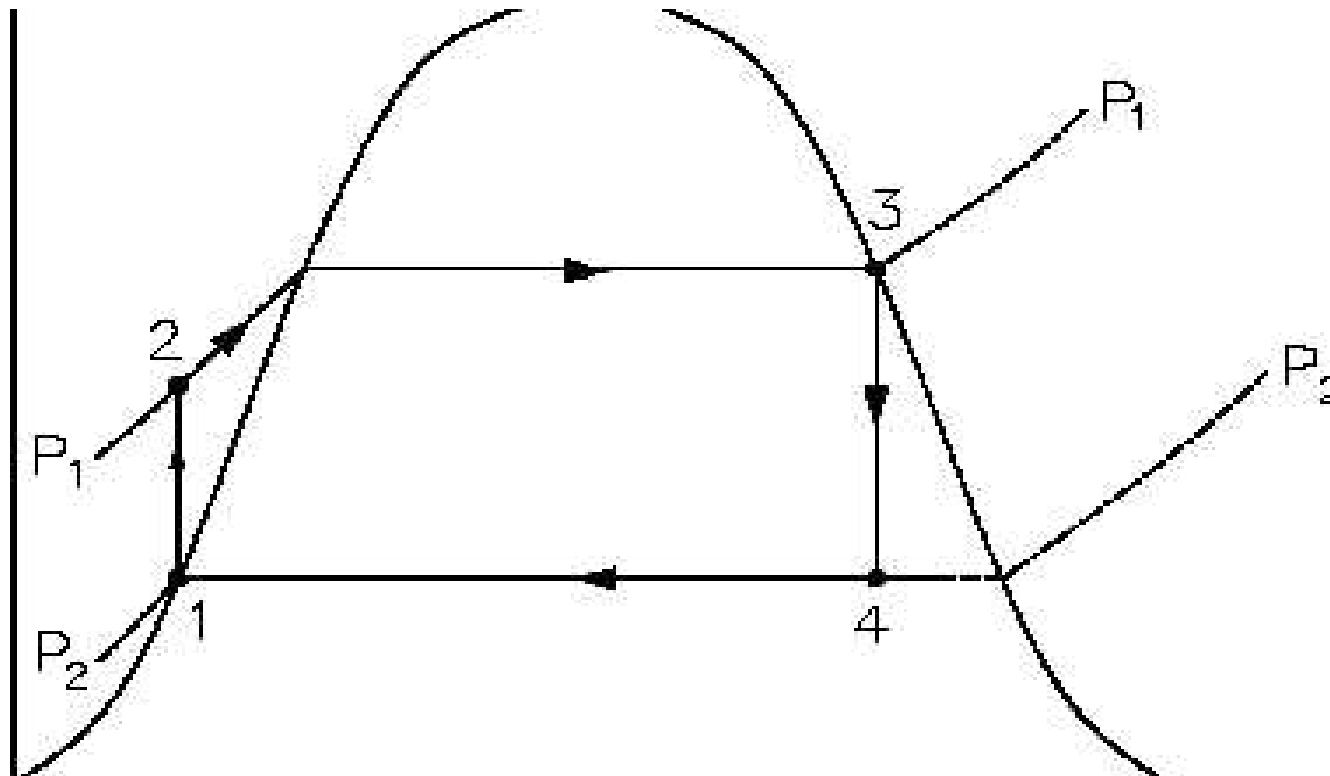
- A **Thermal Power Station** is a power plant in which the prime mover is steam driven.
- Water is heated, turns into steam and spins a **Steam Turbine** which drives an **electrical generator(Alternator)**.
- After it passes through the turbine, the steam is condensed in a **Condenser**; this is known as a **Rankine cycle**.

Rankine Cycle

- There are four processes in the Rankine cycle, each changing the state of the working fluid. These states are identified by number in the diagram to the right.
- Process 1-2: The working fluid is pumped from low to high pressure, as the fluid is a liquid at this stage the pump requires little input energy.
- Process 2-3: The high pressure liquid enters a boiler where it is heated at constant pressure by an external heat source to become a dry saturated vapor.
- Process 3-4: The dry saturated vapor expands through a turbine, generating power. This decreases the temperature and pressure of the vapor, and some condensation may occur.

Rankine Cycle

- Process 4-1: The wet vapor then enters a condenser where it is condensed at a constant pressure and temperature to become a saturated liquid. The pressure and temperature of the condenser is fixed by the temperature of the cooling coils as the fluid is undergoing a phase-change.



What is a boiler?

- The steam generating Boiler is basically a heat exchanger which has to produce steam at the high purity, pressure and temperature required for the steam turbine that drives the electrical generator.

Boiler Parts

- The Boiler includes the Economizer, the steam drum, the chemical dosing equipment, and the furnace with its steam generating tubes and the super heater coils.
- Necessary safety valves are located at suitable points to avoid excessive boiler pressure.
- The air and flue gas path equipment include: forced draft (FD) fan, air preheater (APH), boiler furnace, induced draft (ID) fan, fly ash collectors (electrostatic precipitator or baghouse) and the flue gas stack.

Air Pre-Heater (APH)

- **APH is a heat exchanger in which air temperature is raised by transferring heat from other fluid such as flue gases.**

APH TYPES

1. **Recuperative Type** : Heating medium is on one side & air is on the other side of tube /plate & heat transfer is by conduction through the material which separates the media.
2. **Regenerative Type** : Heating medium flows through a closely packed rotating matrix to raise its temperature and then air is passed through the matrix to take up the heat.

Boiler Draft Control

- **Induced draft:**

- This is obtained one of three ways, the first being the "stack effect" of a heated chimney, in which the flue gas is less dense than the ambient air surrounding the boiler.
- The denser column of ambient air forces combustion air into and through the boiler.
- The second method is through use of a steam jet. The steam jet oriented in the direction of flue gas flow induces flue gasses into the stack and allows for a greater flue gas velocity increasing the overall draft in the furnace.
- This method was common on steam driven locomotives which could not have tall chimneys.
- The third method is by simply using an induced draft fan (ID fan) which removes flue gases from the furnace and forces the exhaust gas up the stack.

- **Forced draft:**

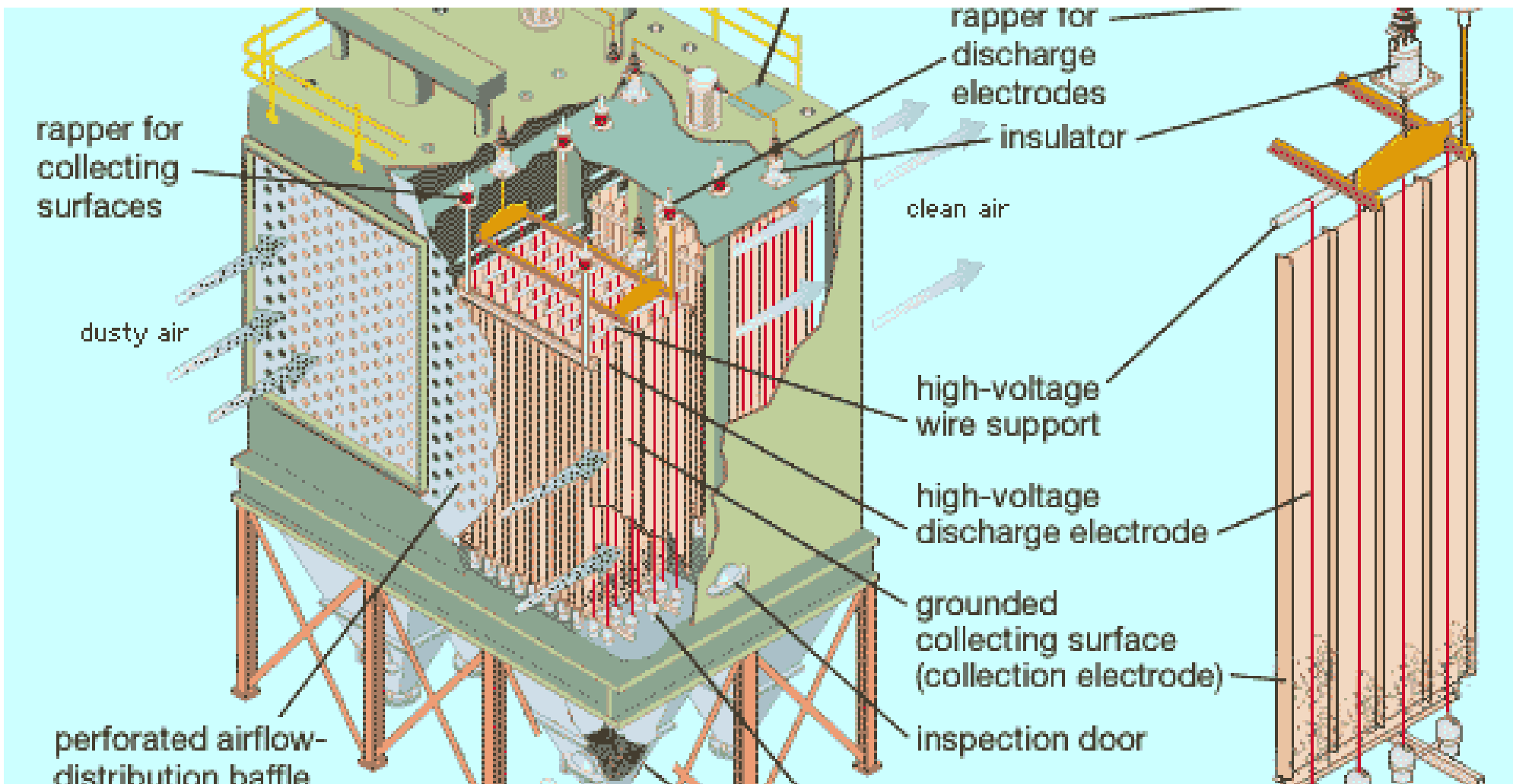
- Draft is obtained by forcing air into the furnace by means of a fan (FD fan) and ductwork.
- Air is often passed through an air heater; which, as the name suggests, heats the air going into the furnace in order to increase the overall efficiency of the boiler.
- Dampers are used to control the quantity of air admitted to the furnace.
- Forced draft furnaces usually have a positive pressure.

- **Balanced draft:**

- Balanced draft is obtained through use of both induced and forced draft.
- This is more common with larger boilers where the flue gases have to travel a long distance through many boiler passes.
- The induced draft fan works in conjunction with the forced draft fan allowing the furnace pressure to be maintained slightly below atmospheric

ESP

- An electrostatic precipitator is a large, industrial emission-control unit. It is designed to trap and remove dust particles from the exhaust gas stream of an industrial process.



Steam turbine

- A steam turbine is a mechanical device that extracts thermal energy from pressurized steam, and converts it into rotary motion.
- Because the turbine generates rotary motion, it is particularly suited to be used to drive an electrical generator – about 80% of all electricity generation in the world is by use of steam turbines.

Turbine Shaft



Principle of Operation

- An ideal steam turbine is considered to be an isentropic process, or constant entropy process, in which the entropy of the steam entering the turbine is equal to the entropy of the steam leaving the turbine.
- No steam turbine is truly “isentropic”, however, with typical isentropic efficiencies ranging from 20%-90% based on the application of the turbine.
- The interior of a turbine comprises several sets of blades, or “buckets” as they are more commonly referred to.
- One set of stationary blades is connected to the casing and one set of rotating blades is connected to the shaft.
- The sets intermesh with certain minimum clearances, with the size and configuration of sets varying to efficiently exploit the expansion of steam at each stage .

Impulse Turbine

- An **impulse turbine** has fixed nozzles that orient the steam flow into high speed jets.
- These jets contain significant kinetic energy, which the rotor blades, shaped like buckets, convert into shaft rotation as the steam jet changes direction.
- A pressure drop occurs across only the stationary blades, with a net increase in steam velocity across the stage.

Steam Condenser

- **Surface condenser** is the commonly used term for a water cooled shell and tube heat exchanger installed on the exhaust steam from a steam turbine in thermal power stations.
- These condensers are heat exchangers which convert steam from its gaseous to its liquid state at a pressure below atmospheric pressure.
- Where cooling water is in short supply, an air-cooled condenser is often used.

Alternator

- An **alternator** is an electromechanical device that converts mechanical energy to alternating current electrical energy.
- Most alternators use a rotating magnetic field but linear alternators are occasionally used.
- In principle, any AC electrical generator can be called an alternator, but usually the word refers to small rotating machines driven by automotive and other internal combustion engines

Principle of operation

- Alternators generate electricity by the same principle as DC generators, namely, when the magnetic field around a conductor changes, a current is induced in the conductor.
- Typically, a rotating magnet called the rotor turns within a stationary set of conductors wound in coils on an iron core, called the stator.
- The field cuts across the conductors, generating an electrical current, as the mechanical input causes the rotor to turn.
- The rotating magnetic field induces an AC voltage in the stator windings. Often there are three sets of stator windings, physically offset so that the rotating magnetic field produces three phase currents, displaced by one-third of a period with respect to each other.

Poles verses RPM

- The output frequency of an alternator depends on the number of poles and the rotational speed.
- The speed corresponding to a particular frequency is called the *synchronous speed* for that frequency.
- This table gives some examples:

Poles	RPM at 50Hz
2	3000
4	1500
6	1000
8	750
10	600
12	500
14	428.6
16	375
18	333.3
20	300