bulk solids handling Volume 1, Number 2, May 1981

Design and Operation of Coal Storage and Homogenisation Systems

G. Fischer, Germany

Planung und Betrieb von Halden- und Mischsystemen für Kohle
Planification et fonctionnement de systèmes de haldes et de mélanges pour le charbon
Planificación y marcha de sistemas de vaciadero y mezcla para carbón

石炭貯蔵および均質化システムの設計と運用

煤炭贮存与均化系统的设计和操作

تصميم وتشغيل أنظمة الخلط وتخزين الفحم

Planung und Betrieb von Halden- und Mischsystemen für Kohle

Die Plannung von Kohle-Haldeanlagen sollte immer mit der grundlegenden Frage und Entscheidung beginnen, welche Methode der Wiederaufnahme bzw. Rückgewinnung wünschenswert ist. Dieser Beitrag gibt einen Überblick über die verschiedenen Methoden des Absetzens und Wiederaufnehmens und deutet deren Vor- und Nachteile für spezielle Anwendungen an. Planungskriterieren werden aufgezeigt unter besonderer Berücksichtigung von Lagersystemen für Kohle.

Planificación y marcha de sistemas de vaciadero y de mezcla para carbón

La planificación de vaciaderos de carbón debería siempre comenzar con la pregunta básica y la decisión de que método es deseado para la recarga ó recuperación. Esta contribución dá una vista general sobre los diferentes métodos del depositado y recargo del carbón e indica las ventajas y desventajas de aplicaciones especiales. Criterios para la planificación son presentados con consideración especial a sistemas de almacenamiento de carbón.

Planification et fonctionnement de systèmes de haldes et de mélanges pour le charbon

La planification de haldes de charbon devrait toujours commencer par la question et la décision importantes: quelle méthode de reprise au stock, éventuellement de récupération est souhaitable. Cet exposé donne un aperçu des différentes méthodes de dépôt et de reprise au stock, et indique leurs avantages et désavantages pour des utilisations particulières. Des critères de planification sont présentés, en tenant compte des systèmes de stockage du charbon.

Summary

The planning of coal storage plants should always commence with the basic question and decision relating to the desirable method of material reclamation. This paper highlights the various methods available for stockpile stacking and reclamation indicating the basic advantages and disadvantages of each for particular applications and offers system design guidelines with particular reference to coal storage systems.

G. Fischer, Gustav Schade Maschinenfabrik, P.O. Box 796, D-4600 Dortmund 1, Fed. Rep. of Germany, Telex: 822429 gschad

1. Introduction

What are the basic requirements and desirable funtions of the typical coal storage plant?

Naturally there are many, especially if not only the present process operational circumstances and requirements are to be considered but also perhaps foreseeable or possible future developments.

A selection of the possible functions that the storage plant can fulfil are, of course, always absolutely necessary. However, only seldom is it possible to satisfy all requirements simultaneously.

When therefore, is a coal storage plant a highly efficient one?

Generally speaking, only when it consists of all the absolutely necessary functions and has as many of the desirable features as possible taking account of the future.

When a coal storage plant is planned, it is of course necessary to investigate completely the given basic operational situation. At the same time the required functions and characteristics of the plant must be determined. Then, of course, the real engineering planning commences involving a basic search for the most favourable means to achieve an optimum cost effective design and operational system. It is usually difficult especially for the non-specialist, to keep in mind all the important points of view and to meet all requirements simultaneously. Therefore, the planning engineer generally works step by step in sequence.

What therefore is the optimum sequence of steps at the process plant design and specification stage?

Quite certainly, from past experience it is not correct or desirable to decide at the outset on the type of machine and method for stacking or stockpiling the coal. Relatively few methods of stacking exist and as such available stacking methods and devices are rather easy to survey. With very few exceptions stackers for all given tasks and for virtually any given capacity can be obtained.

Therefore possible design constraints and restrictions relating to the functioning of the storage plant are not in general related to restraints imposed by the availability of suitable stacking equipment.

Consequently, the more difficult field of material reclamation and the associated problems should be treated in the initial stages of plant and process selection [1,2,3].

In so doing, it is recommended that the process designer starts with the simple question: Is the stockpile to be reclaimed from the front slope or from the side slope?

2. Material Reclamation from the Front Face and Side of the Pile

Fig. 1 illustrates the basic differences between material reclamation from the front slope of a stockpile and from the side slope. The left side shows longitudinal stockpiles which are being reclaimed from the front slope. Reclamation from the front slope can be effected, for instance by means of a drum-type reclaimer or a bridge-type reclaimer (Fig. 2).

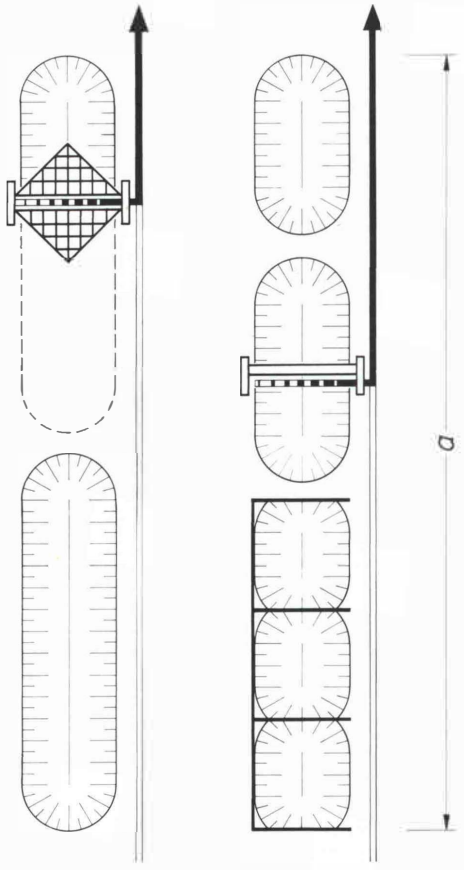

Fig. 1: Stockpile material reclamation from the front and side slopes

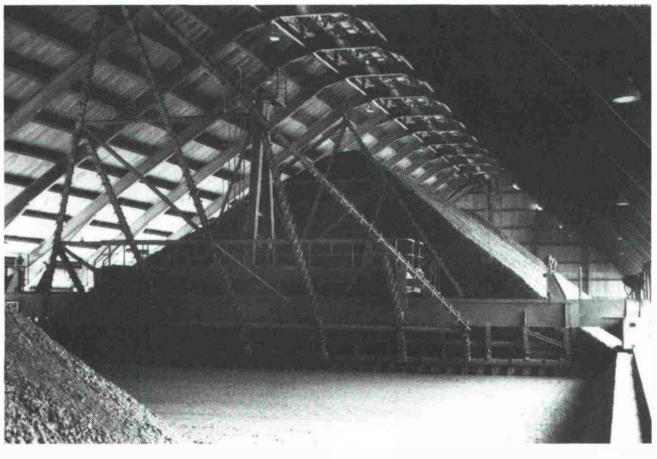

Fig. 2: Bridge type scraper reclaimer inside a storage building

Due to its working method and design this type of machine is restricted in its use to the front slope of the stockpile, that is, it cannot travel along the total length of the pile to give it the ability to reclaim material from several stockpiles arranged in line one behind the other in any required sequence.

This means that reclaimers operating at the pile front slope are normally one-product machines. With particular reference to coal storage, the following essential aspect should be considered: If at any place within the stockpile centre, coal ignites and is burning or is expected to burn, it cannot be reclaimed by a machine which is restricted in its operation to the front face of the stockpile.

The right side of Fig. 1 shows a longitudinal stockpile which is being reclaimed in a lateral manner from the side slope. The method of reclamation can be achieved for example by means of portal-type reclaimer (Fig. 3). In this case the

Fig. 3: Portal scraper reclaimer for coal blending — 50m span (Courtesy of Klöckner power station, Rauxel)

situation is quite different. Again due to its working method, the reclaimer is able to operate in any required place in its travel range (a) and at any required time in any sequence. In the upper part two longer stockpiles are drawn which should contain different products. In the lower part three short stockpiles are shown which are divided by separating walls. These five products separately stored can in this case — as they are reclaimed from the side — be reclaimed by one single reclaimer in any required sequence. In addition it will also be possible, naturally, in the event of danger of fire or self-ignition, to traverse the reclaimer to the relevant stockpile region usually in a matter of minutes, thus permitting the safe reclamation of the endangered stockpile section.

Reclaiming coal stockpile from the side slope has advantages if comparisons are made with the front face method; namely, in practically all possible situations it is a favourable aspect in coal storage plant if there is a basic facility to separately store and reclaim different distinct materials and qualities.

Even if the designer assumes in the first instance that he will be dealing with only one product, he should never the less consider incorporating into the design alterations to make the system flexible enough to accommodate at some future

time the possibility of multiple but separate material storage and reclamation.

Operating conditions at, for example, a modern power station may change and may quickly cause the necessity that in addition to the normal fuels an extremely low sulphur coal may be required. Or in the shipping intermediate storage at a mine subsequent additional materials may have to be stored because, for example, production possibilities or market requirements have changed. Also the possible danger of self-ignition of coal may be an important factor, especially for a modern large stockpile, in the case of which the reclamation of the fire-risk section should be undertaken only by a heavy duty machine due to capacity and safety reasons.

It must be remarked that machines that reclaim material from the side slope of the stockpile are to be preferred also from the point of view of availability; namely, in those cases where several machines are working one behind the other on the same rail track. If one machine fails, the neighbouring one can of course fulfil its tasks in replacement.

The above points and comments relate essentially to longitudinal stockpile systems. It should be expressively noted, however, that circular stockpiles too, can be reclaimed from both their front slope and from the side. The centre line of the pile in this case is no longer a straight line but a circular one. The above therefore appertains not only to longitudinal stockpiles but is directly applicable to circular stockpiles.

3. Stockpile Reclamation from the Side

Only the most important of the reclaimers that can be utilised for stockpile material reclamation from the side slope will be discussed below:

Firstly, consider the cantilever scraper reclaimer (Fig. 4).

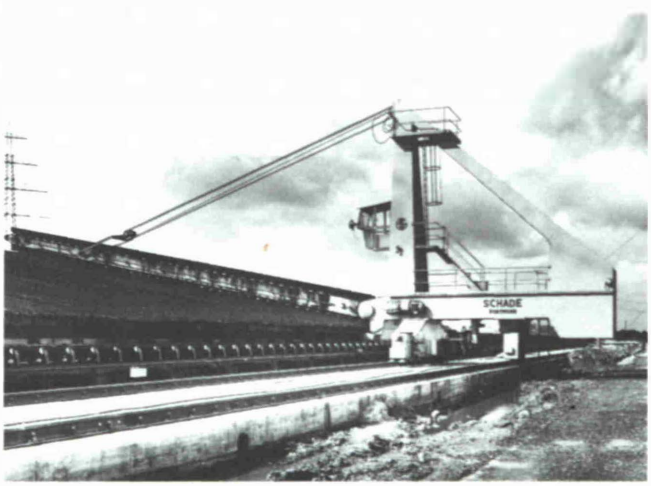

Fig. 4: Cantilever scraper for coal blending
(Courtesy of Scholven power station, VEBA Kraftwerke Ruhr AG)

This reclaimer has, similar to every scraper reclaimer, a continuous double stranded link chain provided shovels in evenly spaced intervals. The shovels in the lower stringer of the chain remove the coal from the pile surface layer by layer and feed it towards the lower reverse point of the chain where it is deposited onto the reclaim belt conveyor running alongside the stockpile. The two travelling rails of the cantilever scraper reclaimer are arranged at the same side of the pile laterally to the outgoing conveyor. Due to its very simple procedures of movement the cantilever scraper reclaimer normally operates automatically.

Economically built cantilever scraper reclaimers today have an upper capacity limit of approximately 1,500 t/h with a maximum design width of 25 to 30 m.

For wider stockpiles and larger capacities, the portal-type scraper reclaimer is an especially suitable machine, particularly with regard to effective utilisation of space, economy and high reliability. The working method of this machine is somewhat similar to the cantilever scraper reclaimer. The travelling rails, however, are arranged in this case on both sides of the stockpile. A portal structure spanning the complete stockpile serves as a support and as a guiding frame for the scraper boom. Fig. 5 shows a portal scraper reclaimer in operation.

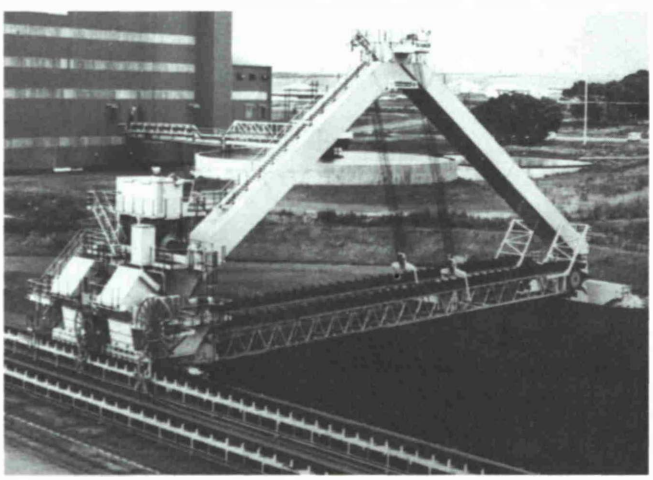

Fig. 5: Portal scraper reclaimer 50 m span, nominal capacity 2,000 t/h washed coal

The portal scraper needs no counterweight and therefore is a machine that is not only suitable for installation in the open-air but also for enclosed stockpile systems. Portal scraper reclaimers which work with a very simple motion cycle are nearly always operated automatically.

The upper limit of capacity for the portal scraper reclaimer is typically in the region of 3000 t/h. The pile design widths currently in operation range up to approximately 60 m.

In addition to the above there are also available stacker-reclaimers, which similar to the scraper reclaimer operate from the side of the stockpile and which in addition are equipped with a conveyor tripper carriage and a conveyor boom for pile stacking (Fig. 6). Because of this dual purpose function a separate stacker inclusive rails and a feeding conveyor alongside the stockpile is as a result not necessary. However, such a machine will only be suitable in those cases where the requirement of simultaneous stacking and reclaiming is not given.

Cantilever scraper reclaimers and portal scraper reclaimers which work from the side of the stockpile are suitable essentially for storage plants which demand a maximum flexibility of operation. For those cases where the material to be stacked has a relatively small particle size distribution, e.g. 0—50 mm, it is sufficient to form the stockpile according to the CHEVRON method (Fig. 7) or perhaps in cone shells. For

this type of application a non-slewing stacker is all that is required. If the pile is to be enclosed this method of stacking can be accommodated by means of a conveyor system located below and inside the roof structure.

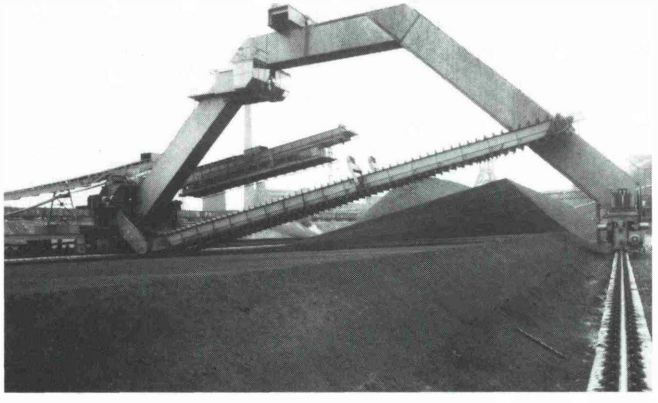

Fig. 6: Portal stacker/reclaimer, span 47 m, capacities 1,600/900 t/h coking coal (Courtesy of Zollverein Coking Plant, Ruhrkohle AG)

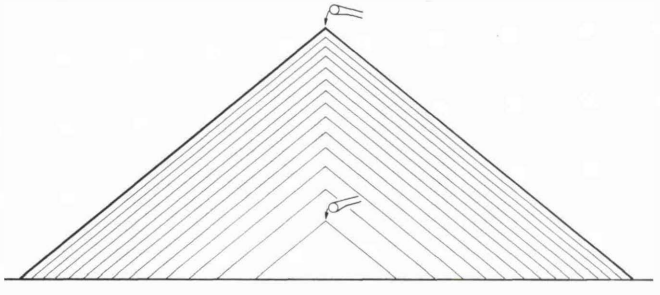

Fig. 7: CHEVRON type blending bed

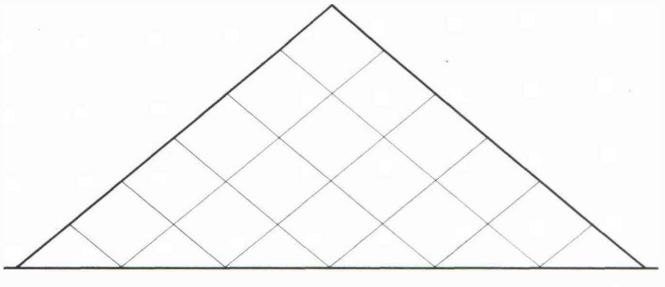

Fig. 8: WINDROW type blending bed

For storing raw coal (e.g. 0—150 mm) such stacking methods are often not entirely successful due to the large particle size segregation that is evident, as the fine particles would tend to move towards the upper part and the larger particles would move towards the lower part of the pile cross-section. In the corresponding sequence of material reclamation this distinct difference in quality throughout the stockpile cross-section would be evident in the stockpile output flow stream. In cases where it is necessary to avoid such characteristics the stockpile would be built up according to the WINDROW method (Fig. 8). As a result, coarse and fine grained particles are evenly distributed throughout the total stockpile cross-section.

Scraper reclaimers that operate from the side of a stockpile are not only suitable for storage plants but under certain conditions are also particularly suited to blending and homogenisation functions. This fact is within the industry not so well known as it should be. For materials with a small particle size range the method of layering within such a blending plant would be with OBLIQUE layers. This method of stacking should be restricted to those materials which do not tend to segregate greatly (e.g. 0—30 mm) and in this context the homogenising method will be particularly relevant and usable for coking coals and power station coals.

Material stacking is effected by a slewing stacker (Fig. 9). The stacker piles the coal up at the natural angle of repose

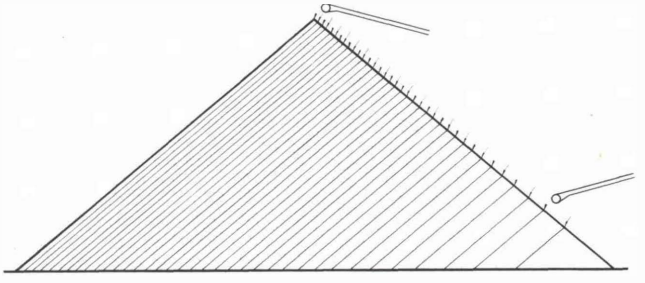

Fig. 9: Blending bed with OBLIQUE layers: Stockpiling by slewing stacker

and OBLIQUE layers are superimposed upon one another. Reclamation is effected by a scraper reclaimer chain (Fig. 10).

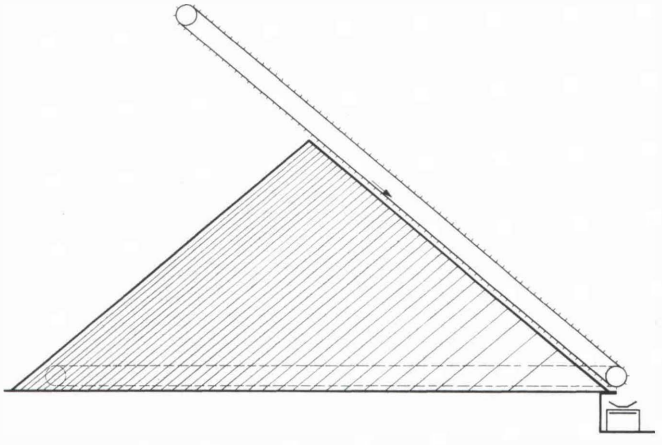

Fig. 10: Blending bed with OBLIQUE layers: Reclaiming by scraper reclaimer

Each shovel of the scraper chain cuts through all the layers in the blending bed. In such a blending bed just as many layers can be deposited as can be attained with other methods such as, for example, CHEVRON layering. If it is assumed in the first approximation that the blending effect is in proportion to the square root of the number of layers, this means that a theoretically similar variability reduction can be expected as for well-tried methods such as CHEVRON and WINDROW stacked layers. In fact the practical results are excellent and this method of homogenisation has for many years been applied within the coal industry with unrestricted success. The machines shown in Figs. 3 and 4, for instance, are currently being used for blending power station coal.

For those applications where there is expected to be a somewhat larger particle size segregation effect due to a larger

particle size distribution, the pile should be formed in accordance with the WINDROW method. The expected homogenisation effect would, however, be somewhat less efficient than with the above OBLIQUE layering method.

In certain cases, however, the right solution is to provide a raw coal storage system with a portal scraper reclaimer, this is particularly relevant when two or three different types of coal have to be stored within separate beds and then reclaimed by one machine.

4. Reclaiming the Stockpile from its Front Slope

Among the machines currently available and which can be utilised for stockpile reclamation from the front slope, mention should be made of the slewing bucket wheel reclaimer (Fig. 11). The bucket wheel reclaimer has a special position in so far as this machine (even with restrictions) is able to reclaim several stockpiles in line. However, due to a basic need for a substantial amount of space, especially during the initial stages of cutting, it is necessary to leave some distance between successive piles and as a result to bear corresponding losses in capacity.

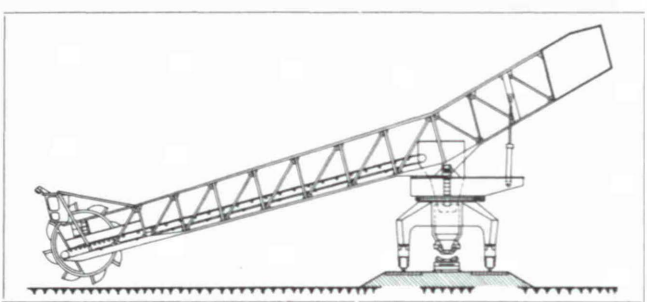

Fig. 11: Bucket wheel reclaimer

It is also true that the bucket wheel reclaimer is not able to effectively cut a section into a continuous stockpile in case of fire and as the sequence of movements is complicated it is difficult in practice to provide for automatic operation.

But for buffer stocks, the slewing bucket wheel reclaimer may nevertheless be the most suitable device. This is the case particularly in circumstances where the required reclamation capacity is very large.

In general it should be kept in mind that the slewing bucket wheel reclaimer is a machine for very high capacity hauling systems, and in this respect it has no practical upper limit.

For bulk material homogenisation, however, this type of bucket wheel is less suitable as the machine operates from only one point at a time within the pile cross-section and requires some considerable time to travel along the total face.

The second large group of reclaimers which are utilised extensively for stockpile front slope reclamation are the bridge-type machines. This range of machines includes the bridge scraper reclaimers, drum reclaimers and bucket wheel bridge reclaimers. Fig. 12 shows a bridge scraper reclaimer for coal. The wide span of 50 m elucidates that today fairly large pile cross-sections can be accommodated by bridge-type machines. This group of machines, irrespective of the special type, consists of a bridge travelling slowly forward to the front slope on parallel rails arranged on either side of the stockpile. The bridge supports a slope raking device, typically a harrow, which is moved back and forth across the face of the pile, causing continuous movement of the material down to the base of the pile to be reclaimed and carried away. In the case of the bridge scraper reclaimer, a scraper chain drags the coal at the foot of the slope onto a reclaiming belt conveyor. When a bucket wheel is used, in addition to the reclaiming belt that runs parallel to the pile, a cross-pile belt running alongside the bridge is used to transverse the material from the buckets.

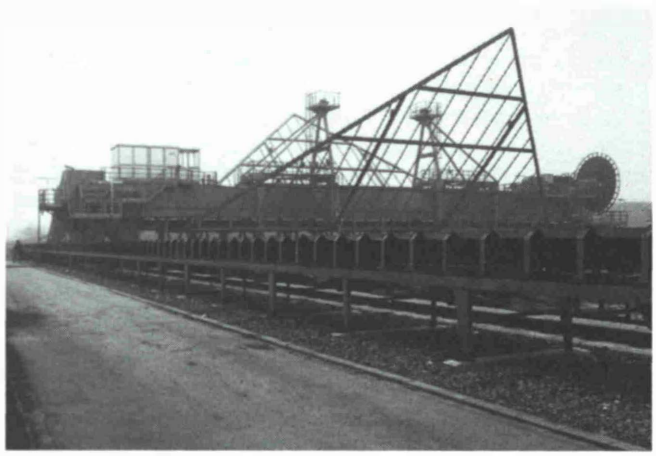

Fig. 12: Bridge-type scraper reclaimer: Span 50 m, capacity 1125 t/h power station coal

For the bridge scraper reclaimer and the drum reclaimer it suffices to structure the pile according to the CHEVRON layering method. Here, however, with regard to particle size segregation the coarse grains are concentrated mainly in the lower and outer sections of the stockpile. But as both machines reclaim the material from the base of the pile cross-section and spread over the entire width of the pile, segregation offers no disadvantage. Bridge-type reclaimers with single bucket wheels would reclaim mainly coarse particles if the bucket wheel is positioned solely at the outer edge of the pile and fine particles if positioned near the centre of the pile cross-section. If a good homogenisation effect is required one should therefore build the pile for these machines by the WINDROW method. Inside a closed building this is, however, difficult to execute, so in such cases a bridge scraper reclaimer or a drum reclaimer are more suitable.

Bridge-type reclaimers, irrespective of their design, are in general less suitable for storage plants but rather are ideally suited for homogenisation purposes. Their main field of application is for the reclamation of materials such as coal which tend to segregate due to their wide range of particle sizes. Here again the bridge scraper should be preferred to the drum reclaimer mainly for reasons of price and simplicity. At the present time, bridge scraper reclaimers are available with reclaim capacities up to about 1,500 t/h with spans up to approximately 50 m.

Capacities of several thousand t/h, however, are reserved mostly for bucket wheel machines.

5. Conclusions

The planning of coal storage plants should always commence with the basic question which relates to the method of material reclamation. With regard to the possibility of storing as many products as required in line one behind the other with due consideration given to the aspect of safety against self ignition, the reclaiming of coal stockpiles from their side slope offers many principle advantages.

For buffer storage plants, reclaiming from a stockpile side slope is always recommended. Particularly relevant material reclamation equipment are the cantilever type scrapers up to pile widths of 25 m and for greater widths portal scraper reclaimers. Portal scraper reclaimers are currently being constructed for pile widths up to approximately 60 m and for reclaim capacities up to 3,000 t/h. If a greater reclaim capacity is required, sometimes two scraper reclaimers will give a favourable solution, otherwise for very high capacities the bucket wheel reclaimer should be chosen. The only reservations concern the case where the coal storage system is under cover. Here cantilever scraper reclaimers and slewing bucket wheels are less attractive due to their requirement for additional space.

Relevant stacking equipment for storage plants (CHEVRON or cone shells stacking) are boom stackers for an open-air constructed pile and a conveyor system and tripper under the roof for enclosed systems.

For blending and homogenisation systems it is important to note that reclaiming the pile from the side can offer certain advantages, especially for longitudinal stockpiles. If particle size segregation is not evident then the OBLIQUE method of material layering can give a good degree of homogenisation. Cantiliver scraper reclaimers should be used in cases where the design calls for small stockpile widths and portal scraper reclaimers should be considered for widths up to 60 m and output capacities up to 3,000 t/h. A slewing stacker is recommended.

If during stacking segregation is expected to take place, for example, in the case of raw coal, and at the same time a high blending effect is required, then the bridge-type reclaimer offers the best choice and solution. Bridge scraper reclaimers are currently available for pile widths up to 60 m and with capacities in the ranges of 1,500—2,000 t/h. For higher reclaim capacities bucket wheel bridge reclaimers are suitable machines, among which drum reclaimers give a better homogenisation effect than units with single bucket wheels. The homogenisation effects, however, achieved by bridge scraper reclaimers and drum reclaimers are virtually the same ones.

Relevant stacking equipment are boom stackers for the open-air pile and conveyor trippers below the roof structure or, in special cases, boom stackers for enclosed systems.

References

[1] Eichholtz, K., "Planung, Bau und Betrieb von zwei Lagern zum Vergleichmäßigen der Rohwaschkohle vor der Aufbereitung", Glückauf 103 (1967), p. 206—214

[2] Koch, H., et al., "Das 1600-MW-Steinkohlenkraftwerk Scholven der Hibernia AG", Mitt. Vereinig. Großk.-Betr. 48 (1968), p. 369—398

[3] Reichert, G., "Erfahrungen mit den steinkohlengefeuerten Blöcken im Kraftwerk Scholven", Energie 27 (1975), p. 46—58