COAL HANDLING SYSTEMS

Due to continuously increasing demand for power at lower cost, it has become necessary to set up higher capacity thermal power stations. Rise in capacity of these plants pose problems in coal supply system from the coal mines to the power station and then during its internal handling. The transportation, loading, unloading, storage and processing of huge coal from mines to the plant and also within the plant are the major problems.

When designing a power station careful thought should be given to the coal system including the design and layout of the individual units.

A good handling system should have following objectives:
1. Minimum handling
2. Facilitate in power generation process
3. Flexibility in arrangement
4. Maximum utilization of equipment
5. Maximum utilization of space
6. Efficient utilization of manpower
7. Care for employee safety and convenience
8. Reduced integral transport
9. Easy to supervise
10. Minimum production delays and back-tracking.

Planning for coal handling should follow the systems approach so as to achieve the following:
- Increase the production effectiveness by having right quantity of coal, at right places at the right time, by avoiding delays and following the orderly flow. This helps in improving the productivity
- Reduce accident rates
- Effective utilization of space.

Following principles should be adopted while designing coal handling system:
1) **Planning Principle.** All handling activities should be planned.
2) **Systems Principle:** Handling activities be integrated and coordinated.
3) **Simplification Principle:** Reduce, combine or eliminate unnecessary movements and / or equipment by applying motion economy principles.
4) **Material Flow Principle:** Material flow pattern must be determined by operation sequence and pattern of equipment arrangement. Avoid overcrowding, back-tracking d obstacle and follow a direct path.
5) **Gravity Principle**. Utilize gravity where possible.
6) **Unit size Principle**. Increase size, quantity, weight of the load handled. Since larger the load, lesser will be the cost per unit handled.
7) **Space utilization Principle:** Optimum utilization of space.
8) **Safety Principle:** Safe handling methods and equipment for better working conditions and to avoid unsafe conditions.
9) **Mechanization Principle:** For increasing the efficiency use right type, size and standard equipment.

Coal can be handled manually or mechanically. Manual handling is not possible for modern plants. All the modern plants are employing mechanical handling. Large plants use larger size equipment, while small plants use smaller size equipment for mechanical handling.

**Advantages of mechanical handling as compared to manual handling are:**
- It is economical; operation is easy and smooth.
- It is reliable, lesser manpower required.
- Improved working conditions.
- Minimum labour required on unhealthy working conditions.

**Activities of Coal handling system** - General arrangements of activities/processes involved in mechanical system of coal handling for small and large plants located away from coal mines are shown in flow chart given below:

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Fuel delivery

Unloading

Preparation

Transfer

Outdoor storage

Covered storage

in plant handling

Weighing and measuring

Furnace firing
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The main objectives of primary preparation are:
1. Differentiating between coal and impurities like hard lumps, stones etc.
2. Removal of impurities, dirt and mud.
3. Removal of some sulphur from coal.
4. Sorting out and screening different sizes of coal pieces. Segregating high grade, medium grade and low grade coals.

Following activities are generally performed for primary preparation and cleaning.
1. Sorting out.
2. Removal of dirt.
3. Washing and cleaning.
5. Removal of metallic particles.
6. Dewatering.

Advantages of Primary Preparation and Cleaning of Coal
1. Reduced transportation.
2. Improve coal qualities.
3. Reduces pulverized operation and maintenance costs.
5. Less ash to handle.

Storage of Coal
The coal storage has following basic purposes
1. It is Insurance against complete shutdown of a plant occurring from failure of normal operating supplies to arrive; and
2. It permits some choice of the date of purchase of coal, allowing the purchaser to take advantage of seasonal market conditions.

The storage methods vary depending upon temperature, rains, wind conditions at site. Tropical areas need special storage precautions to avoid spontaneous fires due to self-heating of exposed coals. Type of coal also dictates the choice of handling and storage method. During storage, the coal undergoes oxidation and degeneration due to chemical actions and this is known as "weathering" of coal. The weathering depends upon the nature of coal, method of storage, and exposed area, exposure to atmospheric air, sunlight, temperature, etc.

Transportation of coal - The method of transportation of coal to power station depends primarily on the location station.

Following are the methods of transportation of coal:
- Continuous transport - Buckets on wire ropes-conveyor belts
- Road transport - Tipping trucks
- Rail transport - Rail wagons
- River transport - Barges
- Ocean transport - Barges-cargo ships
Pipeline transport - Pipeline coal slurry transport
- Pipeline gaseous coal transport
Recently, the coal slurry transportation and gasified coal transportation technologies are being considered as economic alternatives, to transportation of solid coal. Coal slurry pipeline carries coal powder suspended in water. At sending end the slurry is prepared and pumped. At receiving end, the slurry is filtered and the coal is reclaimed.
If the plant is situated on the bank of a river or near the sea shore it is often economical to transport coal in barges from where the coal is then unloaded mechanically by cranes or grab buckets. The coal from the coal field to the sea port is usually transported by rail or conveyor.
Dedicated rail routes are most common. The number of wagons per train and amount coal per train varies between 50 to 30 wagons and 3000 to 8000 tons of coal approximately.
Presently in rail transportation, Marry-go-round system (MGR) is being extensively used. The system uses Hopper Wagons which are provided with bottom door by opening of which the coal can be discharged into a ground hopper while the train moves at a slow steady speed of about 1.0 kmph round a loop surrounding the coal store. These trains may be shuttling between the coal loading point of the mines and the unloading point at the power station. Coal discharges upto about 2000 tons per hour are possible with this system.
This system is suitable for round the clock operation. for this system, wagons can be loaded automatically by a sophisticated electronically controlled, integrated loading and weighing system capable of feeding 60 tons of coal into each wagon in one minute with the train moving at about 1.0 to 1.2 kmph.
The coal transport through pipeline has following advantages.
1. This system is capable of transporting very large quantities continuously unaffected by the climate.
2. It is reliable and safe, because of absence of moving machines.
3. It can also be used in difficult terrain where use of other modes of transport is difficult.
4. Manpower requirement is very low and maintenance charges are also low.
5. Loss or theft of coal during transport is eliminated.
6. It has least environmental hazards like noise, dust problem and traffic congestion.
7. It requires very less areas as the site dumping and storage requirement is eliminated
However, this system has following disadvantages:
1. This system requires large quantity of water to make slurry.
2. Preparation of coal at the pumping terminal, and dewatering and recovery of the coal at the delivery terminal requires special arrangements.
3. This results in some loss of useful heat of coal due to added surface moisture of about 10%,
Coal Unloading - For unloading coal in all modern power stations, mechanical unloading devices are required as number of wagons arrived every day is large.

Following equipments are generally used for unloading from railway wagons:
(i) Unloading bridges or tower cranes
(ii) Grab buckets
(iii) Car shakers
(iv) Rotary car dumpers
(v) Coal accelerators etc

When the coal is transported by sea, the unloading devices used are:
a) Unloading bridges or tower cranes
b) Self unloading boats
c) Coal accelerators
d) Portable conveyors.
A traveling gantry crane on unloading bridges is used for unloading large coal carrying vessels. Some modern boats are equipped with their own unloading conveyors and long swinging conveyor boom which can be adjusted to carry the coal from the vessel to the desired storage point on the shore.

When the coal is transported by road, the use of tipping trucks with scoops is always recommended. As already mentioned, the method of transport of coal by road is employed only for smaller plants.

The type of coal unloading equipment used in thermal power plant depends upon the type of output plant handling mode, i.e., by road, rail or ship.

Storage at Plant
Coal reserves for large plants are usually stored outdoors next to the plant. Bulldozers are used as outside storage equipment and this enables coal to be pushed to which ever stockyard is most convenient. It has the great advantage of flexibility of application. The size of storage near the plant depends upon the storage in the mining. In case the storage in the mining area is not sufficient, the storage near the plant should be large enough to meet 3 to 4 months requirement of the plant.

In-plant handling:
Preparation -
Primary preparation and cleaning should be performed in the plant with final preparation. The cleaning and primary preparation is shown in Fig. below:
As seen in the figure below, crushing may be done before and/or after screening. The equipment used for crushing includes rotary crushers, double roll crushers, hammer mills, etc. Fine coals are washed in specific gravity type cleaning system wherein sulphur, sand and washable impurities like dirt, pyrite sulphur is removed from coal and specified purity is obtained in the form of floating coal, which is accepted.
The coal preparation plant can either be located near the coal receiving point or at the point of actual use, i.e. just before indoor live storage (bunker).
The coal preparation plant includes the following equipment:
(a) Crushers  
(b) Sizers  
(c) Dryers  
(d) Magnetic separators.

The flow diagram of the coal preparation plant is shown in Fig below:

The coal crushers are necessary to prepare the coal of required size before feeding to the combustion chamber. The part of the coal obtained from mines which does not require further processing is called acceptable coal.
sizing is bypassed. The capacity of coal crushers (available upto 600 tons per hour) must be sufficient enough to meet the peak load requirements. The crushed coal is passed over the sizer (generally vibrating screen) which removes over sized coal and feedback to the crusher.

The sized coal is then further passed on to the drier to remove the free excess from the coal. In the drier, hot flue gases are passed through the coal storage in closed spaces for removing the moisture from the coal. Before supplying the coal after preparation to the storage hopper, the iron scrap and metallic particles are removed with the help of magnetic separators. These iron particles though may not harm in mechanical stokers type of combustion chambers, but may choke the burners and may also increase the wear of the handling equipment.

**Coal Transfer**

After the coal is prepared, it is transferred to live storage (bunkers), for which one of the following equipment in suitable combination are used depending upon the local conditions. :

1. **Belt conveyors** - consists of an endless belt moving over a pair of end drums (rollers). at some distance a supporting roller is provided at the centre. belt conveyor is suitable for the transfer of coal over a long distance.

![Belt conveyor diagram](image)

2. **Screw conveyors** - consists of an endless helical screw fitted to a shaft. The screw while rotating in a trough transfers the coal from feeding end to discharge end.

![Screw conveyor diagram](image)
3. **Bucket elevators** - consists of buckets fitted to a chain. The chain moves over two wheels. The coal is carried by the buckets from bottom and discharged at the top.

4. **Grab bucket elevators** - it lifts and transfers the coal on a single rail or track from one point to another. This requires less power for operation and requires minimum maintenance.

5. **Skip hoists** - it consists of a vertical or inclined hoistway a bucket or a car guided by a frame and a cable for hoisting the bucket.
6. Flight conveyors. - it consists of one or two strands of chain to which steel scraper or flights are attached which scrap the coal through a trough having identical shape.

Live storage or covered storage (or Boiler room storage)
This is the storage from which coal is withdrawn and supplied to combustion equipment with little or no handling. this storage also is known as bunker and consists of about 24 to 30 hours of coal requirements of the plant and usually in covered area in the plant near the boiler furnace.
In-plant handling of Coal
An implant handling system feeds the coal from covered storage (boiler room storage to the firing equipment. In case of mechanical stoker firing, Only Chutes are required to feed the coal from storage bunker to the firing units. Gates and valves are provided in this system to control the flow according to the load of the plant.
The pulverized fuel firing system requires a number of equipments for implant handling such as chutes, pulverized mills, feeders, weighing equipment, etc. The chutes corrosion and abrasion resistant materials.
Implant handling also uses the same equipment as used during transfer of coal such as belt conveyer, screw conveyors, bucket elevators etc. Weigh Lorries hoppers and automatic scales are used to record the quantity of coal delivered to the furnace.

Coal weighing methods
Weigh lorries, hoppers and automatic scale: are used to weigh the quantity of coal. The commonly used methods to weigh the coal are as follows;
(i) Mechanical (ii) Pneumatic (iii) Electronic,

COAL CRUSHING AND PULVERIZING
After the preparation, the coal is taken to the crusher for being broken into the feed size. Pulverizing process of coal has three functions: (a) feeding, (b) drying, and (c) grinding. The feeding system controls the fuel feeding rate according to the boiler demand and the required primary air rate for drying, and then transporting the pulverized coal and primary air system to the burner. Dryers are the integral part of the pulverizing equipment. adjustment of air temperature and quantity to suit the moisture content of coal and also to provide the required proportion in air fuel ratio is an essential function of the pulverized. The grinding function is performed by impact, attrition, crushing, or combination of these. The main requirement of grinding is that, it should not only be fine, but also of a consistent degree of fineness.

for large scale generation of energy, the efficient method of burning coal is confined still to pulverized coal combustion. the pulverized coal is obtained by grinding the raw coal in pulverizing mills. the various pulverizing mills used are (1) bowl mill, (2) hammer mill, (3) ball and race mill, (4) bowl mill. The coal pulverizing mills reduce coal to powder form by three actions, 1) impact,2)attrition (abrasion),3). Crushing. in impact type mills, the hammers break the coal into smaller pieces whereas in abrasion type the coa; pieces rub against each other or metal surfaces to disintegrate. in crushing type mills, coal caught between metal rolling surfaces gets broken into pieces. the crushing mills use steel balls in a container and these balls act as crushing elements.

1. Ball Mill.- A line diagram of ball mill using two classifiers is shown in Fig. It consists of a slowly rotating drum which is paralleled with steel balls. Raw coal from feeders is supplied to the classifiers from where it moves to the drum by means of a screw conveyor. As the drum rotates the coal gets pulverized due to the combined impact between coal and steel balls. hot air is introduced into the drum. The powdered
coal is picked up by the air and the coal enters the classifiers, where sharp changes in the direction of the mixture throw oversized coal Pericles. The over-sized particles are returned to the drum. The coal air mixture from the classifier moves to the exhausted fan and then it is supplied to the burners.

2. Ball and Race Mill.

in this mill, the coal passes in between the rotating elements again and again until it has been pulverized to desired degree of fineness. The coal is crushed between two moving surfaces, namely, ball and races. The upper stationary race and lower rotating race driven by a worm and gear hold the ball between them. The raw coal supplied falls on the inner side of the races. The moving balls and races catch coal between them to crush it to a powder. The necessary force needed for crushing is applied with the help of springs. The hot air supplied picks up the coal dust as it flows between the balls and the races and then enters the classifier. Where oversized coal particles are returned for further grinding, where as the coal particles of required size are discharged from the top of classifier. In this mill coal is pulverized by a combination of crushing, impact and attrition between the grinding surfaces. The advantages of this mill are as follows:
(i) Low capital cost,
(ii) Lower power consumption,
(iii) Lower space required,
(iv) Lower weight.

However, in this mill there is greater wear as compared to other pulverisers. The use of pulverized coal has now become the standard method of firing in the large boilers. The pulverized coal burns with some advantages that result in economic and flexible operation of steam boilers.
The fuel moves to the automatic balance and then to the feeder and ball mill through which hot air is blown. It dries the pulverized coal and carries it from the mill to the separator. The air fed to the ball mill is heated in the air heater. In the separator dust (fine pulverized coal) is separated from large coal particles which are returned to the ballmill for regrinding. The dust moves to the cyclone. Most of the dust (about 90%)
from cyclone moves to bunker. The remaining dust is mixed with air and fed to the burner.

3. **Ball tube mill.**
Preparation of pulverized fuel with an intermediate bunker and ball tube mill is shown in Fig below.

Coal is generally ground in low speed ball tube mill. It is filled to 20-35% of its volume, with steel balls having diameter varying from 30-60 mm. The steel balls crush and ground the lumps of coal. The average speed of rotating of tube or drum is about 18-20 rpm.

4. **Shaft mill.**
The fuel from bunker is feeder via automatic balance. Then from duct fuel goes to mill where it is crushed by beaters secured on the spindle of the mill rotor. The pulverized fuel is dried up and then blown into shaft by hot air. Secondary air is delivered into the furnace through holes to burn the fuel completely.
Ash Handling
After coal, ash handling is another major task. In the case of coal fired boilers about 10 to 15% of the total weight of the coal fired is collected in the form of ash. A thermal power plant of parity produces about 2000 to 3000 tons of ash per day. This will require a large ash m and also requires a large area of land for dumping.
A large quantity of ash produced in steam power plants using coal. Ash produced is about 10 to 20% of the total coal burnt in the furnace. Handling of ash is a problem because ash coming out of the furnace is too hot, it is dusty and irritating to handle and is accompanied by some poisonous gases. It is desirable to quench the ash before handling due to following reasons:
1. Quenching reduces the temperature of ash
2. It reduces the corrosive action if ash
3. Ash forms clinkers by fusing in large lumps and by quenching clinkers will disintegrate
4. Quenching reduces the dust accompanying the ash.
The ashes should be discharged and dumped at a sufficient distance from the power plant. Ash handling is a major problem due to the following difficulties in the handling and disposal:
(i) It is hot when comes out of the boiler furnaces
(ii) It is abrasive and wears out the conveyors, containers and Other handling equipment
(iii) It produces dust nuisance.
(iv) It produces poisonous gases.
(v) It has corrosive action.
(vi) It forms clinkers by fusing together in lumps,
(vii) It is dusty hence irritating and annoying to handle.

**Principle requirements of an ash handling system.**
1. The ash handling plant should be able to handle large clinkers, boiler refuse, dust, etc., with minimum efforts and attention.
2. The plant should be able to deal with hot and wet ashes, and operate with minimum noise and within desirable / mandatory limits of dust nuisance.
3. Minimum operation and maintenance charges.
5. Should be able to handle the maximum quantity of ash produced / likely to be produced.
6. It should have provision on meeting the additional capacity with minimum changes.

**ASH HANDLING EQUIPMENT**
Mechanical means are required for the disposal of ash.
The handling equipment should perform the following functions:
1. Capital investment, operating and maintenance charges of the equipment should be low.
2. It should be able to handle large quantities of ash,
3. Clinkers, soot, dust etc. create troubles; the equipment should be able to handle them smoothly.

4. The equipment used should remove the ash from the furnace, lead it to the conveying system, to deliver the ash to a dumping site or storage and finally it should have means to dispose of the ash.

5. The ash equipment should be corrosion and wear resistant.

Fig. below shows a general layout of ash handling and dust collection system.

The commonly ash handling systems are as follows:

(i) **Hydraulic system**;
(ii) **Pneumatic system**;
(iii) **Mechanical system**
(iv) **Steam jet system**

1. **Hydraulic system**.

In this system, ash from the furnace grate falls into a system of water possessing high velocity and is carried to the sumps. It is generally used in large power plants. Hydraulic system is of two types, namely **low pressure hydraulic system** used for continuous removal of ash and **high pressure system** which is used for intermittent ash disposal.

Fig. below shows hydraulic system.
In this method water at sufficient pressure is used to take away the ash to sump. Water and ash are separated. The ash is then transferred to the dump site in wagons, rail cars or trucks.

The loading of ash may be through a belt conveyor, grab buckets. if there is an ash basement with ash hopper the ash can fall, directly in ash car or conveying system, **Water Jetting**.

Water jetting of ash is shown in Fig. below.. In this method a low pressure jet of water coming out of the quenching nozzle is used to cool the ash. The ash falls into trough and is then removed.

![Water jetting in ash handling](image)

**Ash sluice ways and ash sump system.**

This system shown above uses high pressure (H.P) pump to supply high pressure (H.P.) water jets which carry ash from the furnace bottom through ash sluices (channels) constructed in basement floor to ash sump fitted with screen. The screen divides the ash
sump into compartments for course and fine ash. The fine ash passes through the screen and moves into the dust sump (D.S.). Dust slurry pump (D.S. pump) carries the dust through dust pump (D.P.), suction pipe and dust deliver(D.D.) pipe to the disposal site. Overhead crane having grab bucket is used to remove coarse ash. A.F.N. represents ash feeding nozzle and S.B.N. represents subway booster nozzle and D.A. means draining apron.

The hydraulic system of ash handling is clean, dustless and healthy, because it is totally enclosed, its ash carrying capacity is considerably large, therefore, it is more suitable for large power plants, and this system is gaining more popularity in modern thermal power station because of these advantages.

2. Pneumatic system: -

In this system, the ash from the boiler furnace outlet falls into a crusher where larger ash particles are crushed to small sizes. The ash is then carried by a high velocity air or stream to the point of delivery. Air leaving the ash separator is passed through filter to remove dust, etc, so that the exhauster handles clean air which will protect the blades of the exhauster.

Installation of pneumatic system should avoid sharp bends and the lifts should be provided through a gradual sloping of the conveyor pipe. This system has been specifically developed for the handling of both abrasive and very fine, dusty materials such as ashes, fly ash, soot and fine coal.

**A pneumatic system has following elements:**

- Conveyor pipeline with fetid inlets.
- Air tight receiver combined with an efficient separator.
- Air tight discharger gates for the receiver and separator.
- Air washer or filter.
- Air exhauster.
- Storage bin with discharge gate and chute.

**A pneumatic system has following advantages:**

- In this all dust nuisance is eliminated because the materials are handled in a totally enclosed conveyer conduit.
- The materials are conveyed in a dry condition, and therefore it is discharged freely by gravity.
The entire conveyor layout is quite flexible and can thus make to fit varying physical plant conditions.
It is easy to install and is economical.

Disadvantages:
- Large amount of wear in conveyor pipes.
- High labour and maintenance charges.
- It is comparatively dirty and noisy.

3. Mechanical ash handling system

Commonly used mechanical handling system include wheel borrows, bucket elevator, belt conveyor; skip hoist, rail road cars, motor trucks, barges etc.

(a) Wheel barrows. The ash is collected directly through the ash outlet doors from the boiler into the containers / barrows moving on rails towards the dumping sit. this system is suitable for small stations.

(b) Bucket elevator. This is useful equipment when vertical lift is involved in movement of ash, The bucket is attached to an endless chain and collecting the ashes under the boiler, elevating and dumping them in storage. This system is limited to small power plants.

(c) Belt conveyors. The ash must be thoroughly quenched before it is fed on to the conveyor belt. The ash is allowed to fall through a water seal over the belt conveyor and then is carried continuously towards the dumping site or overhead bunkers. The ash is carried to the dumping site from the ash bunker with the help of trucks. The control valve is opened and closes manually to load the truck.

The ash may also be conveyed to the dump site in wagons or rail cars. The loading may be through a belt conveyor, bucket elevator or direct by gravity from the boiler hoppers. This system has high initial cost.
4. Steam Jet System - This system utilizes jets of high pressure steam, blowing in the direction of travel through a conveying pipe in which the ash from the boiler ash hoppers is fed. The application of the system is for small and medium size plants. In this system ash can be removed economically through a horizontal distance of 200 meters and through a vertical distance of about 30 meters. This equipment can be installed in a limited space and also in awkward position. Moreover the operation is noisy and the pipes carrying ash have greater wear and therefore, the pipe is required to be lined with nickel alloy.

Uses of Ash and Dust:

- Ash (fly ash) is widely used in the production of cement. Concrete made of fly ash has improved workability and strength greater than cement based concrete. The percentage of fly ash and/or bottom ash to be used in the production of concrete depends on quality of coal, combustion characteristics as these effects the chemical and physical quality of ash.
- Due to better alkaline values, ash is used for treating acidic soils. Its use for agriculture purposes have also been recently established. It has been found that ash supplies essential nutrients such as sulphur, calcium, zinc, etc. It has also been found if the ash issued in limited quantity in soil, it increases the yield of corn, turnip, and white clover.
- When about 10% of normal cement is added to pulverized fuel ash, the product acts as hardening materials and can be used for factory floors, side roads, foot paths, road base and various other construction activities.
- Pulverized fuel ash can be used as load bearing fill material.
- It can also be used for building the blocks or bricks which can be obtained by adding it to clay.
- It is used for filling up the disused quarries or abandoned mines.

DUST COLLECTION AND DISPOSAL - In coal fed furnaces the products of combustion contain particles of solid matter floating in suspension. This may be smoke or dust. The production of smoke indicates that combustion conditions are faulty and amount of smoke produced can be reduced by improving the furnace design. Smoke is produced due to the incomplete combustion of fuels, smoke particles are less than 10µ in size.

The disposal of smoke to the atmosphere is not desirable due to the following reasons:

1) A smoky atmosphere is less healthful than smoke free air.
2) Smoke is produced due to incomplete combustion of coal. This will create a big economic loss due to loss of heating value of coal.
3) In a smoky atmosphere lower standards of cleanliness are prevalent. Buildings, clothings, furniture, etc., becomes dirty due to smoke. Smoke corrodes the metals’ darkens the paints.
To avoid smoke nuisance the coal should be completely burnt in the furnace. The presence of dense smoke indicates poor furnace conditions and a loss in efficiency and capacity of boiler. A small amount of smoke leaving chimney shows good furnace conditions whereas smoke does not necessarily mean a better efficiency in the boiler room.

To avoid the atmosphere pollution the fly ash must be removed from the gaseous products before they leaves the chimney. The removal of dust and cinders from the flue gas is usually effected by commercial dust collectors which are installed between the boiler outlet and chimney.

**The principal characteristics of fly ash:**
- Density
- Disparity (particle size)
- Electric resistance (for electrostatic precipitators)
- Coalescence of ash particles

**Types of Dust collectors**
Dust collectors can be classified into two broad categories:

1. **Mechanical Dust Collectors.**
2. **Electrical Dust Collectors.**

**Different types of dust collectors for different firing system are as under:**
(a) Gas and oil firing: - No dust collector is necessary.
(b) Stoker firing: - . Cinder catchers, cinder vane fans.
    - Centrifugal collectors (cyclonic separator)
(c) Pulverizing fuel firing - centrifugal collectors, wet scrubbers,
    - Electrostatic collectors.

**Mechanical dust collectors** - they are subdivided into **Dry type and wet type**
In wet type collectors, also known as scrubbers, water sprays are used to wash dust from the flue gases.

(A) **Dry type mechanical dust collectors**
**Gravitational Separators:** - The basic principles of these mechanical dust collectors are shown in fig (a.) by increasing the cross-sectional area of duct through which dust laden gases are passing, the velocity of gases is reduced and causes heavier dust particles to fall down. Changing the direction of flow (Fig. (b)) of flue gases causes the heavier particles to settle out. Sometime baffles are provided as shown in Fig (c) to separate the heavier particles.
1. Cinder Catcher. - Cinder catcher is used to remove dust and cinders from the gas. In this catcher the dust laden gas is made to strike a series of vertical baffles that change in direction and reduce its velocity. The separated dust and cinders fall to the hopper for removal. Cinder catchers are ordinarily used with stoker firing.

2. Cinder Vane Fans. - It is essentially an induced draft fan with an arrangement to withdraw part of the whirling gas from the casing through small tangential slotted openings. Dust laden gas from a stoker fired furnace entering the scroll outer side. While the gas sharply changes direction to enter the rotor, the centrifugal force carries the dust particles along the edge of the scroll.
3. Cyclonic (Centrifugal) Separators.

In this collector, a high velocity gas stream carrying the dust particles enters at high velocity and tangential to the conical shell as shown in Fig. This produces a whirling motion of the gas within the chamber and throws heavier particles to the sides and fall out of the gas stream and are collected at the bottom of the collector. These cyclone collectors can be used as single unit or multi-units in parallel. The performance of these collectors depend upon flue gas volume, particulate loading, inlet velocity, temperature, diameter to height ratio of cyclone and dust characteristics.

4. Bag House Dust Collectors.

Generally, low sulphur coal (less than 1%) and temperature under 300°C favour a Bag-house collector (i.e. fabric filters), while higher sulphur content and higher temperatures favour an electrostatic precipitators. A well designed and maintained bag-house collector (particle size above 1 µ) will collect 99.9% of dust and the efficiency is independent of the amount of dust in the flue gas.
Fabric filters are made of porous material which retains particulate matter while the carrier gas flows out through the voids. A fabric filter element is usually made in the form of a long, hollow cylindrical tube that provides a large surface area per unit of gas volumetric flow rate (sq.m/cum gas flow). The reciprocal of this parameter is called the air-to-cloth ratio. A fabric filter system usually contains a large number of fabric filter elements arranged in parallel rows, called a bag-house. A power plant bag house might contain several thousand vertical hollow cylinders, each ranging in diameter from 125 to 300 mm and up to 12.5 m in height.

(B) *Wet type mechanical dust collectors (scrubber)*

It is similar to a mechanical ash collector but has a flowing water film on its inner walls. Due to this film, collected ash is removed more rapidly from the apparatus to the bin and there is less possibility for secondary capture of collected dust particles by the gas flow. The degree of ash collection in scrubbers varies from 0.82 to 0.90. The dust laden gas enters through the inlet pipe.

**Electrostatic Premeditators (ESP)**

It has two sets of electrodes, insulated from each other, that maintain an electrostatic field between them at high voltage. The flue gases are made to pass between these two sets of electrodes. The electric field ionizes the dust particles that pass through it attracting them to the electrode of opposite charge. The other electrode is maintained at a negative potential of 30,000 to 60,000 volts. The dust particles are removed from the collecting electrode by rapping the electrode periodically. The electrostatic precipitator is costly but has low maintenance cost and is frequently employed with pulverized coal fired power stations for its effectiveness on very fine ash particles and is superior to that of any other type.
An Electrostatic precipitator has following basic components

**Gas Conditioning.**
Gas conditioning is the injection of small quantitative of SO\(_3\) into the flue gas. This reduces electrical resistivity of fly ash and thus makes the dust more amenable to collection in the electrical precipitated. Thus, it increases the collection efficiency of the precipitator.

**Installation of Dust Collectors**
Dust collectors are installed between the boiler outlet and the chimney; generally on the chimney side of the air-heater. In this case, the heat utilized for heating the air in the air-heater is more as there is no loss of heat in collectors, as heaters are prior to the dust collectors. But some prefer keeping the dust collectors before the air-heaters because it maintains the air-heater more clean and reduces the cleaning charges. However, the general practice is to keep the dust collectors after the air-heaters and use soot blowers to clean the air-heater surface area.

**Combined operation of dust collectors**
In order to take advantage of different types of dust collectors, these are used in various combinations.

**Some of the commonly used combinations are:**
- Combined cyclone and bag-house collectors
- Combined dry mechanical and electrical collectors
- Combined wet mechanical and electrical collectors