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TECHNICAL MEMORANDUM NO. 8 OF 1956

HANDLING AND STORAGE OF COAL

(Witwatersrand University Coal Preparation Course
3rd Year Coal Mining Students).

BY

DR. P. J. VAN DER WALT

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HANDLING AND STORAGE OF COAL

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The primary objects of a coal preparation plant include one or more of the following:-

(a) To reduce the size of the coal

(b) To divide the coal into various size fractions

(c) To remove impurities from the coal

(d) To blend coal from two or more seams or shafts.

A considerable amount of mechanical handling is invariably involved in order to achieve these objects, by means of suitable mechanical appliances. The handling normally includes:-

(1) Conveying the coal to the plant as a whole

(2) Conveying from unit to unit within the plant

(3) Loading the finished products for transportation.

Frequently it is also desirable to store the raw coal or the products, prior to treatement or loading respectively.

While/ ....

While these are ancillary operations, they have a considerable influence on the overall performance and efficiency of the plant, principally due to breakage and segregation (according to size or density), which inevitably occurs during handling and storage. Breakage, for example, may be responsible for loss of revenue, due to the production of unwanted sizes (or lower priced sizes), and may lead to complaints from customers. Segregation may result in loss of efficiency due to poor distribution of the load to various units and may have an adverse affect on the sales value of a product (the latter because consumers usually only sample the top layers of a consignment).

Mechanical handling equipment is costly and the type of equipment installed and its arrangement has an important bearing on the initial cost of the plant and on its subsequent operating cost.

The choice of mechanical handling equipment and its design accordingly merits very careful consideration. Frequently the choice represents a compromise between ideal performance and minimum cost of the plant.

COAL HANDLING EQUIPMENT

In order to minimise mechanical handling equipment, it is customary to elevate the raw coal to some convenient height and then to allow it to gravitate through the plant. Nevertheless conveying in a substantially horizontal plane, is frequently also necessary. Handling equipment may conveniently be divided into three categories according to whether the function is :-

(a) To / ....

(a) to elevate the coal - or

(b) to convey it horizontally - or

(c) to lower it.

The first catagory includes bucket elevators, conveyor belts, scraper conveyors and Redler type conveyors.

The second catagory includes belt, scraper, Redler and plate conveyors and shakers.

The third catagory includes chutes, launders (gravity) and mechanical loading devices.

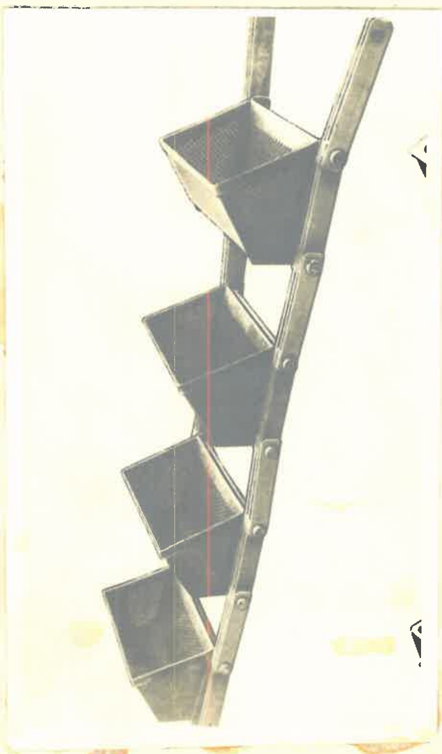
Bucket Elevators

A bucket elevator consists essentially of a series of robust buckets attached to either one or two endless chains, depending on the duty. The chains pass over two sets of sprockets or tumblers, situated at the upper and lower ends of the elevator respectively, and the whole is usually encased. Coal is fed into the lower portion of the elevator (or boot) and is discharged at the upper end. A typical design of buckets and chains is shown in Fig. 1. The buckets may be constructed of perforated plate if it is necessary to drain wet material. Guide plates upon which the chains slide are frequently provided. When using chains of the type shown in Fig. 1, the tumblers are usually hexagonal. When handling sticky material, square tumblers are frequently an advantage, because the buckets are rapped as they pass over the head tumblers, thereby facilitating discharge. In order to maintain tension on the loaded strand, bucket elevators are driven through the upper tumblers or sprockets.

Bucket elevators can be operated in an almost

FIG. 1.

BUCKETS AND CHAIN FOR BUCKET ELEVATOR



vertical position, and this is a great advantage in minimising space requirements. The ideal angle for a bucket elevator is 60 to 70 degrees. If the angle is substantially greater, there is difficulty in preventing spillage recirculating. These elevators are particularly suitable for handling dusty material and for coal requiring dewatering.

Breakage can be quite substantial however, due to the relatively large drop occuring during feeding and discharge and considerable maintenance is involved.

Within reasonable limits, any size of material can be handled.

Scraper Conveyor

A scraper conveyor is in many respects, similar to a bucket elevator. The essential difference is that flat plates (or flights) are substituted for the buckets and these plates drag the coal along a plate.

These conveyors may be either horizontal or inclined. If the flights are reasonably deep, the maximum angle of inclination is of the order of 30°.

They are ideal for distributing coal to a number of points and are particularly usefull for filling a bunker to its maximum capacity. In the latter application, the bottom plate is frequently omitted, the coal being dragged along the top of the heap as it forms.

Scraper conveyors may be used for drainage operations by providing a perforated bottom plate.

As in the case of bucket elevators, the conveyor may be totally enclosed and is therefore, also suitable for handling dusty material.

Breakage / ....

Breakage is not excessive provided that the inlet and discharge chutes are carefully designed, but maintenance is high.

All normal sizes of coal are readily handled.

"Redler" Type Conveyor

A Redler type conveyor is similar to a scraper conveyor in appearance, the difference being that the material is moved en mass, by means of suitably designed bars as shown in Fig 2.

These conveyors have all the advantages of scraper conveyors and have the additional advantage that they may be operated vertically. Furthermore, a single unit may be used to move coal horizontally in one or more stages and to elevate it simultaneously, thus eliminating transfer points and minimising breakage. Redler conveyors are very compact and require the minimum of supporting structure.

Up to the present, their application has been restricted to dry coal not exceeding about 3 inches in size.

Belt Conveyors

A typical belt conveyor is shown in Fig. 3. As will be seen, it consists essentially of an endless rubber belt, supported on a series of rollers or idlers, individual sets of idlers being arranged in such a manner that the belt will trough when loaded and thereby increase its capacity. The belt is driven by means of a drum or pulley situated at the discharge end of the conveyor. A snub pulley is frequently provided to increase the contact angle on the head pulley.

The spacing of the idlers varies with the width of the belt and its duty. At the feed point the idler spacing is

FIG. 2 REDLER CONVEYOR

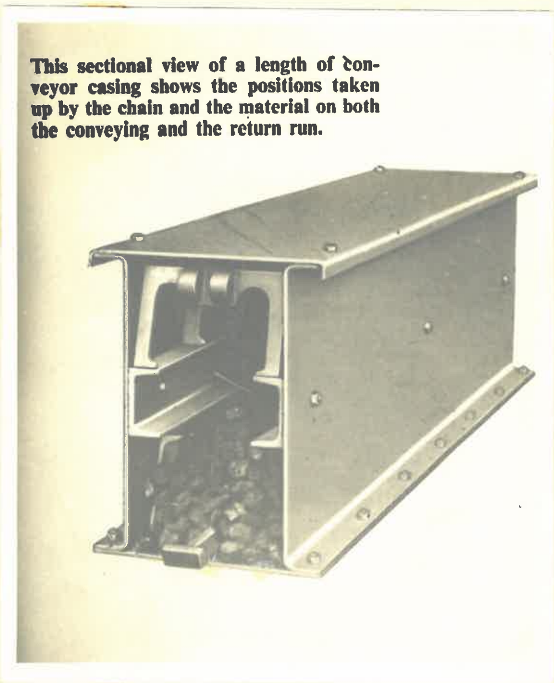
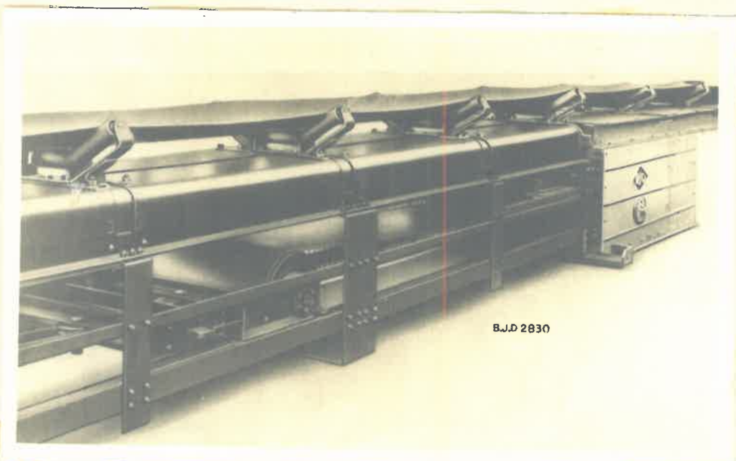


FIG. 3 BELT CONVEYOR



usually much closer (approximately ½ normal), in order to withstand impact. If large coal is handled, the idlers at the feed point are frequently covered with rubber which acts as a cushion, thus protecting both the belt and the idlers. Recently coiled spring idlers, as shown in Fig. 4, have been developed for heavy duty applications. These idlers have the following principal advantages

(a) they withstand shock loads at the feed point.

(b) The belt is virtually in continuous contact with the idler, thus minimising wear.

(c) the belt is self troughing with load thus eliminating possibility of spillage.

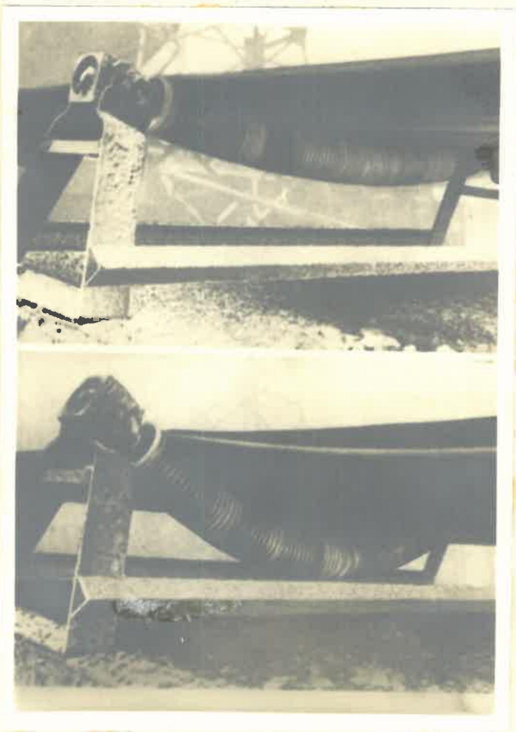
(d) there are only two bearings.

Skirt boards or plates must be provided at the feed point of belt conveyors, in order to prevent spillage. If the conveyor is fed at more than one point, continuous skirt boards over the feeding zone are preferable.

Belt conveyors should be provided with decking plates to prevent spillage falling on the return portion of the belt, and thus getting between the belt and the head drum and tail drum. Scrapers should also be provided to remove fines adhering to the belt.

If the conveyor is inclined, anti-run back gear must be provided. This may consist of a ratchet or may be built into the reduction gear, the latter being preferable. If the conveyor is long, a fluid coupling is an advantage.

FIG. 4 SPRING IDLER



Belt conveyors may be operated both horizontally and inclined. If run of mine coal or coal containing fines is handled, the maximum angle of inclination is approximately 18°. If no small coal is present, the angle of inclination should not exceed 15 or 16° degrees.

Conveyor belts are frequently used for loading large coal into trucks, and are then termed boom loaders. For such applications, the conveyor is arranged to pivot so that it can be lowered into the truck and thus minimise breakage. The maximum angle of inclination is again about 16°.

When conveying small coal, the belt speed may be as high as 300 feet per minute, but should not exceed 200 feet per minute, when handling large coal in order to reduce breakage at the discharge point. In the case of boom loaders, the belt speed is normally 80 to 100 feet per minute.

Belt conveyors may be used to distribute coal to a number of points or for filling bunkers. This is achieved by using either a plough or a shuttle. The former should be avoided whenever possible as it may cause damage to the belt.

<u>Shaker Conveyors</u>

Shaker conveyors are frequently used for loading large coal into trucks and are generally similar to shaking screens.

<u>Chutes and Launders</u>

Dry or dewatered coal is allowed to gravitate from one process unit or item of handling equipment, to another via a channel or chute as it is more commonly called.

Chutes dealing with moist small coal should have a minimum angle of inclination of 45°. If the chute is long, the angle of the lower portion may be somewhat reduced to a minimum of 35°. Chutes handling large coal may have a minimum angle of inclination of 35°.

Coal is frequently flushed from one unit to another, with the aid of water. The conveying channel in this case is termed a launder.

Launders should be relatively narrow in order to maintain a sufficient depth of water to flush the coal. The minimum angle of inclination of launders is 5 to 10°, depending on the size of the coal. It is sometimes possible to reduce the angle slightly by lining the launder with glass plates. Glass also has good wearing properties. Launders are frequently lined with tiles to increase their life.

BUNKERS AND BINS

The need for storing coal before or after treatment depends mainly on mining procedure and on transportation arrangements. Storage of coal in bunkers or bins invariably gives rise to breakage and segregation, and should not therefore be resorted to unnecessarily. In some instances, however, the advantages of storage more than compensates for these disadvantages. For example, if the output rate from a mine is liable to fluctuate considerably, it is good practice to feed a washery via a surge bin and constant rate feeder. This ensures a steady load and optimum efficiency. The bin, in such a case, should just be of sufficient capacity to "iron out" the fluctuations.

The primary object in designing most bins is that they must empty completely under the force of gravity. This entails vertical side walls and a sloping bottom leading to one or more outlets. For ease of manufacture, the cross section of a bin is usually square or rectangular. In order to ensure that the bin will empty completely, the angles of inclination of the lower portion, must be sufficiently large to prevent the coal "hanging up". In the case of a bin of rectangular cross section, the angle of the valley formed by adjacent walls is smaller than the angle of the walls themselves, and is therefore the deciding factor. In order to be self clearing, the valley angle should be not less than 45°.

Conical bins are frequently used for storing large quantities of run of mine coal (termed stock piles). In such cases, the apex angle of the cone should not exceed 90°.

Both steel and concrete are used for the construction of bins. Each material has its own relative merits and the choice is largely a matter of opinion. Generally, concrete is cheaper for the construction of bins of capacity larger than about 500 tons.

Bins discharging to trucks etc. are usually provided with either quadrant doors or flat doors actuated by means of a rack and pinion. If the bin discharges to a conveyor, some form of constant rate mechanical feeder is frequently provided, and no door is required, except for control.

Feeders commonly used are of three types, viz:-

(a) Endless belt type
(b) Shaker type
(c) Electrically vibrated type.

In the case of the first two types, the feed rate is usually controlled by means of adjustable slide doors. In the third type, the amplitude of the vibration controls the feed rate.

Breakage / ....

BREAKAGE DURING HANDLING AND STORAGE

Breakage during mechanical handling occurs mainly at the feed and discharge points of conveyors, elevators etc., and can never be entirely eliminated. Breakage can be minimised, however, by paying carefull attention to the design and arrangement of feed and discharge chutes etc. Impact on chutes and structural steel members, should be avoided, and the velocity of the coal should be kept as low as possible.

The degree of breakage also depends to a large extent on the hardness and size of the coal handled, and varies considerably. Some idea may be obtained of the normal breakage occuring from the results of a test recently carried out. A sample of coal of average hardness and nominally minus 2 inches in size, was taken from a conveyor belt, was then screened at $\frac{3}{8}$" square and was found to contain 33% of $-\frac{3}{8}$" material. A further sample was taken from another conveyor belt after the coal had passed over three transfer points and the proportion of $-\frac{3}{8}$" material was found to have increased to 37.5%. This represents an increase of nearly 15% in the original proportion of $-\frac{3}{8}$" coal.

Breakage in bins occurs due to the fall into the bin and is greatest when the bin is empty and least when it is full. Several techniques may be adopted to minimise breakage in bins. These include:-

(a) Use of spiral chutes and other anti-breakage devices.

(b) Loading from one side of the bin and allowing the coal to slide down the heap.

(c) Use of boom loaders in stock piles.

SOME NOTES ON SEGREGATION

Segregation in Bins.

Segregation within bins occurs unavoidably when the material contains mixed sizes, large particles tending to roll outward on the cones or ridges of the more sluggish finer material when the bin is being either filled or discharged. Conditions are agravated when a series of classifying screens are situated directly above storage bins. In such cases, the smaller particles pass through the feed end of the screen deck, while the near size particles pass through towards the end of the deck. A particular commercial size fraction is therefore already segregated before it enters the bin.

There is no simple solution to the problem of segregation in bins. In the case of a stock pile, feeding a washery, the best procedure is to provide a bin having a number of outlets and to draw from as many as possible simultaneously. If the bin discharges into trucks, the use of layer loading assists considerably in obtaining a reasonably uniform mixture in the truck.

Segregation in Chutes and Launders

When curved chutes or launders are used, the larger and heavier particles tend to occupy the outer portion of the curve, and the material thus becomes segregated. This may lead to operational difficulties in subsequent units of equipment.

Segregation on Belts

If a conveyor belt is fed from a chute or another belt, at right angles, large particles tend to fall furthest

from / ....

from the point of discharge and thus occupy the one side of the conveyor.

DR. P. J. VAN DER WALT
ASSISTANT DIRECTOR - ENGINEERING.