FUEL RESEARCH INSTITUTE OF SOUTH AFRICA.

TECHNICAL MEMORANDUM NO. 4 OF 1956

SIZING OF COAL

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

BY

DR. P. J. VAN DER WALT

FUEL RESEARCH INSTITUTE OF SOUTH AFRICA

Technical Memorandum No. 4 of 1956

SIZING OF COAL

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

In South Africa, coal is generally screened into the following nominal commercial sizes:-

Commercial Designation	Nominal Size inches, square
Rounds	+ 4"
Cobbles	- 4" + 1½"
Nuts	- 1½" + ¾"
Peas	- ¾" + ¼"
Duff	- ¼"

These may be regarded as the basic size fractions, In practice, however, individual collieries depart somewhat from these sizes. Frequently due to the type of screen installed, the equivalent round aperture screen surfaces are used for these separations. Some collieries depart slightly from the nominal upper and/or lower limits in order to meet market demands for particular sizes. For example, if a colliery has a large demand for peas, the upper limit for peas may be increased to ⅞" or evan 1 inch square. Other collieries again may produce intermediate sizes for particular customers. For example, the lower limit of the cobble fraction is frequently increased and both large and small nuts may be marketed. Certain large consumers are supplied with mixtures of the

nominal / ....

nominal sizes. For example, in the past power stations normally purchased peas, but at present the demand cannot be met and they have to be satisfied with a mixture of peas and duff (termed pea-duff or mixed-smalls). The railways use coal nominally - 6" + 1¼" square in locomotives.

TYPES OF SCREENS

A variety of screens are used to produce these commercial sizes and may broadly be grouped into the following types:-

(1) Grizzlies
(2) Trommel Screens
(3) Shaking Screens
(4) Vibrating Screens

Grizzlies

The simplest type of grizzly consists of a number of equally spaced parallel bars, supported in a longitudinally inclined position so that coal delivered to the upper end will slide down over the bars.

Another type is the rotary grizzly. This grizzly is illustrated in Fig. 1 and consists of a number of parallel shafts each provided with a series of discs or rolls usually rotating in the direction of flow of the coal. This type of grizzly is claimed to be more efficient than the fixed bar type and has the added advantage of lower head room requirements.

Grizzlies lend themselves to robust construction and are consequently ideal for screening run of mine coal before a primary crusher or picking table, these being their principal applications.

Trommel / ....

FIG. 1 LIVE ROLL GRIZZLY

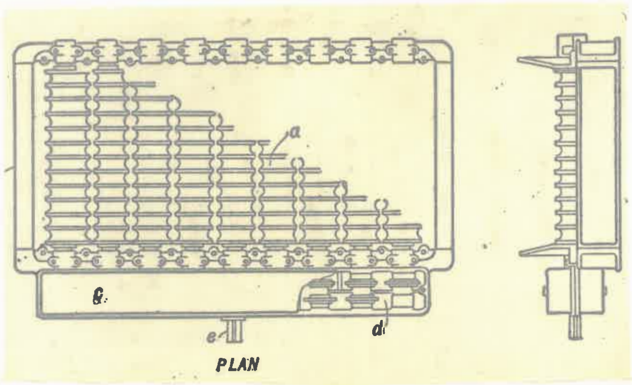


FIG. 2 CYLINDRICAL TROMMEL

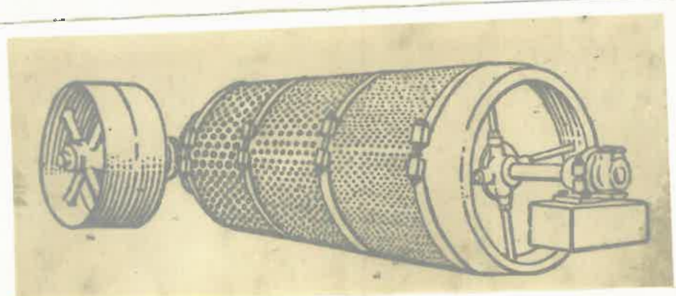
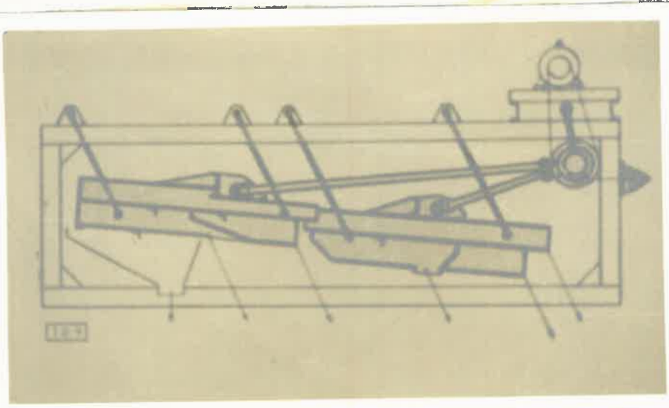


FIG. 3 SHAKING SCREEN



Trommel Screens

A revolving or trommel screen consists of a cylindrical jacket of perforated plate or wire cloth attached to the outside of rings or spiders and supported on a central shaft, the whole usually being slightly inclined. A trommel of this type is illustrated in Fig. 2. Trommels generally similar to the one shown but having a conical jacket are also encountered.

By increasing the aperture of succesive sections of the jacket from the feed end, a number of size fractions may be produced. As the screen revolves, the particles in it either pass through the perforations or are carried up the rising side until gravity overcomes frictional and centrifugal forces, whereupon each particle rolls or slides down until it comes to rest and then is carried up again.

Trommels have a relatively low capacity and tend to give rise to substantial size degredation. In modern coal preparation practice, trommels have become virtually obsolete having been displaced by shaking and vibrating screens.

A few trommel screens are still in operation on the older South African collieries, being used to screen the smaller sizes and are usually situated directly above a series of small coal bins.

Shaking Screens

Shaking or jigging screens consist essentialy of robust frames, supported from hangers and given a longitudinal reciprocating motion by means of cranks or eccentrics through relatively long connecting rods. A typical screen of this type is shown in Fig. 3. It is customary to arrange the screen frames in pairs driven from the same crankshaft in order to balance reciprocating forces as far as possible. When applying a simple harmonic reciprocating motion, individual frames are slightly inclined in order to facilitate motion of the coal along the screen surface.

Particles passing through the perforations may fall freely or they may be gathered by a blank plate on the bottom of the screen frame and thus be conveyed to the lower end for discharge to a conveyor etc. Alternatively a second screen surface with smaller perforations may be fitted in place of a blank plate to rescreen the undersize (usually termed a double deck screen). Double deck screens are frequently employed to carry out a combined screening and dewatering operation.

Factors determining rate of flow of material over the screen surface are:-

(a) the inclination
(b) length of stroke
(c) number of strokes per minute.

These screens are usually operated at low speeds and large amplitudes. (e.g. 100 rpm and amplitude of the order of a few inches).

Special shaking screens which may be operated in a substantially horizontal position have also been developed. This is achieved by the use of suitable reciprocating motion e.g. the screen may be shaken by a differential-motion drive head that moves the screen forward slowly and reverses sharply into a more accelerated return stroke.

Shaking screens with simple harmonic motion are however, the more common in South Africa.

The principal advantages of shaking screens are:-

(1) Low head room required.

(2) It conveys in a horizontal direction while screening, thus frequently simplifying plant layout.

(3) Coal is handled gently with relatively little size degradation.

(4) Simplicity, low maintenance and ease of maintenance.

This type of screen is normally fitted with ordinary perforated plate decks, and have the disadvantage that the apertures tend to become "pegged" with near size particles. When screening small damp coal the apertures tend to "blind". Screen surfaces have recently been developed which overcame these difficulties to a certain extent. The capacity of shaking screens is relatively low compared with vibrating screens.

Vibrating Screens

Vibrating screens are operated at relatively high frequencies (600 to 1,800 rpm) with small amplitudes of vibration (usually less than ½ inch). High-frequency vibration is more effective than the slow movement of the shaking screen in keeping the apertures clear of wedged particles and in stratifying the feed and bringing the smaller particles in contact with the screen surface. This results in a high capacity per unit of screen area and these screens are consequently much smaller and more compact than is the case for shaking screens.

As in / ....

As in shaking screens, the movement of the particles over the screen surface is caused either by gravity alone, the vibration alone or more commonly as a resultant of both.

There are a great variety of vibrating screens which may be divided into two main classes viz:-

(a) Those having a substantially rectilinear vibration

(b) Those having a more or less elliptical vibration.

In the first class, the drive may be either mechanical or electromagnetic and the movement may be either harmonic or unsymmetrical. An example of a mechanically vibrated screen is shown in Fig. 4, and of a magnetically vibrated screen in Fig. 5. In the former example the vibration is at 45° to the screen surface while in the latter it is perpendicular to the screen surface. Because of the direction of the vibration, the mechanically vibrated screen may be operated at a much smaller inclination than the magnetically vibrated screen illustrated.

The second class of vibrating screens are actuated either by means of eccentrics or by means of rotating unbalanced weights.

Vibrating screens are supported either by means of hanger rods or ropes or by means of springs. Some damping arrangements are usually provided to minimise the transmission of vibration to the supporting structure.

In modern coal preparation practice, vibrating screens are largely displacing shaking screens for sizing small coal

(below / ....

FIG. 4 LOW HEAD VIBRATING SCREEN

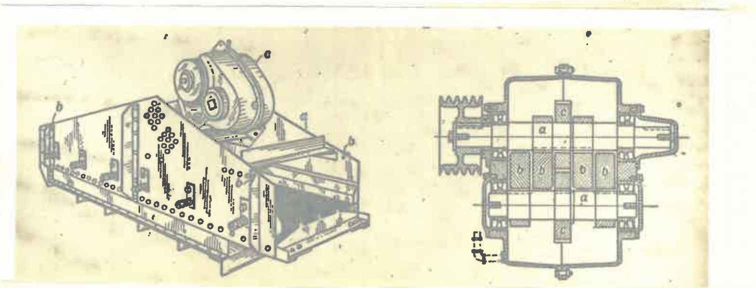
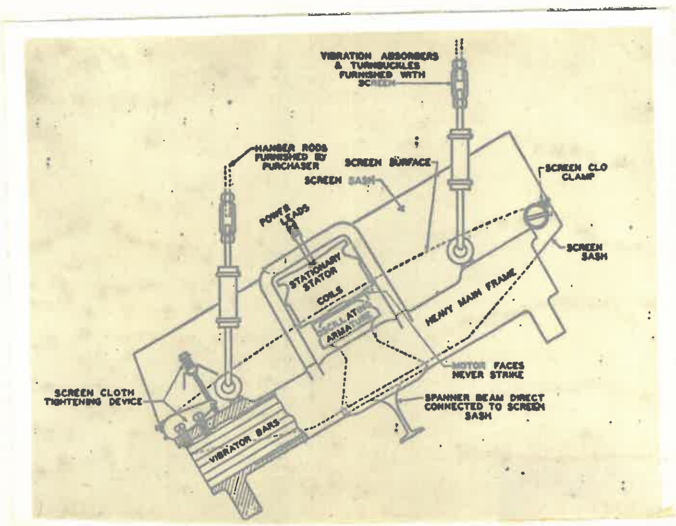


FIG. 5 ELECTRICALLY VIBRATED SCREEN



(below about 1 inch) and for dewatering fine sizes. Their application to large coal sizing is rapidly expanding, but they do tend to cause breakage if the coal is friable.

SCREEN SURFACES

For coal sizing operations, punched plate surfaces are commonly used in conjunction with shaking screens. The perforations are usually circular, but square and elongated perforations are encountered. These plates are robust, but as the size of the aperture decreases, the percentage of open area must be reduced in order to retain adequate strength. Since the coal passes over the screen with a sliding motion, the apertures tend to peg easily, and elongated particles, which are otherwise smaller than the aperture, slide over the apertures without passing through. A variety of perforated plates have recently been developed which overcome these difficulties to a certain extent.

When shaking screens are used for dewatering purposes, wedge wire decks are normally fitted.

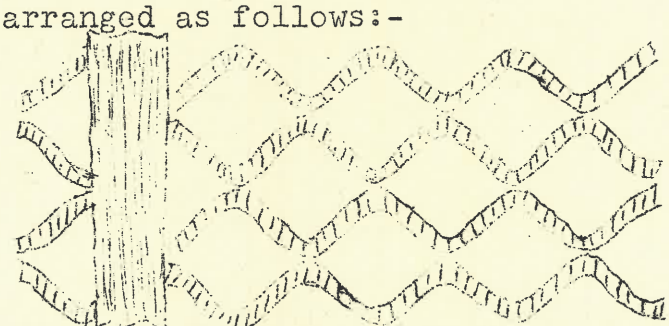
Woven wire screen cloths are usually fitted to vibrating screens. For sizes larger than about ½ inch, square aperture meshes are mainly used. For smaller sizes, a variety of woven cloths with elongated openings are made. Square apertures give the sharpest separations, but they lose more in effective aperture and capacity from inclination. (If the screen is inclined, the effective opening is represented by the projected area which is somewhat smaller than the actual opening).

While the round aperture, which is equivalent to a square aperture screen varies from coal to coal, the following ratio is frequently used:- $\frac{\text{Round hole diameter}}{\text{Square side}} = 1.16$

SCREENING OF MOIST SMALL COAL

When screening moist coal at sizes below about ½ inch, the small particles tend to compact in the apertures and cause blinding of the cloth. It has been found that elongated apertures having a large length to width ratio, blind less readily than square apertures, probably due to vibration of individual wires.

A new type of cloth has recently been developed, (Serpa screen) which it is claimed does not blind. This is again probably due to vibration of individual wires. Individual wires are arranged as follows:-



This cloth has the advantage of having substantially square apertures.

Another recent development is the use of a heated screen cloth to prevent blinding. Electrical current is either induced in, or passed directly through the screen surface which may be either woven wire or punched plate. Installations which have been inspected appear to operate satisfactorily.

WET SCREENING

In the case of certain separating processes, it is imperitive to remove as much as possible of the fine particles (1/16" and smaller) from the feed coal. If the feed coal is moist (due to wet mining methods, for example), these particles adhere to the larger lumps and can only be removed effectively

with / ......

with the aid of wet screening. A vibrating screen is preferable for this purpose and a large volume of rinsing water is required for satisfactory results. As a rough guide, the quantity of rinsing water required is approximately 4 times the quantity of coal to be removed.

CAPACITY AND EFFICIENCY OF SCREENS

Clearly the factors influencing the capacity and efficiency of screens are closely inter-related, and a statement of both required to assess the performance. For example, it is possible to have a high capacity and low efficiency and vice versa. In other words, capacity figures should only be compared on the basis of equal efficiency.

In general, the width of the screen influences the capacity and the length determines the efficiency, assuming a constant bed thickness at the feed end.

In practice, capacities are often expressed in terms of tons of unscreened coal per hour, per square foot of screen area.

Capacity figures on this basis are dependent upon factors such as :-

(a) Type of screen (shaking or vibrating)
(b) Inclination of screen (effective aperture)
(c) Type of cloth and size of aperture (percentage open area)
(d) Size distribution of the coal
(e) Surface moisture content of the coal.

As can be expected, capacities expressed in this way vary widely. The more scientific approach is to define the capacity in terms of the quantity of material passing unit area in unti time. Apart from mechanical aspects (type of screen and cloth etc.), which cannot be considered here, this quantity and the efficiency is affected to a very large extent by the coal being screened.

In any screening operation over apertures substantially equidimensional in two directions at right angles, particles having a width greater than 1½ times the aperture may be increased or decreased in their proportion in the total feed without affecting the rate of passage of undersize, or the efficiency appreciably. (Large particles only influence power consumption and rate of wear).

Similarly, the proportion of material with a width less than ½ the aperture (some authors state ¾ the aperture), may also be varied within wide limits without effect on the screening efficiency. The proportion of these particles naturally influences the rate of material passing through the screen. Material in the intermediate size range (i.e. 0.5 to 1.5 times aperture), is known as the critical size material and is the fraction on which the difficult selection must be done.

Thus for any given screen and desired efficiency the capacity varies inversely as the proportion of critical-size material and vice versa.

Capacity (for a given efficiency) on feeds containing a considerable proportion of fines, is decreased materially by moisture contents in the range of about 5 - 15%, by reason of the caking tendency of moist fines. Higher moisture content increases capacity because of the lubricating and carrying power of the water.

The efficiency of a screen can be assessed in several different ways. Some of these methods depend on

relatively / ....

relatively complicated formulae of doubtful value. The simplest and most direct method (and the one on which the consumer will base his complaints), is to judge the performance from the proportion of undersize material in the oversize product. On this basis, 5% undersize material denotes highly efficient screening on all but the finest sizes of material, 15% is fair and if the feed coal is moist, this figure may rise to 40 or even 50%. In South Africa, a maximum of 15% undersize in the product is normally acceptable.

Similarly, the proportion of oversize in the through product is sometimes also of importance (e.g. in South Africa where duff is cheaper than peas). Unless screen apertures are used which are not equidimensional, the presence of oversize is mainly due to torn cloths, displaced wires or general mechanical wear.

DR. P. J. VAN DER WALT

ASSISTANT DIRECTOR,
ENGINEERING DIVISION.