7

Coal Handling, Storage, Preparation & Feeding

7.1. INTRODUCTION

Coal handling and storage systems are experiencing many changes as coal gradually plays a dominant role as a fuel. The predicted growth in coal fired plants is 90% in the next five years, as 250 new power stations are expected by 2000 only in USA.

Continuously increasing power demand even in developing countries calls for setting up of higher capacity power stations. Rise in capacity of plant poses problems in coal handling systems. A good coal handling plant must perform two duties as unloading the coal from railways wagons as fast as possible and then transferring the unloaded coal either to coal bunkers or in the stock pile for storage and then feeding the coal from the stock pile to the bunkers when railway wagons are not available.

Today, most of the world's coal production is still consumed in the countries where it is mined. Only about 10% of the total production are traded internationally. Coal used for power plants accounts for only 30% of the total coal traded internationally, and much of this goes only short distances, such as from Poland to Russia and Western Europe and from USA to Canada. In contrast, 65% of the world's oil is traded internationally.

The future of the world coal trade will require construction of greatly enlarged transportation system and this in turn will involve massive investment and long lead times. Much progress has been already made by improving operating procedures and by scaling up conventional equipment. Even with present technology, there are still considerable opportunities for increasing the capacity of the present infrastructure by improving existing ports to take larger ships and adding more large ships to the dry bulk fleet.

Main sources of exported coal are likely to be the USA, Australia, Southern Africa, Canada, Poland, USSR and possibly China. In due course, Columbia and Botswana are likely to emerge as significant exporters of coal.

7.2. OUT-PLANT HANDLING OF COAL

Continuously increasing demand for power at lowest cost calls for setting up of higher capacity power stations. Rise in capacity of the plant poses a problem in coal supply system from the coal mines to the power station.

With an increase in power plant capacity, the coal requirements per day are considerably large. An annual consumption of a 2000 MW station amounts to approximately 5 million tons per year or 20,000 tons daily over 250 days.

The coal from the coal mines to the power station is transported by sea or river or rail or road. The supply of coal by road is limited to a small capacity power plant and this mode of handling the coal does not play much important part in modern capacity power plants.

(*a*) **Transportation by Sea or River.** Pithead generation is the answer to the bottlenecks of coal transport by rail from the mines to power station. The concept of seaboard stations recognises the immediately realiable potential of sea transport along the country's coast line. If the power plant is situated on the bank of river or near the sea shore, it is often economical to transport the coal by ships or barges. The coal brought by the ship is unloaded mechanically by cranes or grabbuckets at the site of the power plant. The unloaded coal from the ship is either sent to storage yard or directly to the conveyor system which carries coal directly to the combustion chamber hopper. Many power stations located on the banks of the large river in U.S.A. receive coal by barge as it is more economical than other modes of transport. This mode of transport is on the upsurge because of better equipments and improved navigation. Barge transport terminals on Mississippi and Ohio rivers are increasing.

Coal is generally transported in the largest possible vessel because the freight savings obtained depend on the length of the haul and availability of shore facilities for loading and unloading at adequate rate. An average saving of 25% can be achieved using a 150×10^3 dwt instead of 60000 dwt ship. Until recently, the largest ships, carrying coal were in the *Panamax* class (50 to 80 thousand dwt). The growth of trade and improved port facilities have allowed an increased use of ships in the 120 to 175×10^3 dwt class.

The future of Ocean transport in India is also bright. With the current development of the Bengal-Bihar coalfields and Haldia port loading facilities, 56.5 miles downstream of Calcutta, coal supplies can be made to the coastal stations to synchronise with their commissioning. Coal unloading from ships at the receiving ends would be alongside piers where suitable docking facilities are constructed in time. Haldia's rail connection with main Howrah-Kharagpur line is at Panchkura railway station about 71 kilometres from Howrah. This will provide the rail communication between Haldia and Raniganj coalfield 325 km from Haldia. Haldia port is currently being developed for handling two million tonnes of coal per year. The loading of 1500 tons of coal per hour is also provided at the station and the capacity of the storage yard is of 350×10^3 tons of coal. The Haldia port facility will be capable of loading the ships of 60,000 dwt class.

The coal from the coal field to the sea port is usually transported by rail or conveyor. The unit train is the most economical transportation system for inland transport of coal. These operate on dedicated routes and avoid extra delays and costs of marshalling. The number of wagons per train and amount of coal per train lie between 50-130 wagons and 4000-13000 tons of coal.

The loading and unloading of huge amount of coal to the ships are the major problems with ship transport. High speed loading and unloading facilities are developed so that each operation can be performed within 3 to 4 hours.

A huge ship loader shown in Fig. 7.1 established at the Alabama port has tripled its coal handling capacity. The machine moves on the rails and handles 50,000 tons of coal per hour. Its 30 m long boom rises to clear ship masts and chute and controls the direction.

Fig. 7.1. Shiploader at Alabama port.

(*b*) **Transportation by Rail.** The transportation of coal by rail is the most important means of transportation in common use. The coal supply to Indian power plants is mainly by rail as unfortunately river transportation is not available. This mode of transport plays very important role for power stations which are located interior. A railway siding line is taken to the power station and coal is either delivered to the storage yard or close to the point of consumption.

The ordinary rail tracks available (like in India) will not be able to supply the required coal to large power stations.

To overcome this difficulty, a "unit train" system has come into existence both in Europe and U.S.A. The "unit train" system consists of 130 to 150 wagons and each wagon can be titled individually. The couplings are so designed that they remain intact even though the next wagon is being titled. There is no necessity to remove the coupling during unloading the coal from one wagon after another. A circular route is arranged for the train linking the coalfields to the power station. The trains move continuously round the clock along the circular track of train. The train track being in continuous form, is known as 'Merry Go Round' (MGR) in U.K.

A 3200 MW Monros power station (64 km from Detroit) in U.S.A. uses a unit train system to get coal from coal fields 576 km away from the power station. The coal is loaded at the rate of 3000 tons per hour. Unloading at the rate of 17400 tons is done for each trip. Each train is pulled by 5 locomotives of 3000 H.P. at a speed of 64 km per hour.

Another unit train system used in U.S.A. is at River Rouge power station of 933 MW capacity. No driver is required for the engine during unloading for this system. The engine is started every time by remote control and one wagon is unloaded and that moves one car length and stops again. This results in saving in man power and time during unloading. The first MGR system will be installed in India to carry coal from Kusmunda mines to Kobra plant of 1100 MW capacity.

Rapid Train Loading System for Gevra Project.

A British firm, in collaboration with a firm in Calcutta, will supply a rapid train loading system for Western Coalfields Ltd., Gevra, Madhya Pradesh, at a value of Rs. 45 million.

The Gevra opencast mining project, when completed, will have a production capacity of five million tonnes (Mt) a year in the first phase. This capacity will be extended to 10 Mt a year in the second phase. The mine is linked to the Korba super thermal power station, which will have an ultimate capacity of 2100 MW.

The rapid train loading system will be of the merry-go-round type, that is, the train will operate on a closed circuit track without any shunting operation at either loading or unloading point, and will be used to deliver coal from the mine to the Korba power station. Trains consisting of up to 35 wagons will 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 up to 1.2 km/hr.

The system will be suitable for round the clock operation, seven days a week, and will despatch 10 Mt of coal a year from mine to power station, that is, 18 to 20 trains a day.

(*c*) **Transportation by Ropeways.** This is very efficient method of transporting the coal from the mine to the power station. This is particularly used when the distance between the mine and power station is less than 10 kilometres. The major advantage of this system is, it supplies the coal continuously and free from workers' strike which is common with rail transport.

(*d*) **Transportation by Road.** The transportation of coal by road is used only for small capacity plants. The major advantage of road transport is that the coal can be carried directly into the power house upto the point of consumption. This is better system for small capacity plant as traffic restrictions are comparatively less.

The lorries used for coal transport are self-tripping, their containers have usually one or two hydraulic cylinders which are actuated by the engine itself. The lorries are emptied after weighing is carried out on weighing platform by end tripping either into ground hoppers with belt conveyors underneath or on to the open coal storage.

The selection of proper method of coal supply from the coal mines to the power stations depends upon the system capacity in tons per hour, location of the plant with respect to rail or water facilities available and location of available outside storage and overhead coal bunkers.

The coal handling system used at Koradi power station in Maharashtra is a typical one as ropeways, railways and road transport are used simultaneously to supply the coal to the power plant.

(*e*) **Transportation of coal by pipeline.** The power demand throughout the world is increasing quite faster and coal is going to be the only fuel to run the thermal plants as liquid fuel prices are escalating day by day. In most of the countries, the power generating stations are far away from the coal mines and the existing railway facilities are not sufficient to cope up with the increasing demands. In India, it is expected that the power demand will be doubled by the end of the century and it is physically impossible for the railways to haul the required coal to the coming-up power plants.

Transportation of coal by pipeline is considered most speedy method among all available. Pipe lining of coal slurries from remote mines to strategically located generating plants shows great promise for future development.

The pipeline coal transport system offers many advantages as listed below :

(1) It is a continuous transport system unaffected by the climate and weather.

(2) It is capable of transporting very large quantities of coal (25 million tons per year with a single pipeline).

(3) It has high degree of reliability and safety as the moving machines are limited to the stationary pumping and boosting stations.

(4) It is easy to carry the pipeline through difficult terrain like hills, valleys and swamps compared with other modes of transport.

(5) Man-power requirement is low and maintenance charges are also low.

(6) Loss of coal during transport due to theft is totally eliminated.

(7) Requirement of large areas as in the case of railway system for site dumping and storage is eliminated.

(8) The system is amenable to automation, increasing its reliability and smooth operation. 99% reliability has been already proved with the operation of Black Mesa system in USA from last 20 years.

(9) It produces the least environmental disturbance as noise and dust problem and traffic congestion is drastically reduced.

(10) It provides simplicity in installation and increased safety in operation.

(11) It is more economical than other modes of transport when dealing with large volume of coal over long distances (50 – 75% of rail cost).

(12) The impact of inflation on the operating cost is less than other modes of transport.

Some of the disadvantages of the system are listed below :

(1) It requires large quantity of water as 1 kg of coal requires one kg of water.

(2) Preparation of coal at the pumping terminal as well as dewatering and recovery of the coal at the delivery terminal requires high capital and operating cost.

(3) Consumers must be able to use coal with added surface moisture (10%). This also results in some loss in the useful heat of coal.

The System. The pipeline transport system can be divided into three main sub-systems as described below :

(*a*) *Coal Preparation and Pumping Terminal.* The washed coal is crushed to a suitable size (14 mesh) and fed into storage bunker. The crushed coal and water is mixed to form a homogeneous slurry in the slurry preparation plant. The formed slurry is then pumped into the pipeline system. The pressure at which the slurry is pumped lies between 50 bar to 300 bar depending upon the distance and the type of the terrain.

A typical coal preparation system is shown in Fig. 7.2.

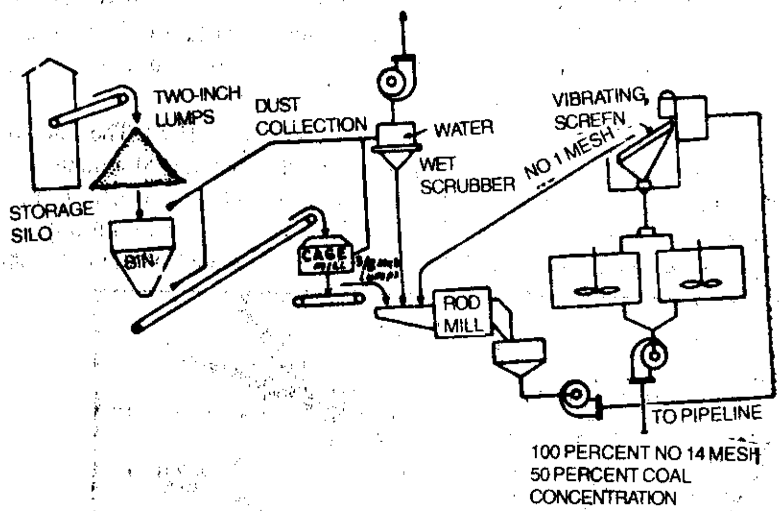


Fig. 7.2. A typical coal preparation system used for pipe transport.

(*b*) ***Pipeline and Booster Pump Station.*** The pipes are made of high quality steel capable of standing the high pressures and resisting corrosion. Pipes are coated with anti-corrosive layer and wrapped with special polythene tape. To inhibit internal corrosion, chemical additives are often introduced in the coal-water slurry. The pipe diameter varies from 30 cm (for 5 million tons of coal per year) to 95.5 cm (for 25 million tons of coal per year). Booster stations are provided when the pipe line is considerably long. The number of booster stations and their locations are based on the topography of the land along the pipe line.

(*c*) ***Recovery Terminal.*** This is the last and delivery terminal of the system. Here, the coal is dewatered and recovered for use. The system includes slurry receiving tanks, dewatering plant, drying arrangement and storage bunker. The dewatered and dried coal generally contains 9% surface moisture as further drying affects the economics adversely.

A typical recovery system is shown in Fig. 7.3.

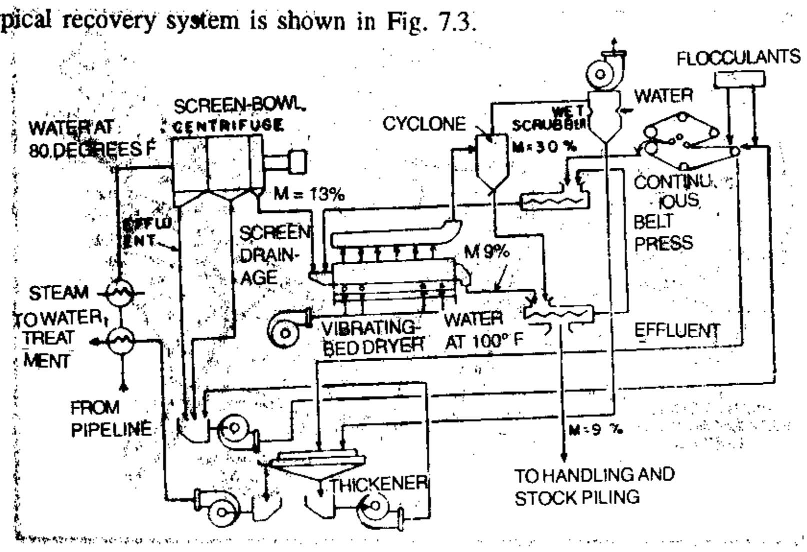


Fig. 7.3. Coal recovery system.

The first coal slurry pipeline went into operation in London. A pipe of 20 cm in diameter and 660 m long which moved 50 tons of coal per hour from barges at a dock on the Thames to a nearby powerhouse.

The longest coal slurry pipeline currently in operation is the Black Mesa line (45 cm in diameter) in USA which transports 5.5 million tons of coal per year through 273 miles from the mine in Arizona to the Mohave power plant of 1580 MW capacity in the southern tip of Nevada.

The Black Mesa line shown in Fig. 7.4 has been in steady operation since 1970. The line crosses a high desert plateau and four mountain ranges. Between the pump station-2 at Gray Mountain and No. 3 near Williams, the line climbs 3000 ft in 25 miles. The last 12 miles of the route drops 3500 ft down. The arrangement of coal supply at Mohave station is shown in Fig. 7.6. It is regarded as a prototype for the larger systems that will be built in the west before the end of the decade. One such system is planned by

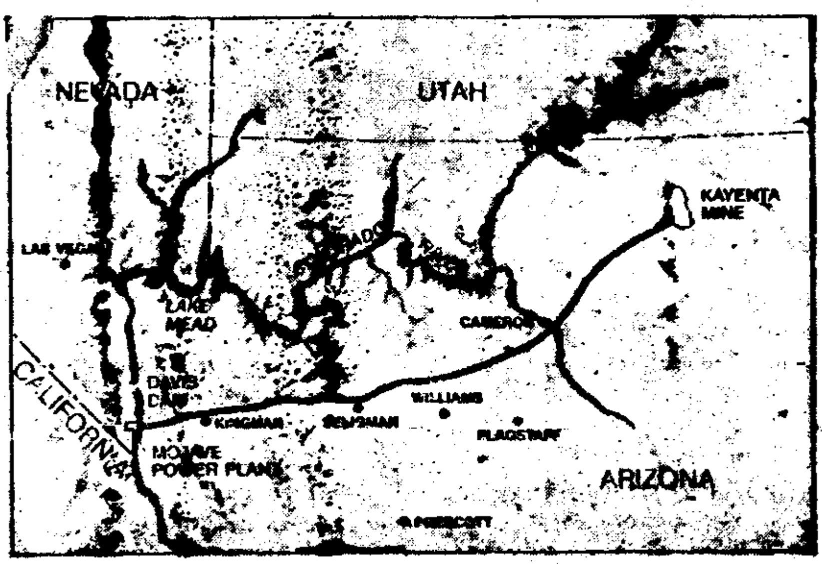


Fig. 7.4. Black Mesa Pipe Line in USA.

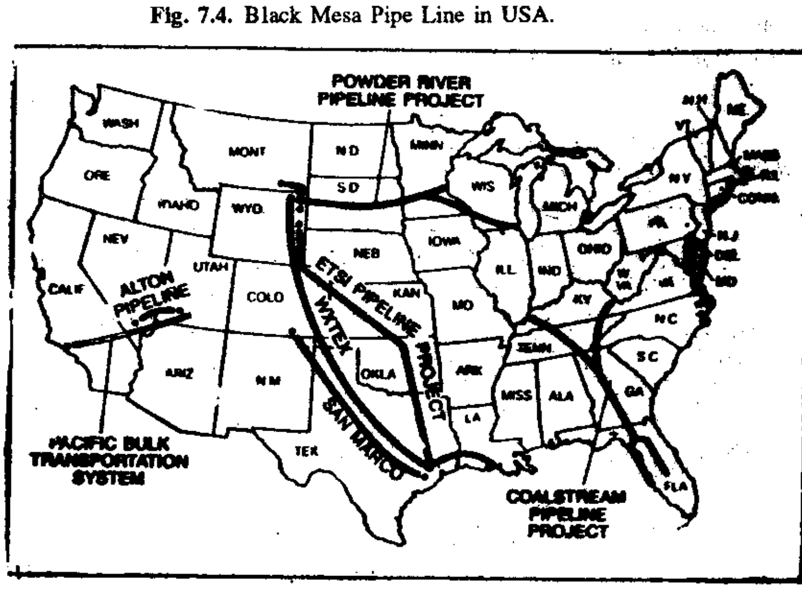


Fig. 7.5.

Energy Transportation System, Inc (ETSI) which will move coal from mines in Wyoming south as far as 1400 miles to Oklahoma, Texas and Louisiana. This will use 20,000 acre feet of water through 85 cm pipeline from Lake Oahe reservoir and will be able to transport 30 million tons of coal per year.

The longer coal slurry pipelines scheduled to go into operation by the end of the decade in USA are shown in Fig. 7.5.

Bechtel Petroleum is currently negotiating the construction of two new coal slurry pipelines in Asia. 450 mile pipe line to run from Inner Mongolia to the port of Quinhuangdao and to four power stations.

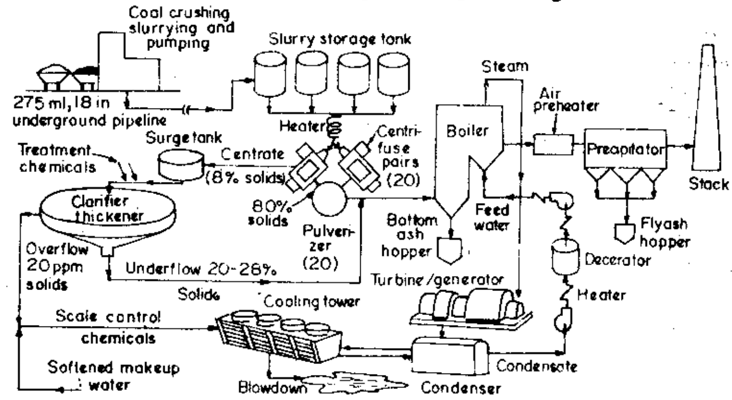


Fig. 7.6. Coal supply arrangement at Mohave power plant.

Proposals for two new coal slurry pipelines, both about 1200 miles long, are also under consideration in India. The best prospects appear to be from Singrauli mines to Wankoban power plant in Gujarat (1200 km) and to Vapi, a proposed 2000 MW plant at 1000 km distance from Singrauli.

The pipelines for carrying the ores of iron and copper are also used in USA and other countries. A 67 km iron ore slurry pipeline between Kudremukh and Mangalore operated with digital computer control is first pipeline in India.

Severe winter in foreign countries means a battle against frozen coal. Weather conditions, such as rain or snow, coupled with very low temperature and high winds, can cause entire train loads to freeze solids. The coal in the wagon can freeze to few metre depth. The following methods are used to control the coal freeze.

- Enclosed thawing sheds where electric heating is used to melt the ice. High capital costs and increasing operating costs limit its use to large utilities. Further, rapid heating may stress and damage the wagons.
- Mechanical methods are used in loading and unloading the cars. They shake, crush, ram, vibrate and break-up large frozen coal chunks.
- Freeze control agents are preferred now-a-days because of their good performance and relatively low cost. Some act as antifreeze, other weaken the crystalline structure of ice. The common agents used are glycol, oil and calcium chloride based compounds. Glycol, the most commonly used agent is applied about 2 pt/ton where coal is loaded into the silo or car.

7.3. STORAGE OF COAL AT PLANT SITE

The purpose of coal storage is twofold. First, fuel storage is an insurance against complete shutdown of a power plant occurring from failure of normal supplies. Second, the storage permits choice of the date of purchase allowing the management to take advantage of seasonal market conditions. Storage of coal protects the plant failure in case of coal strikes, failure of the transportation system and general coal shortages.

A coal storage is normally sized to have capacity of a quarter of the annual burn (1.25) million tons for 200 MW capacity plant. If the quantity is stacked at a height of 10 m, it would cover an area of 30 acres.

The storage of coal is undesirable, because it costs more as there is risk of spontaneous combustion, possibility of loss and deterioration during storage, interest on capital cost of coal lying dormant, cost of insurance, handling costs required by storage and reclamation, cost of area required, cost required to protect the stored coal from deterioration and many others. With all these disadvantages of coal storage, it is more important to public service stations as light and power have become vital and essential in every day domestic and industrial life.

A storage of 10% of the annual consumption is sufficient in most of the cases, although the factors such as nearness to coal fields, transportation facilities and weathering effects on coal must also be considered. The past experience of management concerning the frequency of interruption of coal mining by labour action has induced to store more coal than would otherwise be considered economical. It is not very uncommon to find a full twelve months coal supply in storage where ample area is available at lower cost.

The coal storages are generally divided into two groups as Dead Storage and Leave Storage. The dead storage supplies the coal where there is a shortage of coal due to mine strike, railway strike and shortage of coal due to some other reason. Storage from which coal is withdrawn to supply to combustion equipment with little or no rehandling is known as 'Live Storage'. The capacity of live storage is comparatively small compared with dead storage.

The coal storage (particularly dead) needs protection against losses by weathering and spontaneous combustion. All coals tend to combine with oxygen and slow oxidation takes place. This process of oxidation without burning is known as weathering which reduces the heat value of coal. If the oxidation is rapid, it may result in spontaneous combustion. To store the coal containing high sulphur is more troublesome because local heating further aggravates the reaction between sulphur, air and water causing rapid deterioration of coal and increases the chances of spontaneous combustion.

Lower rank coals (Lignite and bituminous) have a higher tendency to ignite spontaneously compared with high rank coals (anthracite and graphite).

Coal should be stored at a site located on solid ground, well drained, free of standing water, preferably on high ground not subjected to flooding.

The coal is stored by using one of the following methods to reduce the chances of oxidation and combustion :

1. Stocking the Coal in Heaps. The ground used for stocking should be dry and level. Generally concrete floored area is used to prevent the flow of air from the bottom. The coal is piled at height of 10 m to 12 m. During storage of coal in heaps, the coal should be compacted in layer of 15 to 30 cm in thickness by means of bulldozers and rubber-tired scrapers. This effectively prevents the air circulation in the interior of the pile. The pile top should be given a gentle slope in the direction in which rain may be drained off so that the water will be removed. But it should not be drained so rapidly as to cause serious washing.

Another method of removing the heat of oxidation is, the air is allowed to move through the layers evenly so that the heat of reaction is carried away and the temperature oif coal is maintained below the combustion temperature (70°C).

The sealing of stored pile is the best method of avoiding the oxidation of coal after packing as air-tight layer of coal.

Asphalt, fine coal dust, bituminous coating and other coating materials are used for this purpose. A coal pile of 75,000 tons at Post Washington Power Plant was satisfactorily protected by covering with 30 cm coal dust.

2. Under-water Storage. The possibility of slow oxidation and spontaneous combustion can be completely eliminated by storing the coal under water. The dock basins can be used for storage of coal under water.

The following points should be kept in mind during selecting the site for storage and piling.

1. The storage area should be free from standing water.
2. The artificial drainage in the storage area should be provided if well drained area is not available.
3. The storage area should be cleared of all foreign matter such as wood, paper, rags, waste oil or materials having a low ignition temperature.
4. The storage site should be selected in such a way that the handling cost is minimum.
5. The piles should be built-up in successive layers and as far as possible compact.
6. The piles should be dressed to prevent rain from penetrating into the pile.
7. Alternate wetting and drying of coal are undesirable.
8. Stoker size coals should be oil treated before storing. The oil treatment on the surface of coal particles slows the absorption of moisture and O_2 and compaction is not needed.
9. Unsized coal should be as compact as possible and sides of pile should not be steep.

10. Coal should be piled so that air may circulate freely through it ensuring effective ventilation to dissipate heat.
11. The storage site should not be near steam pipes, boiler blow-off lines or any other heated elements or hot water lines and tanks and hot sewer lines.
12. Storage on hot bright days should be avoided.
13. A provision for temperature check at different points should be made.
14. A conical piling should be avoided.
15. A fire fighting equipment should be easily available at the storage site.

Pulverised Coal Storage in Bunker. Periodically a power plant may encounter the situation where coal must be stored for some time in a bunker, for instance during a plant shutdown. The bunker fires can occur in dormant pulverized coal from spontaneous heating within 6 days of loading. This time can be extended to 13 days when a blanket of CO_2 is piped into the top of the bunker. The perfect sealing of the bunker from air leakage can extend the storage time as long as two months or more. The coal in the bunker can be stored as long as six months by expelling air from above the coal with the use of CO_2 and then blanketting off all sources of air. A control system used for storing the pulverised fuel in bunker is shown in Fig. 7.7.

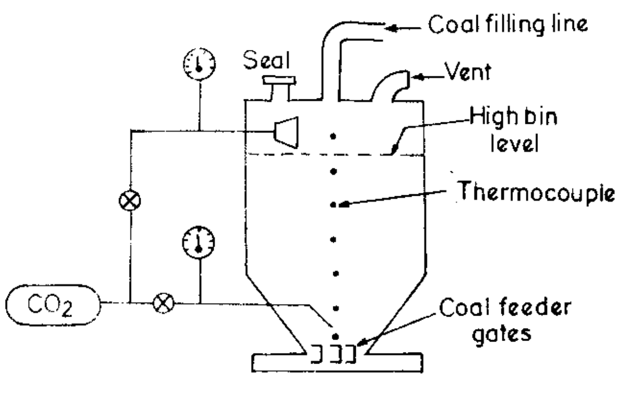
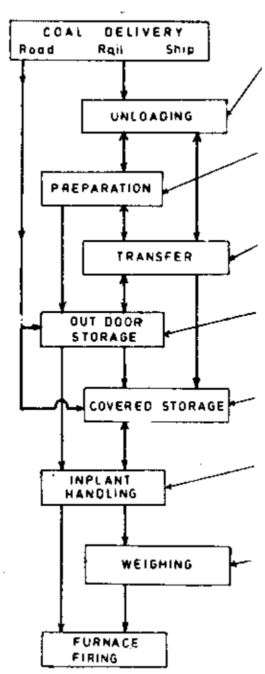


Fig. 7.7. Control system used for storing the pulverised coal with the use of CO_2.

7.4. INPLANT HANDLING OF COAL

In large power stations, it is not possible to handle large quantities of coal manually, therefore, some mechanical handling system must be introduced to the plant for easy and smooth operation and better control.



Unloading Equipments

[Car shakers, rotary car dampers, unloading towers and bridges, self-unloading boats, lifts trucks, cranes and buckets.

Preparing Equipments

[Crushers, sizers, driers.

Transfer Equipments

[Belt conveyor, Screw conveyor, Bucket elevator, skip hoist, flight conveyor.

Storage Equipments

[Bulldozer, scraper, tramways, cranes and conveyor systems.

Covered Storage Equipments

[Bins, bunkers, indicators, gates and values.

[Some equipments which are used for coal transfers.

Weighing Devices

[Scales, coal metres and samplers.

Fig. 7.8. Chart showing operations and devices used in coal handling plant

The coal handling starts at the discharge end of the carrier system (rail head or harbour) and passes through various stages such as delivery to storage, reclamation and feeding to the combustion system.

The inplant coal handling system should be designed in such a way that the inplant transportation should be minimum. The following points should be kept in mind while designing the coal handling plant :

1. The handling method should be simple and sound and require minimum operations and transport.
2. There should not be double handling of coal in the plant.
3. The handling units should be centralised to facilitate inspection and maintenance.
4. The electrical motors should be used as prime-mover as much as possible as they are reliable, flexible and with high residual value.
5. The working parts should be enclosed to avoid abrasion and corrosion.
6. It should be able to deliver required quantity of coal during peak hours. The coal handing plant capacity is generally three times of its normal requirement. It is not possible to give a outline of a coal handling plant as its complexity depends on how coal is received, how the plant is situated and flexibility of the components required. The general flow of coal in the thermal power plant is shown in Fig. 7.8. Typical devices required for each step of handling are also indicated on the flow chart.

It is not necessary to follow the flow chart shown in Fig. 7.8 for all plants. Some intermediate steps may be eliminated or rearranged depending upon the type of the plant, capacity of the plant and load factor.

Coal Unloading and Required Equipments. The type of coal unloading equipment used in the plant depends upon the type of out-plant handling mode as road, rail or ship.

Road transportation of coal by trucks is often more economical for small and medium capacity plants located within 30 to 50 kilometres of coal mines. The use of lift trucks with scops is used for coal unloading as the entire load of the truck can be easily unloaded without additional equipments. The arrangement of unloading as shown in Fig. 7.9. The coal is dumped directly into unloading hoppers which delivers the coal to hoists or conveyors. If the coal is being stored in pile, the trucks travel up ramps and dump coal directly on the pile and bulldozers spread and compact the coal on pile.

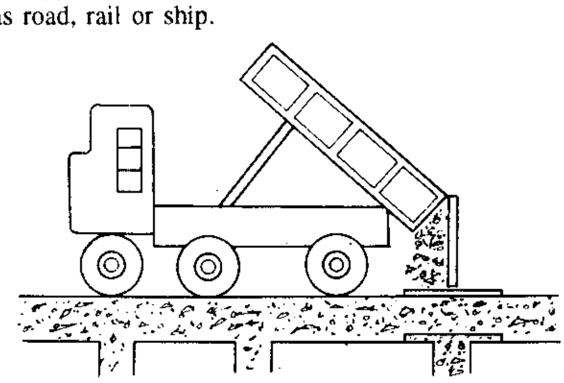


Fig. 7.9. Lift-truck with Scoop.

The railroad movement of coal is generally used for large coal quantities and for longer distances where water transportation is not available. The cars of 50 to 70 tons capacity each, with either flat bottom or a hopper bottom are used. In either case, the gates in the floor or hopper are opened to drop the coal out into an unloading hopper or directly onto a small conveyor hopper. Suitable quick unloading devices of coal cars must be provided at the unloading site. The means used for speedy unloading are (*a*) car-towers, (*b*) rotary car dumpers, and (*c*) coal accelerators.

When the coal is transported by sea, the unloading devices used are : (*a*) coal towers, (*b*) unloading bridges, and (*c*) self-unloading boats.

A travelling 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 belt conveyor boom which can be adjusted to carry the coal from the vessel to the desired storage point on the shore.

Coal Preparation and Required Equipments. The preparation of coal before feeding to the combustion chamber is necessary if unsized coal is brought to the site. The coal preparation plant either can be located near the coal receiving point or at the point of actual use.

The coal preparation plant includes the following equipments : (*a*) Crushers, (*b*) Sizers, (*c*) Dryers, and (*d*) Magnetic separators.

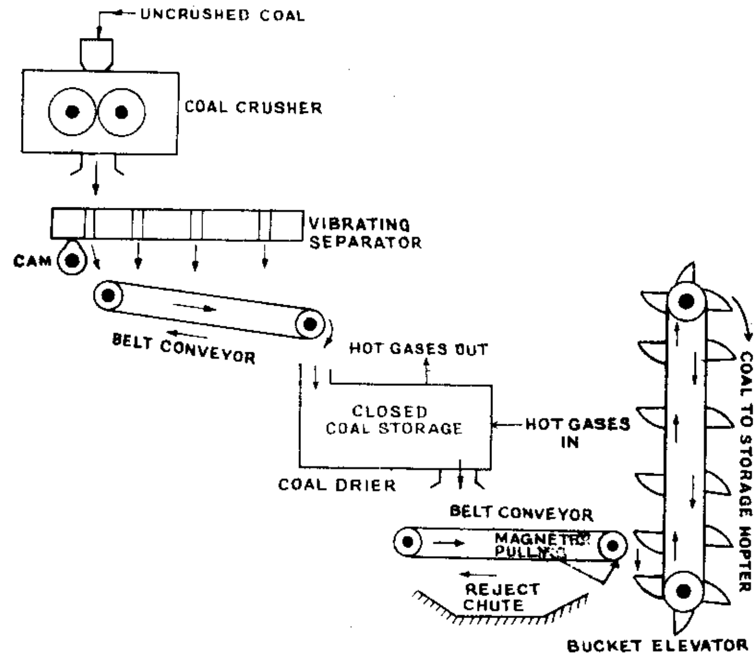


Fig. 7.10. Coal preparation plant.

The coal crushers are absolutely necessary to prepare the coal of required size before feeding to the combustion chamber. Part of the coal obtained from mines does not require sizing and is bypassed. The capacity of the coal crushing plant must be sufficient to meet the peak load requirement. The capacity of crushers used in central plant is as high as 600 tons per hour. Sizers are used along with the crushers for the separation of coal of required size. The crushed coal is passed over the sizer which removes unsized coal and feeds back to the crusher. The sized coal is further passed to the drier to remove the moisture from the coal. The coal driers are used in order to remove the excess free moisture from the supplied coal or if it is wetted during transport. Hot flue gases are passed through the coal storage in closed spaces for removing the moisture from coal.

Before supplying the coal to the storage hopper, the iron scrap and particles are removed with the help of magnetic separators. The removal of the iron particles is necessary as they may choke the burners and may increase the wear of the handing equipment. The separator is usually a magnetized pulley over which the loaded coal belt is run. The iron particles cling to the belt as it travels around the magnetised pulley, whereas the coal falls off sooner. The iron particles drop off into a reject chute as the belt leaves the pulley. Thus the coal and iron are quickly separated. The arrangement of the coal preparation plant is shown in Fig. 7.10.

Transfer of Coal and Related Equipments. Transfer of coal includes the carrying of coal from unloading point to the storage site. It may require one equipment or several depending upon local condition. The type of equipments used for transferring the coal are listed below :

(*a*) Belt Conveyors, (*b*) Screw Conveyors, (*c*) Bucket Elevators, (*d*) Grab Bucket Elevators, (*e*) Skip Hoists, and (*f*) Flight Conveyors.

The details of each are discussed below :

(*a*) **Belt Conveyors.** This is very suitable means of transporting large quantities of coal over large distances. Belt conveyor consists of endless belt made of rubber, canvas or balata running over a pair of end drums or pulleys and supported by a series of rollers (known as idlers) provided at regular intervals. The return idlers which support the empty belt are plain rollers and are spaced wide apart. The layout of the belt-conveyor is shown in Fig. 7.11.

The initial cost of this coal carrying system is not high and power consumption is also low. The belt conveyors are successfully used on inclination up to 20° to the horizontal. An average speed of the belt conveyor is 60 m to 100 m per minute. The load carrying capacity of the belt may vary from 50 to 100 tonnes/hr and it can easily be transferred through 400 metres.

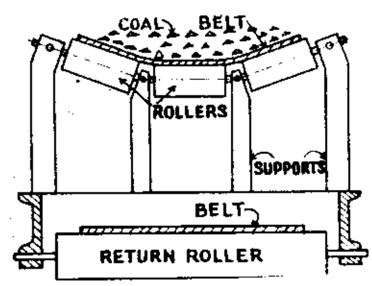


Fig. 7.11. Section through Belt Conveyor.

The advantages and disadvantages of belt-conveyor are listed below :

(*a*) **Advantages**

1. This is most economical method of coal transport in medium as well as large capacity plants.
2. The rate of coal transfer can be easily varied by just varying the speed of the belt.
3. The repair and maintenance costs are minimum.
4. The coal over the belt can be easily protected from wind and rain just by providing overhead covers.
5. The power consumption to carry the coal is minimum compared with other conveyors.

Disadvantages. 1. It is not suitable for short distances and greater heights.

2. It cannot be used to carry the coal at greater heights as its inclination is limited to 20°.

(*b*) **Screw conveyor.** It consists of an endless helicoid screw fitted to a shaft as shown in Fig. 7.12. The driving mechanism is connected to one end of the shaft and the other end of the shaft is supported in an enclosed ball bearing. The screw while rotating in a *trough* transfers coal from one end to the other end as shown in figure. The diameter of screw varies from 15 cm to 50 cm and its speed varies from 70 to 120 r.p.m. as per the capacity required. The maximum capacity of this conveyor is 125 tonnes per hour.

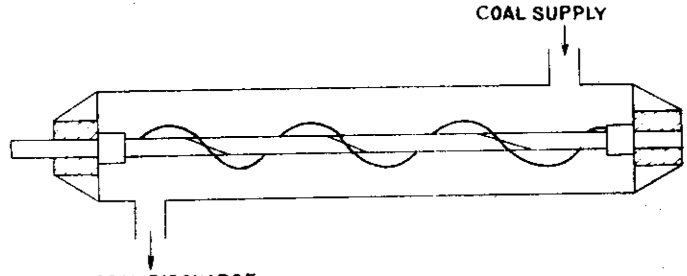


Fig. 7.12. Screw conveyor.

The advantages and disadvantages of screw conveyor are listed below :

Advantages. 1. It requires minimum space and is cheap in the first cost.

2. It is most simple and compact.

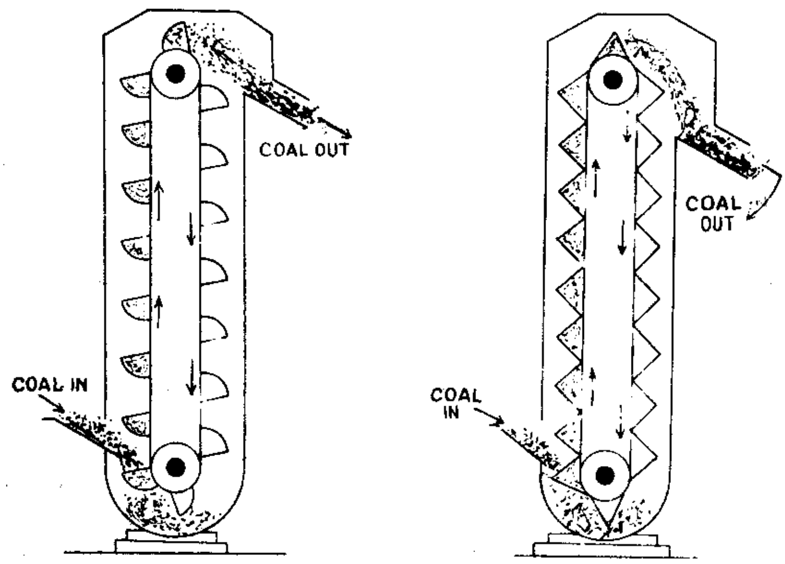
3. It can be made dust tight.

Disadvantages. 1. The power consumption per unit weight transferred is considerably high.

2. The length of feed hardly exceeds 30 metres due to torsional strain on the shaft.

3. The wear and tear is very high and therefore the life of the conveyor is considerably short compared with belt-conveyor.

(*c*) **Bucket elevators.** This conveyor is extensively used for vertical lifts. It consists of buckets fixed to a chain which moves over two wheels as shown in Fig. 7.13 (*a*). The coal is carried by the buckets from the bottom and discharged at the top. Another continuous type bucket elevator shown in Fig. 7.13 (*b*) carries more amount of coal compared with first.



(*a*) Centrifugal (*b*) Continuous

Fig. 7.13.

The maximum height of the elevator is limited to 30.5 m (100 ft) and maximum inclination to the horizontal is limited to 60°. The speed of the chain required in first casé is 75 m/min and continuous type is 35 m/min for about 60 tonnes capacity per hour.

(*d*) **Grab bucket conveyor.** A grab bucket conveyor lifts as well as transfers the coal from one point to another. The grab conveyor can be used with crane or tower as shown in Fig. 7.14. A 2 to 3 cu-m bucket operating over a distance of 60 m transfers nearly 100 tonnes of coal per hour. The initial cost of this machine is high but operation cost is less. Its use for transferring the coal is justified only when other arrangements are not possible.

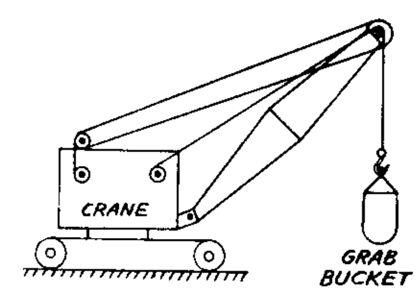


Fig. 7.14. Grab Bucket.

(*e*) **Flight conveyor.** This conveyor is generally used for transfer of coal when filling of number of storage bins situated under the conveyor is required. It consists of one or two strands of chain, to which steel scrapers are attached. The scraper scraps the coal through a trough and the coal is discharged in the bottom of the trough as shown in Fig. 7.15.

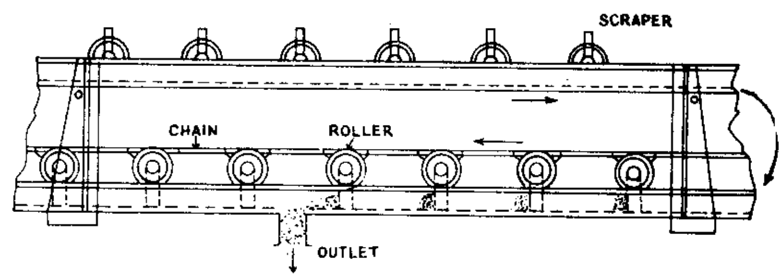


Fig. 7.15. Scraper or Flight Conveyors.

The advantages and disadvantages of flight conveyor are listed below.

Advantages. 1. It requires small head room.

2. The speed of the conveyor can be regulated easily to suit the requirements.

3. It can be used for coal as well as ash transfer.

Disadvantages. 1. There is excessive wear and tear due to scrapping action and therefore the life is short.

2. The repair and maintenance charges are very high.

3. The speed is limited to 300/min. to reduce the abrasive action of the material handled.

4. Power consumption per unit of coal or ash transferred is considerably high due to dragging action.

Covered storage and required equipments. The details of outdoor storage are already discussed earlier. Storage from which coal is withdrawn to supply to the combustion equipments with little rehandling is known as live storage or covered storage. The live storage can be provided with bunkers and coal bins. The most common form of bunker is an overhead suspension type usually made of 6 mm steel plate. Sometimes reinforced concrete is also used for the bunker construction. A protective coating is given to inside surface of the bunker to protect the bunker against the corrosive effects of sulphur in the coal.

The vertical cylindrical type is usually constructed outside the plant building. The troughed suspension type bunkers are constructed inside the building.

Inplant handling of coal. An inplant handling system feeds the coal from live storage to the firing equipment. If simple stoker firing is used, only chutes are required to feed the coal from storage bunker to firing units. In addition to this, gates and valves are included in the system to control the flow according to the load on the plant. The pulverised fuel firing system requires a number of equipments for inplant handling as chutes, pulverised mills, feeders, weighing equipments and many others.

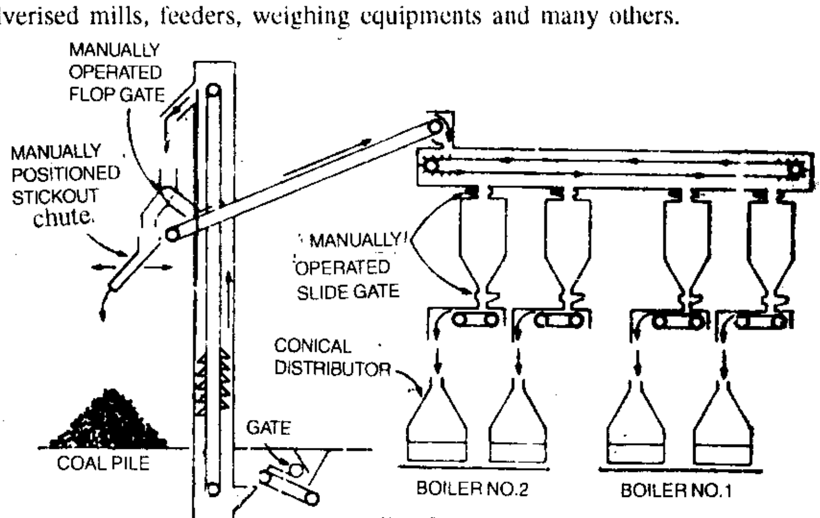


Fig. 7.16.

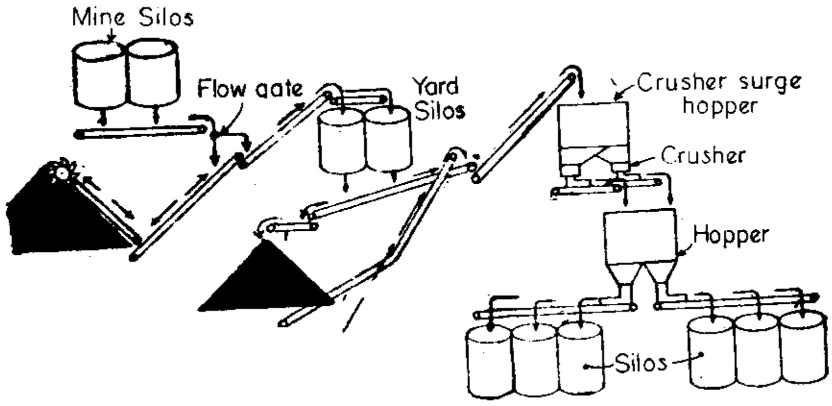


Fig. 7.17.

The equipments used for inplant handling are same as used for coal transfer, therefore it is not necessary to repeat them again. Two typical inplant coal handling systems are shown in Fig. 7.16 and Fig. 7.17.

Coal weighing methods. The cost of fuel used being major running cost of the plant, therefore it is necessary to weigh the coal at the unloading point in order to have an idea of the total quantity of coal delivered at the site. It is also necessary to weigh the coal before supplying to individual boilers in order to know whether the proper quantity of coal is burned or not as per the load on the plant.

Many methods of weighing the coal are used in practice.

7.5. COAL DUST AND ITS CONTROL

Coal dust in the thermal power plant is emitted from the source of unloading the coal till it is supplied to the boiler. The emitted coal dust creates unhealthy atmosphere for the working people and it is a considerable economical loss to the power plant. Therefore, it is essential to reduce the emission of coal dust or to collect the dust emitted and reuse again as fuel.

The first point at which a dust problem arises is at the rotary car dumper, which unloads a unit train – 100 ton car in 90 seconds. Here, the dust control method used is a wet suppression system which applies a special dust control chemical compound. As the car enters the dump structure, a low pressure spray is activated to pre-wet the coal's surface. The dust emission from the coal carried by belt conveyor is also reduced by spraying the water over the surface of the coal. The control of dust at the car dumper depends upon the type of nozzles used, the amount of spray applied and the timing of spray.

Although, the wet suppression is effective and economical, the high efficiency of bag collectors is necessary at certain points. For example, it is necessary at the crusher house where personnel are subjected

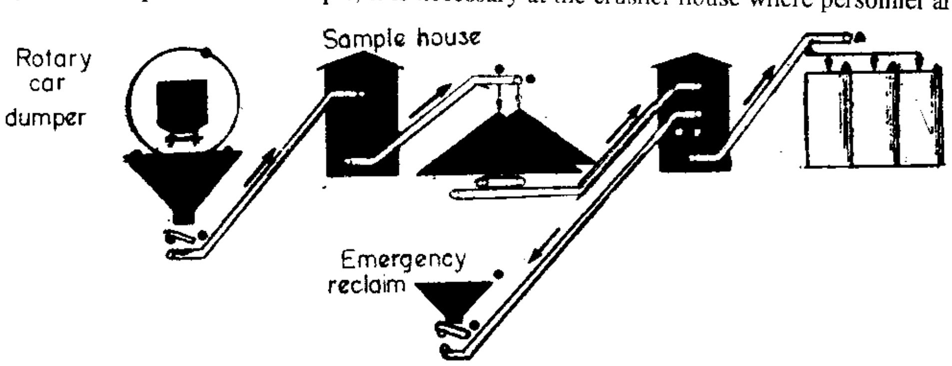


Fig. 7.18.

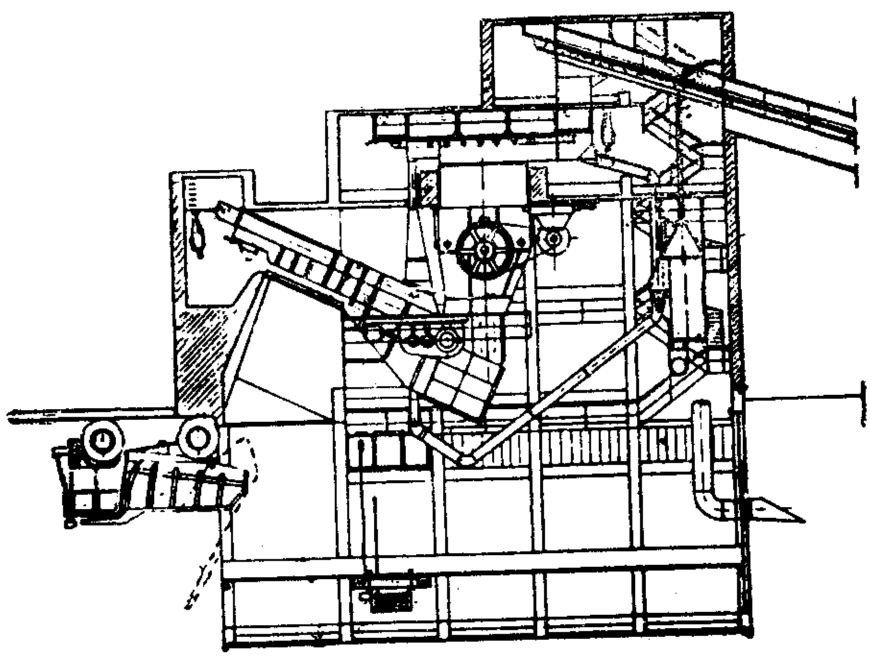


Fig. 7.19.

to high concentration of respirable dust. In addition to provide personnel protection, a bag-house rather than a wet suppression system is used, because adding moisture to the coal interferes with sampling. The bag-house collectors are continuously cleaned by timed compressed air pulses.

Baffilter collectors with wet suppression system are used in combination to reduce the coal dust emission. A combination system used at Coronado station (Arizona) is shown in Fig. (7.18).

7.6. COAL CRUSHING

Crushing is required when handling unsized coal and may be done near the receiving area before the coal is stored in the yard after reclaim. Plant burning pulverized coal generally specifies a coal top size larger than what cannot be handled by the pulveriser, making crusher necessary. Most coal for stoker fired plants is brought in the required size, so crushing is not needed unless it becomes economically advantageous to buy larger lump coal. Several types of crushers as rotary breaker, single roll crusher are used in thermal power plants.

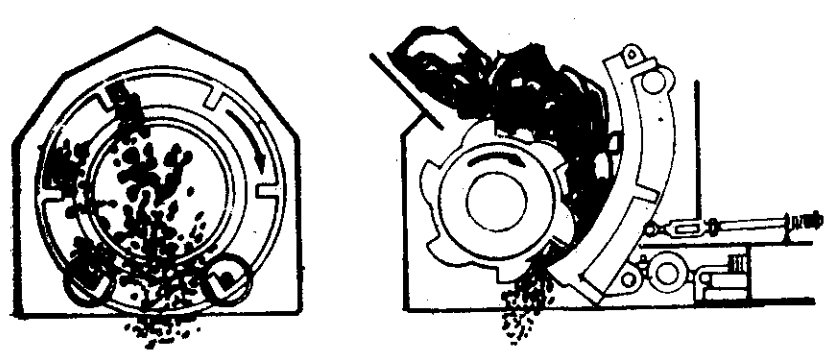


Fig. 7.20.

A typical coal crushing plant is shown in Fig. (7.19) and rotary type crusher and single roll crusher are shown in Fig. (7.20).

Pulverised Fuel Handling Systems. Two methods are in general use to feed the pulverised fuel to the combustion chamber of the power plant. First is 'Unit System' and second is 'Central or Bin System.'

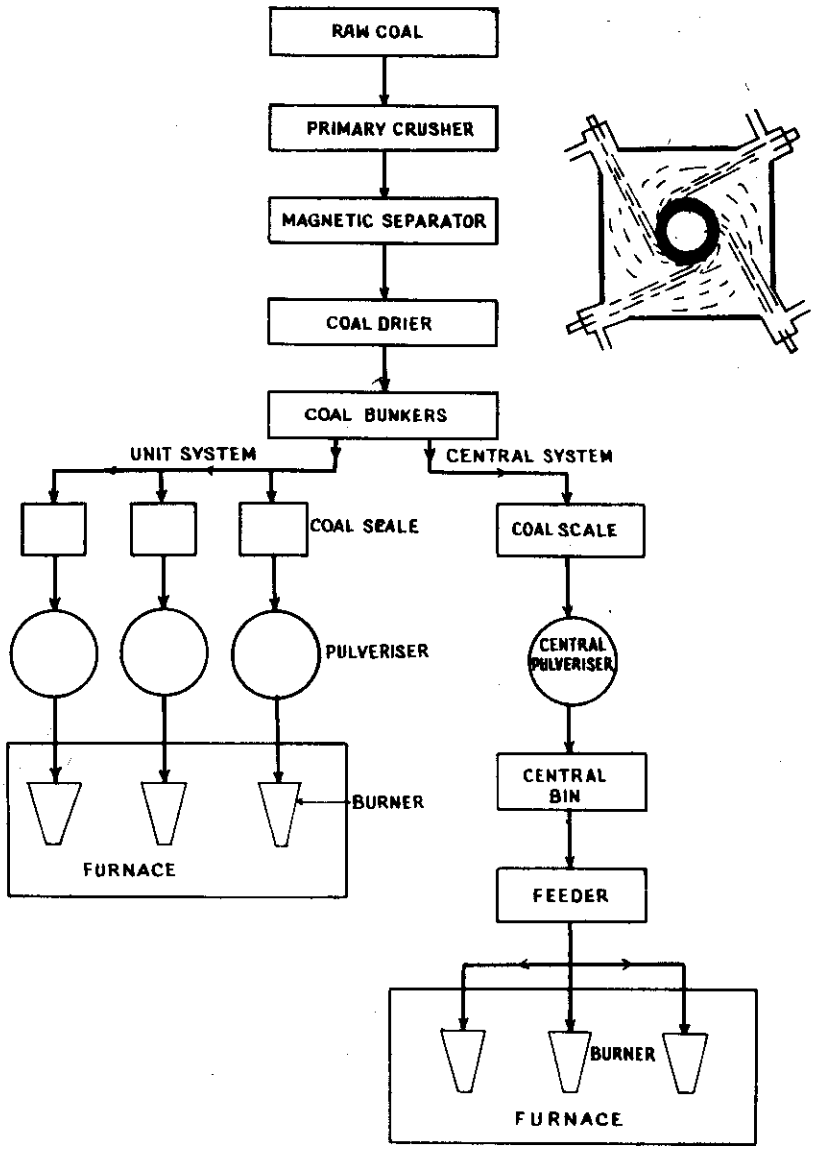


Fig. 7.21. Pulverised coal handling plant showing all required equipments for unit and central system.

In unit system, each burner of the plant is fired by one or more unit pulverisers connected to the burners, while in the central system, the fuel is pulverised in the central plant and then distributed to each furnace with the help of high pressure air current. Each type of fuel handling system consists of crushers, magnetic separators, driers, pulverising mills, storage bins, conveyors and feeders.

The arrangement of different equipments required in both systems is shown in Fig. 7.21 with the help of block diagram.

The coal received by the plant from the mine may vary widely in sizes. It is necessary to make the coal of uniform size before passing the pulveriser for efficient grinding. The coal received from the mine is passed through a preliminary crusher to reduce the size to allowable limit (30 mm). The crushed coal is further passed over magnetic separator which removes pyrites and tramp iron. The further equipments through which coal is passed before passing to pulveriser are already shown in Fig. 7.21.

Unit System. In a unit system, each burner or a group of burners and a pulveriser constitute a unit. Crushed coal is fed to the pulveriser through feeder at a variable rate governed by the combustion requirements of furnace and steam generating rate required in the boiler. The arrangement of unit system is shown in Fig. 7.22. Hot air or flue gases are passed through the feeder to dry the coal before feeding to the pulveriser. The pulverised coal is carried from the mill with the help of induced draft fan as shown in figure. This further carries the coal through short delivery pipe to the burner. The secondary air is supplied to the burner before entering the fuel into the combustion chamber as shown in Figure. A plant feeding one ton of pulverised fuel per hour consumes approximately 10 to 15 kwhr energy.

The advantages and disadvantages of unit system over central system are listed below :

Advantages—

(1) It is simple in layout and cheaper than central system.

(2) The coal transportation system is simple.

(3) It allows direct control of combustion from the pulveriser.

(4) The maintenance charges are less as spares required are less.

(5) In the replacement of stokers, the old conveyor system can be used without much alteration.

(6) Coal which requires drying for satisfactory function of the central system is generally supplied without drying in the unit system.

(7) It affords better control of fuel feed into the boiler furnace.

Disadvantages—

(1) The mill operates at variable load as per the load on the power plant which results in poor performance of the pulverising mill (more power consumption per ton of coal at part load).

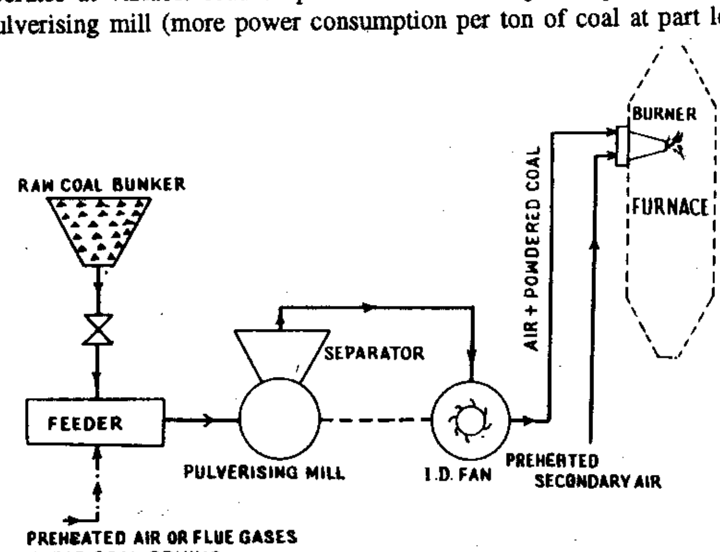


Fig. 7.22. Unit-System.

(2) The total capacity of all mills must be higher than for the central system with the load factors common in practice.

(3) The degree of flexibility is less than of central system.

(4) In the event of the failure of the auxiliaries of one of the burners, the burner has to put off as there is no reserve capacity.

(5) The fault in the preparation unit may put the entire steam generator out of use.

(6) Strict maintenance is desired as the operation of the plant directly depends upon the pulverising mill.

(7) There is excessive wear and tear of the fan blades as it handles air and coal particles.

Central or Bin System. The arrangement of central feed system is shown in Fig. 7.23. The crushed

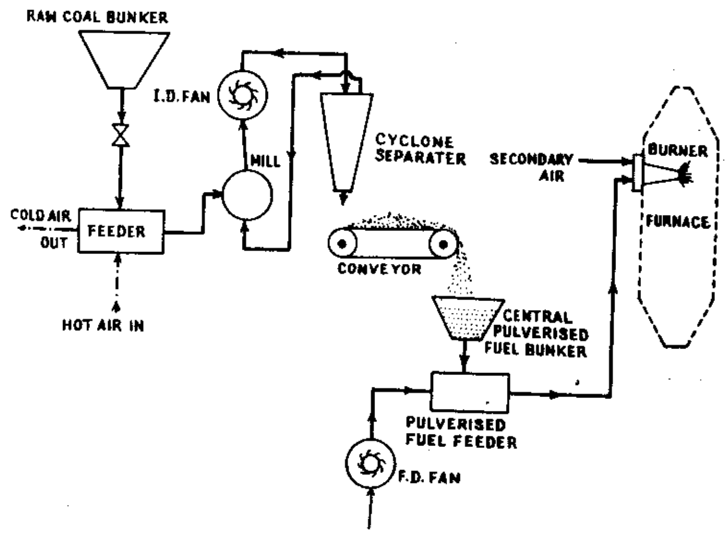


Fig. 7.23. Central or Bin System.

coal is fed to the drier from the raw coal bunker by gravity as shown in Figure. The drying of coal is effected either by using hot gases, preheated air or bled steam. The dried coal is fed to the pulveriser with the help of feeder. The pulverised coal is carried from the pulveriser mill with the help of air as shown in figure and it is separated in the cyclone separater. The separated pulverised coal is transferred to the central bunker (bin) with the help of conveyor as shown in figure. The central system uses practically all the equipments as used in unit system with higher capacity of each part. The storage bins are also used in addition to other equipments. This bin may contain from 12 to 24 hours supply of pulverised coal. The energy consumption of this system lies between 15 to 25 kW-hr per ton of coal pulverised.

The advantages and disadvantages of this system over unit system are listed below :

Advantages—

(1) The central system is flexible and changes can be made to accommodate quick changes in demand. There is always a supply of fuel available in reserve in the boiler bunkers. Since any mill can be used to supply any boiler, the outage of parts of the mills or even a short outage of entire pulverising plant will not cause a boiler plant outage.

(2) There is greater degree of flexibility as the quantity of fuel and air can be separately controlled.

(3) The pulveriser always runs at its rated load irrespective of the load on the plant, therefore its power consumption per ton of coal crushed per hour is less.

(4) Burners can be operated independently of the operation of coal preparation.

(5) The pulveriser can be shutdown when sufficient reserve capacity has been achieved. The same can be used during peak load periods.

(6) The fan handles only air therefore there is no problem of excessive wear of fan blades.

(7) It offers good control over the fineness of coal.

(8) More latitude is provided in the arrangement of the burners.

(9) The boiler aisles are unobstructed.

(10) The labour required is less.

(11) The mill capacity is low as it always works at rated load. But additional equipment needed for separating air from pulverised coal before storing in the bin, and the conveying system itself, offset the economy of lower mill capacity. Presently, the central system has been discarded in favour of unit system owing to building requirements, high initial coal and complications in most of the parts.

Disadvantages—

(1) Central system is higher in first cost and occupies a large space.

(2) The power consumption of auxiliaries is high. Therefore, overall power consumption per ton of coal handled is higher than unit system.

(3) There is possibility of fire hazard due to the stored pulverised coal.

(4) The coal transportation system becomes more complex.

(5) Driers are essential.

(6) The operation and maintenance charges are higher than the unit system of same capacity.

The bin system is not favoured in modern power stations, on account of dangers from explosion of coal-air mixtures and the tendency of the stored pulverised fuel to cake. In addition to this, maintenance costs, losses through vents, capital costs and operating costs are all against the system. Consequently the unit system is adopted universally for all high capacity installations.

Pulverising Mills. The various types of mills used for pulverising the coal are listed below :

(1) Ball mill, (2) Ball and Race mill, (3) Impact or Hammer mill, and (4) Bowl mill.

Ball Mill. The line diagram of the ball mill is shown in Fig. 7.24. It consists of a large cylinder partly filled with various sized steel balls (2.5 to 5 cm in diameter). The coal (6 mm) is fed into the cylinder and mixes with these balls. The cylinder is rotated (130 m/min peripheral velocity) and pulverization takes place as a result of action between the balls and the coal.

The mill consists of coal feeder, pulveriser, classifier and exhauster. The feeders supply coal to the classifier and then it is passed to the pulveriser with the help of screw conveyor. A mixture of tempering air and hot air from air-preheater is introduced in the pulveriser as shown in figure. These streams of air peak up the pulverised coal and pass through the classifier. The over-sized particles are thrown out of the air stream in the classifier and fine material is passed to the burner through exhaust fan.

The output of the mill is controlled by the dampers located in the exhaust fan inlet duct. These dampers vary the flow of air through the mill and thereby control the rate of fuel removed from the mill. The dampers are operated by the boiler's automatic combustion control. The feeder output is regulated by the coal level in the cylinder. When the coal level in the cylinder attains sufficient height to seal off the lower channel then the differential control operates to stop the coal feed.

A ball mill capable of pulverising 10 tons of coal per hour containing 4% moisture requires 28 tons of steel balls and consumes 20 to 25 kW-hr energy per ton of coal.

The principal features of this pulveriser are listed below :

(1) The grinding elements in this mill are not seriously affected by metal scrap and other foreign material in the coal unlike the grinders in most other pulverisers.

(2) There is considerable quantity of coal in the mill which acts as a reservoir. This pulveriser prevents the fire from going out when there is slight interruption in fuel feed caused by coal clogging in the bunker.

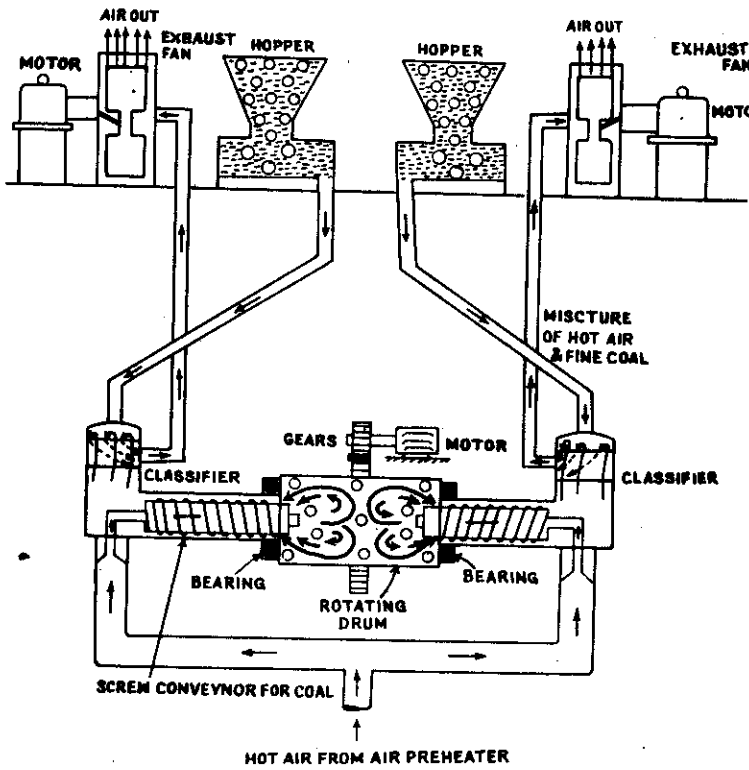


Fig. 7.24. Double classifier Ball Mill.

(3) This mill can be used successfully for a wide range of fuels including anthracite and bituminous coal which are difficult to pulverise.

(4) The system is simple in operation, low in initial cost but operating cost is high.

Ball and Race Mill. This is also known as contact mill which consists of two elements which have a rolling action with respect to each other. The coal passes between the rotating elements again and again until it has been pulverised to the desired degree of fineness. The pulverization is completed by a combination of crushing, impact and attrition between grinding surfaces. The line diagram of ball and race mill is shown in Fig. 7.25. The coal is crushed between two moving surfaces : balls and races. The upper stationary race and lower rotating race driven by a worm and gear, hold the balls between them. The coal is supplied through the rotating table feeder at the upper right to fall on the inner side of the races. The moving balls and races catch coal between them to crush it to a powder. Springs hold down the upper stationary race and adjust the force needed for crushing.

Hot air is supplied to the mill through the annular space surrounding the races by a forced draft fan. The air picks up the coal dust as it flows between the balls and races and then enters into the classifier above. The fixed vanes make the entering air to form a cyclonic flow which helps to throw the oversized particles to the wall of the classifier. The oversized particles slide down for further grinding in the mill. The coal particles of required size are taken to the burners with air from the top of the classifier.

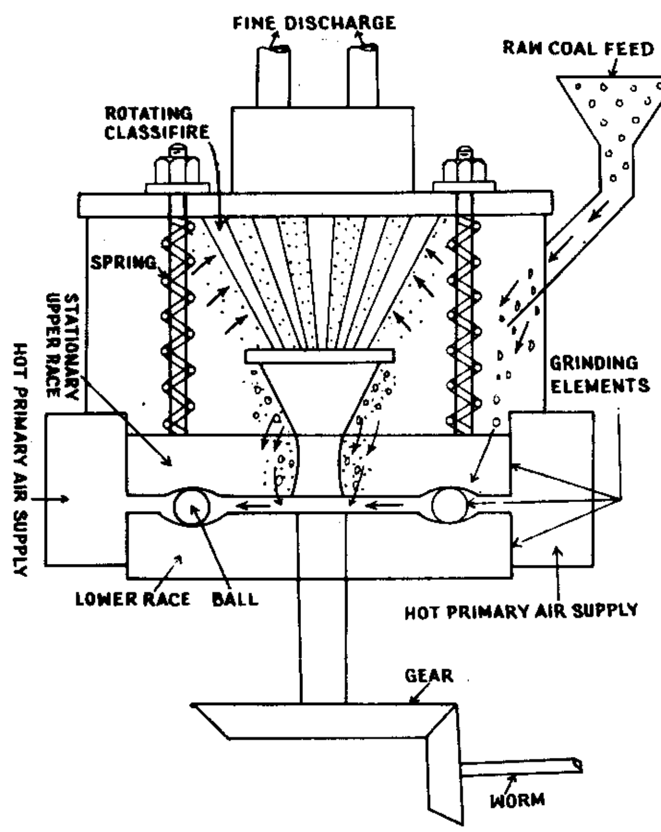


Fig. 7.25. Ball and race mill.

The mill is provided with a means of separating heavy impurities from the coal and thus reducing wear and possible damage to the grinding element. These heavy particles resist the upward thrust caused by the primary air stream and collect in a compartment in the base of mill, and then they are removed periodically.

The automatic combustion control regulates the flow of primary air through the pulveriser and feeder and maintains the coal supply. When more coal is required, the primary air flow is increased automatically and its higher velocity in the mill carries additional coal in the furnace. This action reduces the amount of coal in the pulveriser and decreases the pressure drop, thus causing the feeder controller to supply more coal.

The fan used with this mill handles only air therefore the blades erosion by coal particles is eliminated. As the casing of the pulveriser is under pressure, the leakage of fine coal through the mill casing causes the pulverised fuel to be blown out into the boiler room. This mill can handle coals containing as much as 20% moisture. Mill, feder and fan need nearly 15 kW-hr energy per ton of coal pulverised.

These pulverisers have greater wear compared to other pulverisers. The advantages of lower space occupied, lower power consumptions in kW-hr/ton of coal pulverised, lower weight and lower capital cost have outweighed the wear problem and these pulverisers found general acceptance.

Impact or Hammer Mill. This is known as impact mill as pulverization takes place due to impact. The coal in pulveriser remains in suspension during the entire pulverising process. All the grinding elements and the primary air fan are mounted on a single shaft as shown in Fig. 7.26. The primary air fan induces flow of air through the pulveriser which carries the coal to the primary stage of grinding as shown in figure. In the primary stage of grinding, the coal is reduced to fine granular state by impact with a series of hammers and then into the final stage where pulverization is completed by attrition. The final stage of grinding consists of pegs carried on a rotating disk and travelling between stationary pegs. The finely pulverised coal in the final stage of grinding is carried with the air to the burner through the rotating scoop shaped rejector arms which throw the large particles back into the grinding section.

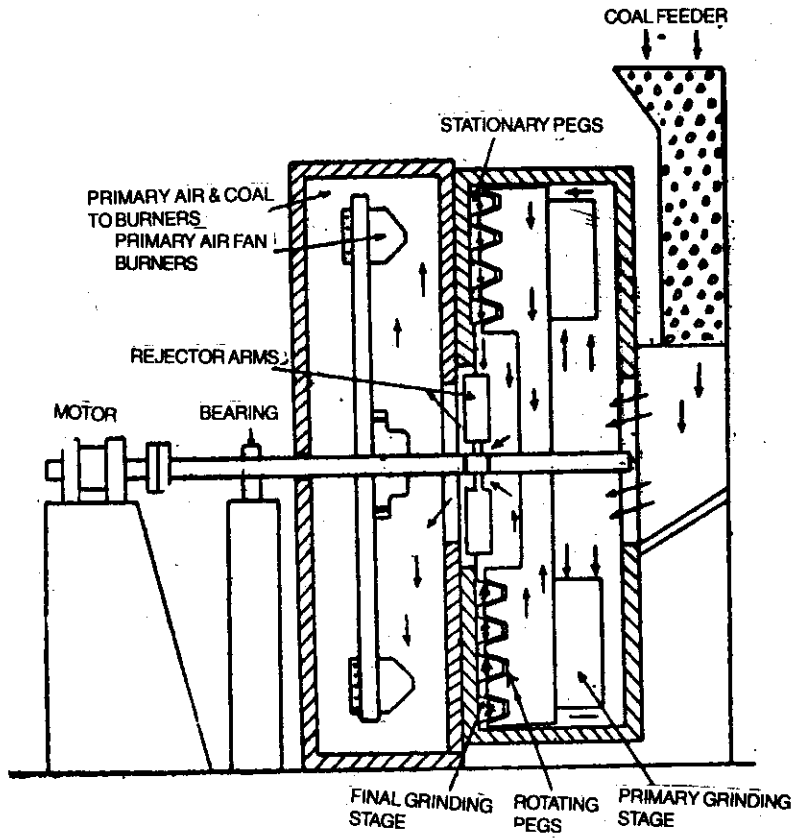


Fig. 7.26. Impact mill.

The output of the pulveriser is controlled by varying the coal feed and the flow of primary air either by hand or by automatic control.

The outstanding advantages of this pulveriser are listed below :

(1) This pulveriser is directly connected to the motor drive and therefore operates at high speed.

(2) The power required to drive the pulveriser is nearly proportional to the coal pulverised over a wide range of rating.

(3) Owing to high speed of the pulveriser and being the fan integral with the pulveriser, this mill requires minimum floor area.

Care must be exercised to prevent scrap metal from entering the pulveriser mill.

In recent years, extensive use has been made of hammer mills to pulverise brown and bituminous coals, shells and peat for Soviet Power Stations. The quality of the product in this mill depends on the physical property of the fuel, which can be estimated by the grindability index. All fuels under the same conditions of pulverisation with decrease in strength characteristics (with increase in Kg) undergo timer pulverization. But uniformity of pulverization of brown coals and shales decreases with increase in Kg while that of bituminous coals and anthracites fines increases. In pulverization of low strength brown coals and shales in hammer mills, fine and non-uniform pulverised fuel is obtained. To attain more uniformity, it is necessary to pulverise these fuels at circumferential speeds of the rotor less than 62 m/sec.

Boul Mill. The arrangement of boul mill is shown in Fig. 7.27. This pulveriser consists of stationary rollers and a power driven boul in which pulverization takes place as the coal passes between the sides of the boul and the rollers. A primary air induced draught fan draws a stream of heated air through the mill, carrying the pulverised coal into a stationary classifier located in the top of the pulveriser. The classifier returns the coarse particles of coal to the boul for further grinding through the centre cone of the classifier. The coal pulverised to the desired fineness is carried to the burner through the fan. The impurities in coal

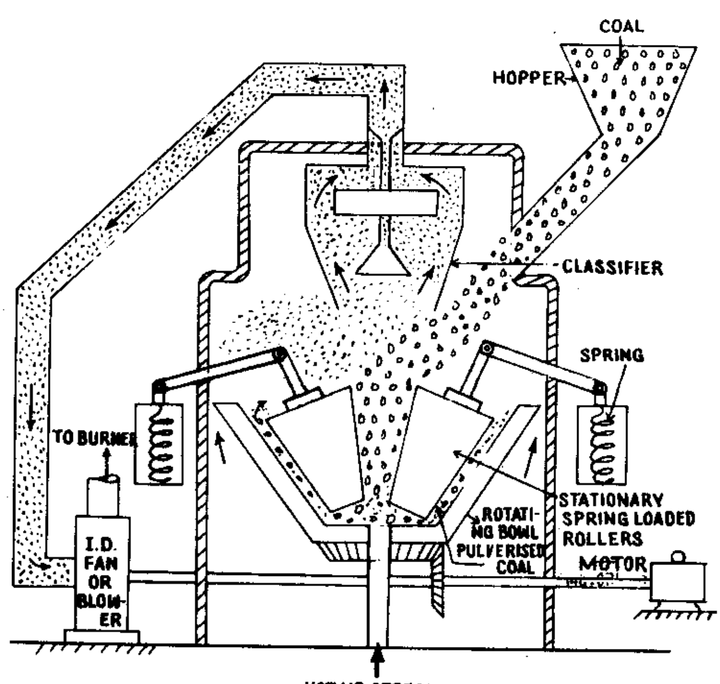


Fig. 7.27. Boul mill.

containing heavy particles are thrown over the side by centrifugal force as these enter the rotating boul. These heavy particles thrown out fall into the space below the boul and are discharged from the mill through a specially provided spout. The automatic control charges the supply of coal to the boul of the mill by adjusting the feeder speed and the flow of primary air by regulating the damper in the line from the pulveriser to the fan.

The outstanding features of this pulveriser are listed below :

(1) The classifier may be adjusted to change the coal fineness while the pulveriser is operating.

(2) The leakage of coal from the mill casing is completely eliminated as the mill operates under negative pressure.

In selecting the mill, the following coal characteristics and their effects on mill operation are considered :

(1) **Higher heating value of the coal,** which affects the ability of a pulveriser to meet the boiler requirement for maximum continuous rating.

(2) **Total moisture content,** used to determine the mill drying capacity.

(3) **Grindability,** used to select the mill size.

(4) **Volatile matter,** used to determine the required coal fineness.

(5) **Sulphur and mineral content,** used to determine pyrite removal sizing requirements.

The fineness required in today's pulveriser differ unit to unit but most of the fuel is ground to atleast 98 – 99% passing 50 mesh and 60 – 70% passing 200 mesh.

The capacity of the pulveriser is also dependent on the raw coal feed size, grindability, moisture content and fineness required of the final coal.

Mill Fires and Causes

Mill fires are most often caused by

(1) Pyrite buildup from pyrite plow failure.

(2) Hot start up with loaded mill.

(3) Accumulation of coal dust in mill devices.

(4) Localized hot spots from poor primary air flow.

The causes of fires are also dependent upon coal properties (volatile matter and moisture) that exceed pulverising rating. Wet coal always blocks feeders, reduces system input and produces a dangerously lean fuel-air mixture in the mill. Better coal handling method and effective trash separation could reduce feeder problems and the likelihood of mill fire. Closing of the multiport outlet valve can prevent the spread of fire from mill to burner lines.

The three major types of quenching methods used are water, steam and CO_2 injection. Use of water has proved inadequate in some deep seated mill fires. Steam injection is effective but a potentially explosive CO-H_2 misture may result from steam coke reaction.

Pulverizers

Boiler downtime associated with pulverizer operation is attributed to five major causes.

(1) Mill fires and explosions.

(2) Failure of pulverizer drive components as gearbox, bearing and shaft.

(3) Failure of grinding elements such as rolls and balls.

(4) Failure of air system components used for coal circulation, classification and transportation.

(5) Furnace related problems such as carbon carryover and slagging.

Selection of Pulverizer

Coal characteristics are important in selecting and sizing pulverizers. Coal analysis determines the number of pulverisers required and their capacity.

Coal variables having greatest effect on the capacity of the pulverizer are coal grindability, required fineness, heating value and surface moisture.

Among all, grindability can be a significant factor in limiting a boiler's rated output when coal with an index value lower than that for which pulverizers were sized is burned. Pulverizer capacity increases with coal's grindability index as shown in Fig. and varies inversely with required fineness as shown in Fig. The energy required to pulverise one kg of coal also increases with fineness of the coal.

The fineness required from the pulveriser is determined by the burning characteristics of the coal. Fineness is typically stated as percent through a 200 mesh sieve at 100% rated mill output. For most bituminous coals, 70% through 200 mesh is sufficient. Because of their free burning characteristics, many sub-bituminous and lignite coals burn completely with 65% through 200 mesh.

The coal's heating value does not change pulverizer capacity, if it affects the amount of fuel pulverised for a given boiler load as shown in Fig. The higher the heating value of the coal, less amount of coal is required and smaller pulverizer is needed.

Surface moisture must be evaporated while coal is being ground in the pulverizer. Air temperatures up to 380°C are required for coal with higher moisture content as shown in Fig.

Variations in coal surface moisture also affect pulverizer and boiler operating characteristics. The C.V. of coal is lower at higher moisture content and requires higher output from pulverizer. The boiler-output cannot be met without increasing pulveriser size. Coal characteristics are seldom constant as coal sources often change. Sizing the pulverizer on coal area basis allows the source variable to be partially accommodated. The system can cope up with a range of mòisture and C.V. of fuel as well as varying grindability.

7.7. COAL WEIGHING METHODS

The consumption of coal and its cost are significantly important as it is the basic ingredient of the thermal power plant. The use of *belt weighers* for continuous weighment of coal is essential for getting optimum plant efficiency at reduced costs. The wighers which are commonly used are listed below :

(1) **Mechanical.** This is based on mechanical principle. This works on a suitable lever system mounted on knife edges and bearings connected to a resistant in the form of a spring or pendulum. The belt travel is measured by a calibrated wheel which provides the drive to the integrator and the resultant value obtained by multiplication of load and speed values is usually displayed by a digital counter. This is commonly used all over the world and in India.

(2) **Pneumatic.** The pneumatic weighers use a pneumatic transmitter weigh head and the corresponding air pressure determined by the load applied is transmitted to the weight indicating receiver which may be either located local (near weigh head) or remote housed in the control panel. It is safe method like mechanical weighers and may be used where electronic system is not permitted for use. Its disadvantages over a mechanical system are cost of installing and maintaining a supply of dry air, the possible freezing of air lines in cold climates and necessity of converting pneumatic signals to work in conjunction with mechanical or electrical measurement of belt travel for integration.

(3) **Electronic.** The operation is based on load cell principles. Various types of load cells are manufactured in this country for the purpose. The load cells produce voltage signals proportional to the applied load, one value for integration, the other value representing belt travel is obtained from a Tacho-generator driven by the belt. This system maintains high accuracy in measurement. Its performance is affected by temperature, noise, dust and humidity of the air.

(4) **Nuclear.** This system operates on gamma ray absorption principle. A radio-active source located in the source head emits gamma-rays which pass through the material on the conveyor to the detector. The current signal output proportional to the applied load (weight of coal on conveyor) provides one value while the other for integration is provided by the Tarchometer measuring the belt travel. Being contactless with the belt conveyor, variations due to belt tension and idler misalignment are also eliminated. Its main disadvantages are that accuracy depends on a consistent speed of material movement and the condition of the detector since this should be kept clean at all times as otherwise absorption value of the gamma-rays will be affected.

EXERCISES

7.1. What do you understand by 'Outside-Handling of Coal' ? What are the different methods of outside coal handling ? Discuss their relative merits and demerits.

7.2. What is the necessity of coal storage ? Discuss the different methods used for coal storage at plant.

7.3. Describe the various mechanical devices used for coal handling in a large steam power plant including its transportation to storage, reclamation and inplant handling. What is each equipment best suited for ?

7.4. Draw a net line diagram of inplant coal handling and indicate the names of equipments used at different stages.

7.5. Describe different equipments used for coal unloading at plant site.

7.6. What are the different types of coal conveyors ? Indicate the use of each and justify that its use is essential at that stage.

7.7. What are the different methods used for coal weighing at plant site ? Describe the construction, principles and operation of each method.