

WORKSHOP - BELTCON 8

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HOMOGENIZATION OF BULK MATERIAL IN LONGITUDINAL AND CIRCULAR STOCKPILE ARRANGEMENTS

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HOMOGENIZATION OF BULK MATERIAL IN LONGITUDINAL AND CIRCULAR STOCKPILE ARRANGEMENTS

1. INTRODUCTION

In recent years, the improvement of quality with greater raw material utilization and optimum applications of processing plants is being striven after more and more in the sector of raw material beneficiation. Greater and greater fluctuation in properties of raw materials, such as ores, limestone and, in particular, run-of-mine coal, removed from deposits suitable for mining today, therefore demands that blending equipment ensures a high-quality end product.

From a materials-handling aspect it is more favourable to disconnect mining operations from processing plants and to optimize each separately, so that undesired fluctuations in the flow of material and standstills in handling are prevented.

Stockpile homogenization systems equalize variations of chemical and physical properties of raw materials and convert low quality raw materials into a uniform mixture of higher quality as required for cement production, coal fired power plants or for example steel production.

2. DEFINITIONS AND THEORETICAL CONSIDERATIONS

In a stockpile, bulk solids are stacked to and subsequently reclaimed from a storage facility. Generally a conventional pile can perform the following functions :

(Fig. 2 : Function of Stockpiling)

1. BUFFERING / DISTRIBUTING is the function of providing sufficient reserve of raw material to guarantee a continuous operation of the processing plant under all normal circumstances. The stockpile acts as a buffer between continuous and discontinuous operation of a mine or quarry, a processing or power plant or acts as a distributing system of a bulk terminal.
2. COMPOSING/BLENDING is the function of the integration of number of raw materials with different chemical and/or physical characteristics in such proportions that a completed pile represents the requisite composition.
3. HOMOGENIZING is the function of a systematic transformation of the input flow of the pile into the output flow, so that the fluctuations of a property in the flow are evened out.

In nature raw materials occur in varying grades, even within the most uniform deposit. When regular increments of the raw material stream is sampled and analysed the degree of variation can be measured. Mostly this variation approximates a normal distribution.

The aim in the homogenizing / blending operation is to narrow down the standard deviation of this normal distribution.

Ideally, the raw material stockpile is laid by a belt stacker in as many thin layers of identical volume as possible. As a result of this large number of layers, varying material properties in superposed layers are offset by the cutting process of machines in operation. The law of continuity tells us that each cross-section of the stockpile contains the same amount of material and this fact is the essential prerequisite for a good homogenization effect. The number of layers is determined by the cross section of the pile, the handling capacity and travelling speed of the stacking machine.

(Fig. 3 : Homogenization Effect)

In simplified terms, and subject to certain statistical assumptions, the homogenization effect and / or the efficiency of such a system are generally expressed by the ratio of the standard deviation of the material characteristic to be tested S_{in} ahead of the blending bed and S_{out} behind the blending bed.

$$\text{Homogenization effect } E = \frac{S_{in}}{S_{out}}$$

where S = standard deviation

Fig. 3.1 shows in principal the fluctuation of the incoming raw material quality around a certain average value \bar{X} . The deviation from this value is Δx . The second diagram shows the decreased fluctuation after the material is leaving a stockpile homogenization system.

Fig. 3.2 for example shows clearly the effect of the homogenizing operation with a standard deviation of the incoming material of 2,5 % and after reclaiming an improved deviation of only 0,5 %.

The practical application of this method, however, is limited by the missing information on the stockpile volume, the correlation between the stockpile layers, the different layer thickness, reclaiming method, errors during sampling and analysis.

Therefor, an empirical factor "k" is to be considered which is obtained by comparison of theoretical values with those received from practical sampling of various homogenization systems under comparable conditions

$$\text{Homogenization Effect } E = k \cdot \sqrt{n}$$

$$n = \text{stockpile layers}$$

The value of "k" normally varies between 0,5 to 0,7.

The result shows us, that the homogenization effect is a function of the stockpile layers n.

3. CLASSIFICATION OF TYPICAL HOMOGENIZATION / BLENDING PLANTS

The arrangement of homogenizing yards respectively blending beds can vary. The following basic classification is known :

(Fig. 4.1 : Longitudinal beds)

The plant consists of at least two beds, one being stacked to and one being reclaimed from. On average one bed is half-full and the other bed half empty, therefore the net effective storage capacity of a two bed plant is 50% of the gross storage capacity. This ratio can be improved in three and four bed plants.

Every time it is an interesting exercise to optimize width and bed length of the stockpile. With increased bed width the capital cost of the machines increases whereas the capital cost of yard conveyor belts, rail tracks, electrical reticulation and land decreases.

(Fig. 4.2: Parallel beds)

The beds are located side-by-side with a slewing stacker along the middle to serve both beds. One pile is destined for material stacking, the other for material reclaiming. In order to avoid a multitude of machines the reclaimer has to transfer from one bed to another by a transfer car or by means of swivel bogies and cross-rails.

(Fig. 4.3 : Circular homogenizing beds)

The circular system comprises a luffing / slewing stacker and a bridge-type reclaimer rotating around a central column, covering the entire area of the circular stockpile.

The material will be fed to the center of the stockpile by means of an overhead belt conveyor. The slewing stacker boom performs a continuous, combined slewing and luffing motion over a preset arc of the circle during stacking to form an endless bed.

A bridge scraper reclaimer with a slope clearing rake is supported at the inner end on a slewing ring and at the outer end on rail mounted drive bogies. The reclaimer is therefore always confronted by a full cross-section consisting of numerous layers of material, resulting in a long-term homogenizing effect.

The stacking mode is decided in conjunction with the duty and the type of reclaimer to be used.

Common stacking modes for stockpile arrangements are shown in the following figures :

(Fig. 5.1 : Chevron Stacking)

The stacker travels at almost constant speed back and forth along the entire length of the stockpile. The boom is raised according to the growth in height of the stockpile. The layer thickness ΔH is reduced as the height of the pile increases.

If reclaiming takes place cross-wise by a bridge-scraper reclaimer highest homogenization efficiency can be achieved.

(Fig.5.2 : Chevcon Stacking)

A similar stacking method - named Chevcon - was developed for a circular stockpile arrangement. The stacker boom slews back and forth over the curved stockpile ridge maintaining a constant pile length. With each individual movement, the end of one movement or the start of the next movement is advanced by the dimension ΔL . In that way many layers - similar to the Chevron mode - are superimposed and the stockpile grows continuously in one direction.

(Fig.6.1 and 6.2 : Coneshell / Strata Stacking)

The cone shell and strata stacking systems were specially developed for being used in connection with a portal scraper reclaimer. Due to the lateral reclaiming a limited effect of blending can be achieved.

(Fig.7.1 and 7.2 : Windrow stacking)

With the already mentioned chevron stacking mode the greater grain segregation can effect the homogenizing result. To compensate this unfavourable effect stacking can be done in a windrow-mode. With this system the discharge point / row along the stockpile changes as shown in the picture. For this operation a slew stacker with an enlarged boom is necessary.

4. COMPARISON LONGITUDINAL V/S CIRCULAR STOCKPILE SYSTEMS

(Fig. 8 : Circular Homogenization System,

Fig. 9 : Advantages/Criteria of a circular stockpile system)

Comparing a longitudinal with a circular stockpile arrangement the following advantages or criteria can be pointed out :

- Lower investment costs in comparison to a longitudinal system of equal "live storage volume".
- High "live storage volume" of appr. 75% compared to 50% of a two pile longitudinal system.
- The circular system is a compact design with shorter belt conveyor lines.
- Flexibility in layout design as a circle often best suits into available space and the direction of the inflow and outflow conveyor is variable over 360°.
- Continuous first in / first out stacking / reclaiming.
- The bed is endless so that the reclaimer is never repositioned.

- Reclaiming is always from a full cross-section with constant material stream.
- The circular homogenizing yard operates fully automatically so that the costs for operation and maintenance are remarkably low.
- Equal layer thicknesses will be achieved. In a longitudinal stockpile the thickness of the layers differs due to the stacker travelling against the direction of the incoming material stream with an increase stacking capacity.
- The number of layers cut is higher for the same bed cross-section, stacker slewing speed and stacking rate.
- For comparable stacking and reclaiming rates the power consumption of a circular system will be lower than for the longitudinal system because of
 - shorter belt length
 - no cable reel motors
 - no travel drives for the stacker.
- The great disadvantage of a circular stockpile system is that a future extension will not be possible. On the other hand a longitudinal stockyard can easily be adapted to new demands of storage capacity as there are no limits regarding the pile lengths.

5. CONCLUSION

In summary, one can say, that stockpile HOMOGENIZATION systems equalize variations of chemical and physical properties of raw materials and convert low quality grades into a uniform mixture of a higher material quality.

On a basis of an easy example it was tried to explain the importance and the meaning of the homogenizing effect.

After presenting different types of homogenization plants in connection with common stacking modes a rough comparison was made between a circular and a longitudinal system.

In conclusion it must be noted that each of the previously described systems presents particular advantages for a specific application and that both systems will still be used in the future.

Thank you very much.

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Distributing**

**2. Composing or
Blending**

3. Homogenizing



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Function of Stockpiling

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$$\text{Homogenization Effect } E = \frac{S_{\text{in}}}{S_{\text{out}}}$$

S = Standard Deviation

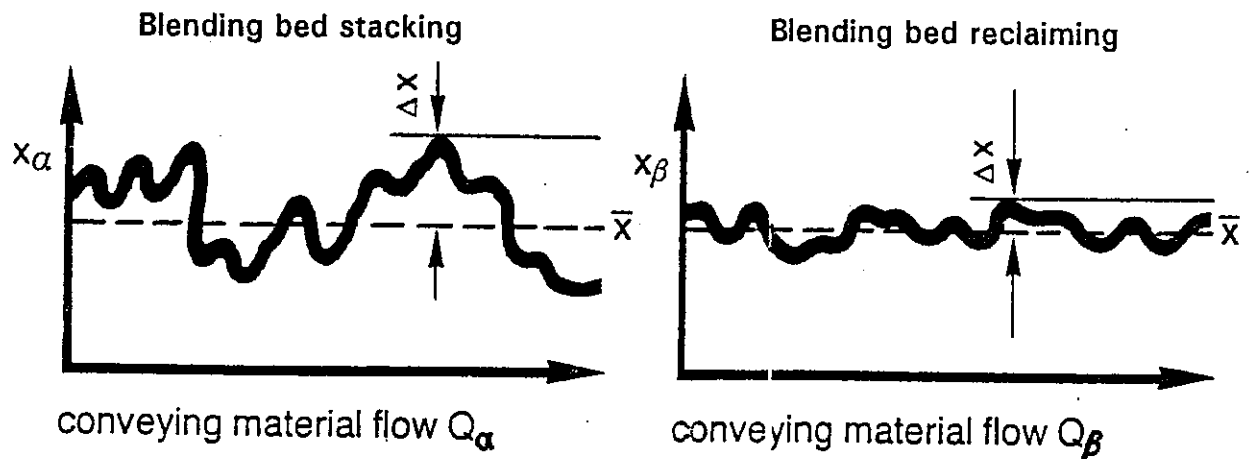


Fig. 3.1 Characterization a material property before and after reclaiming (\bar{x} = average value, Δx = deviation)

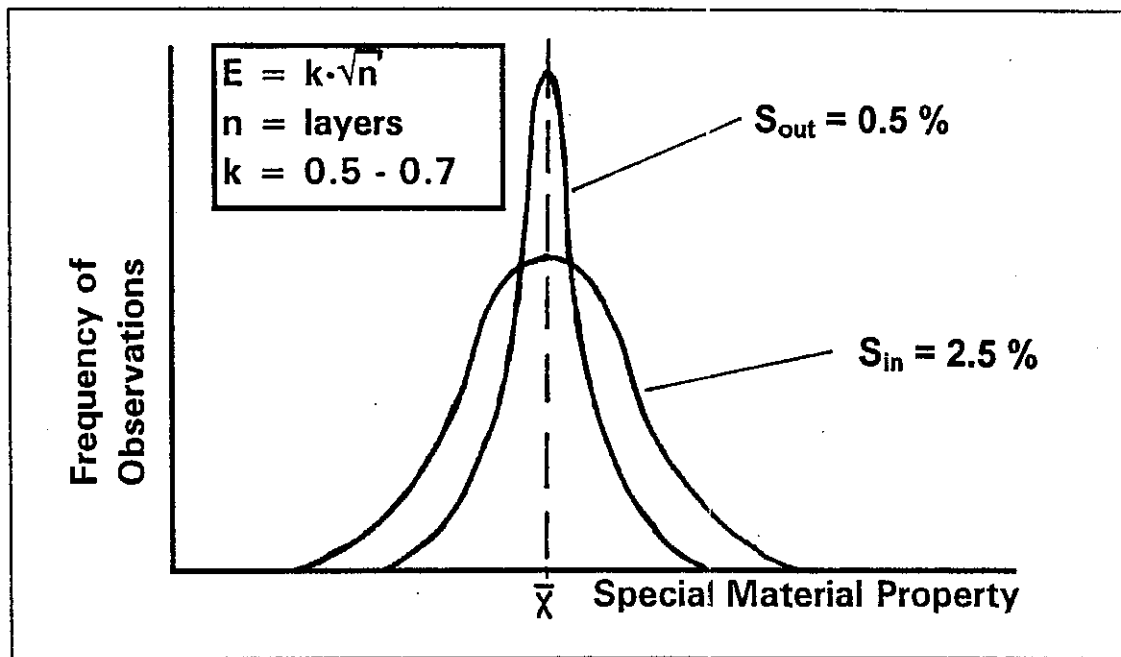


Fig. 3.2 Homogenization operation



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Homogenization Effect

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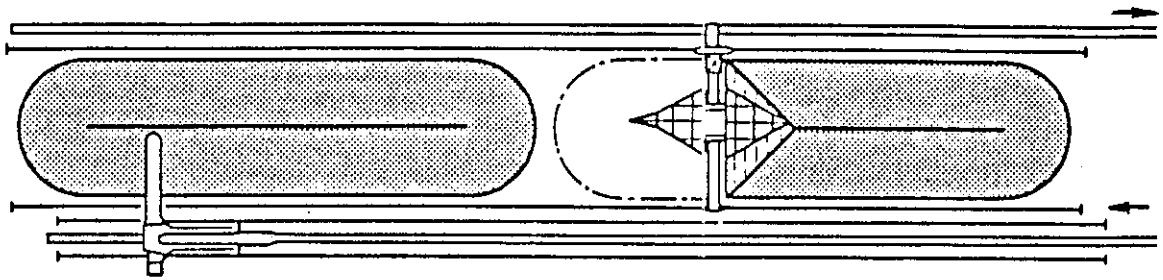


Fig. 4.1 Longitudinal beds

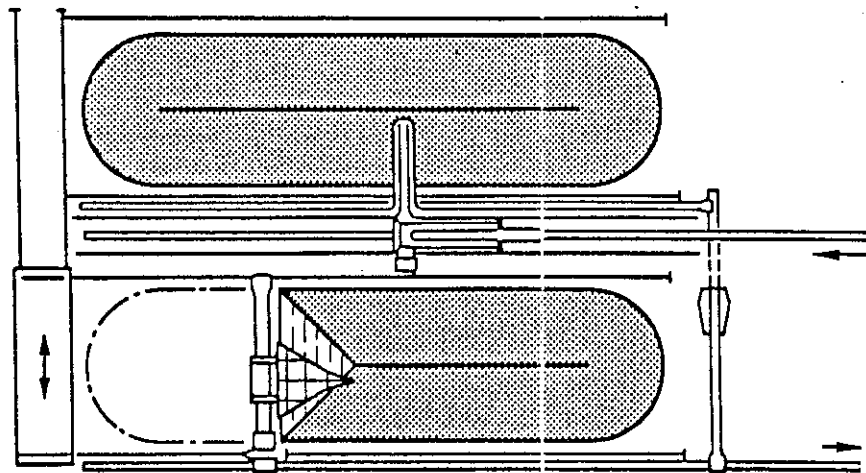


Fig. 4.2 Parallel beds

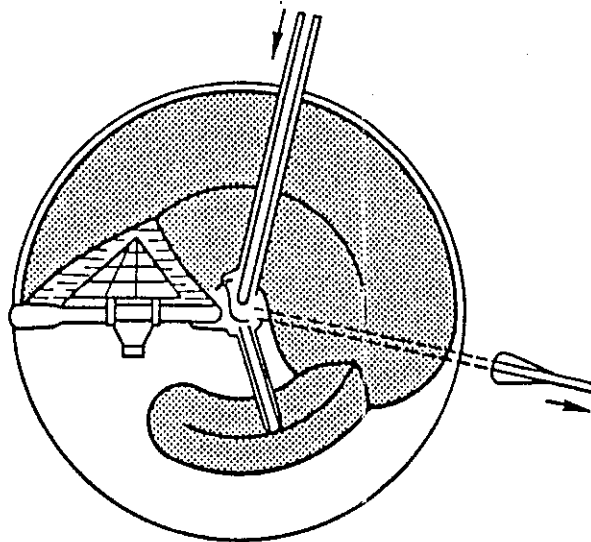


Fig. 4.3 Circular beds

(VDJ 3972)



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Arrangements of Stockpiles

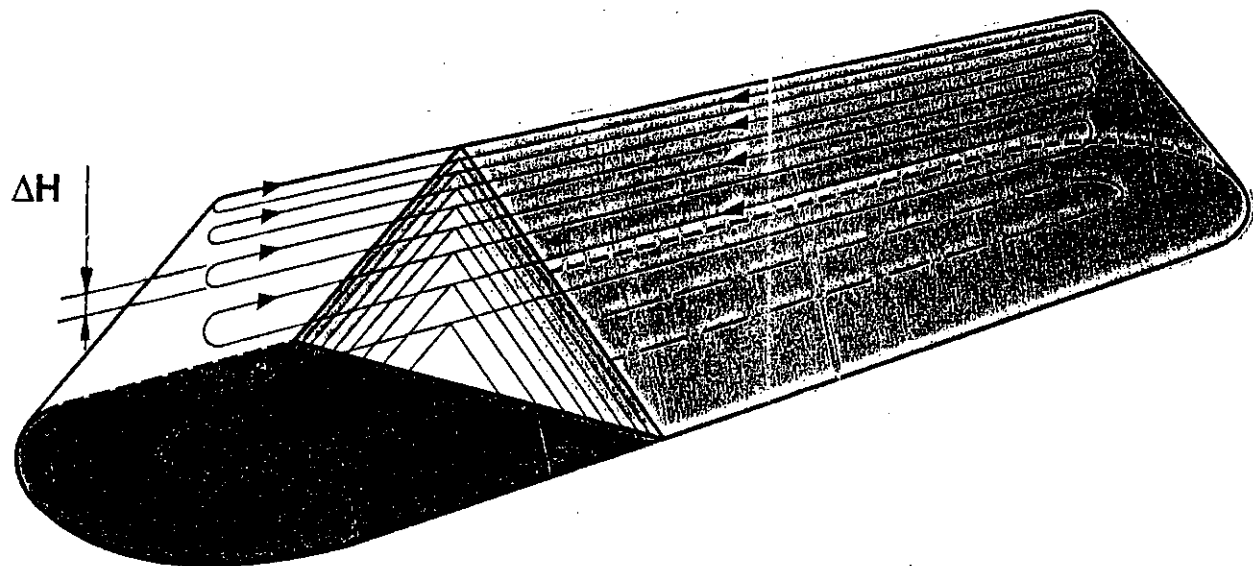


Fig. 5.1 Chevron stacking (longitudinal bed)

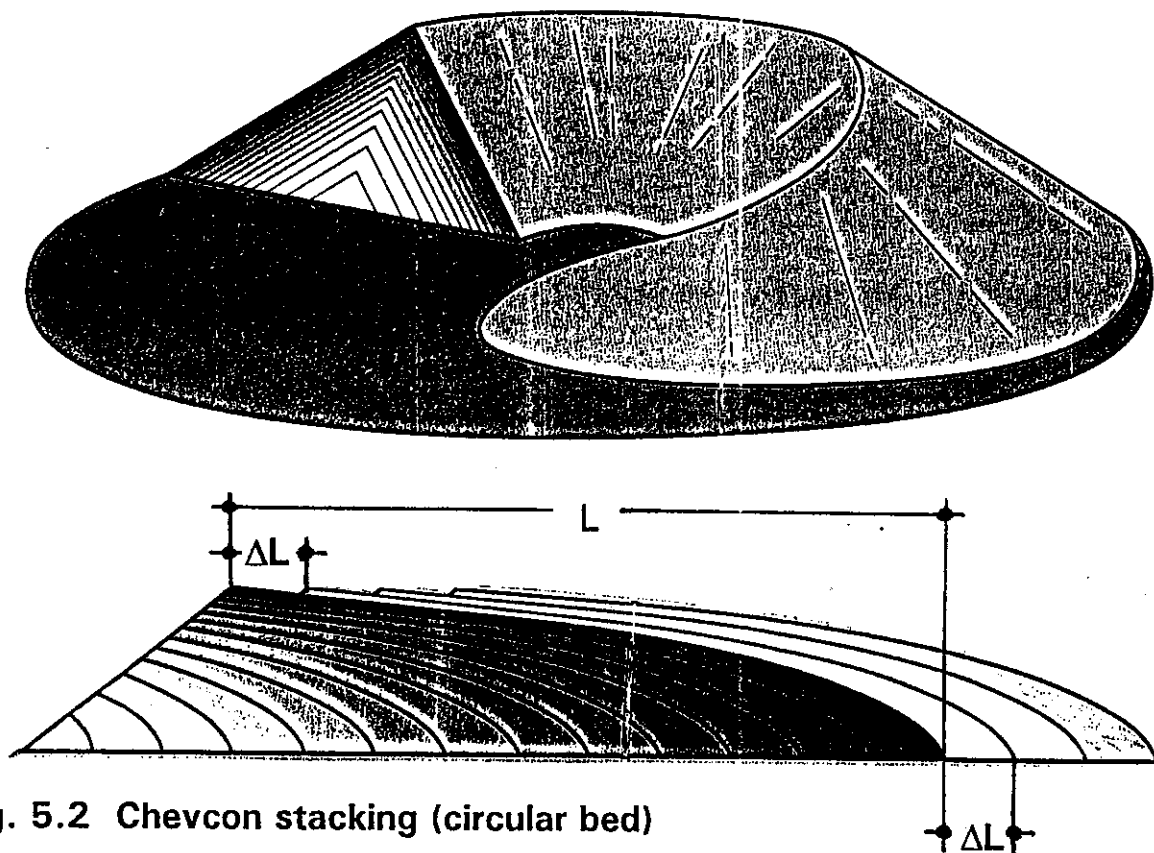


Fig. 5.2 Chevron stacking (circular bed)



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Stacking Methods
Developed for Bridge Reclaimer

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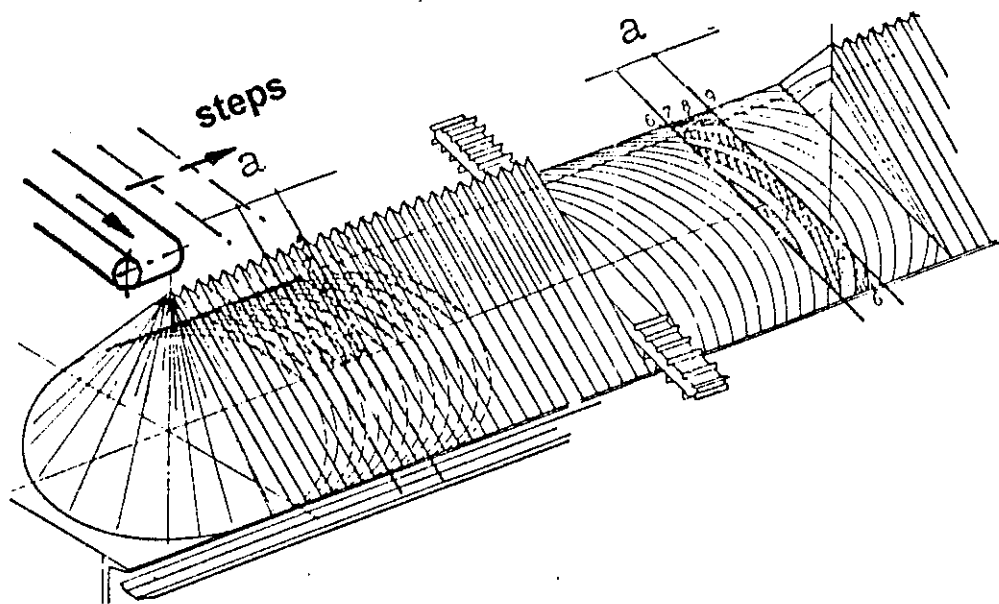


Fig. 6.1 Coneshell stacking

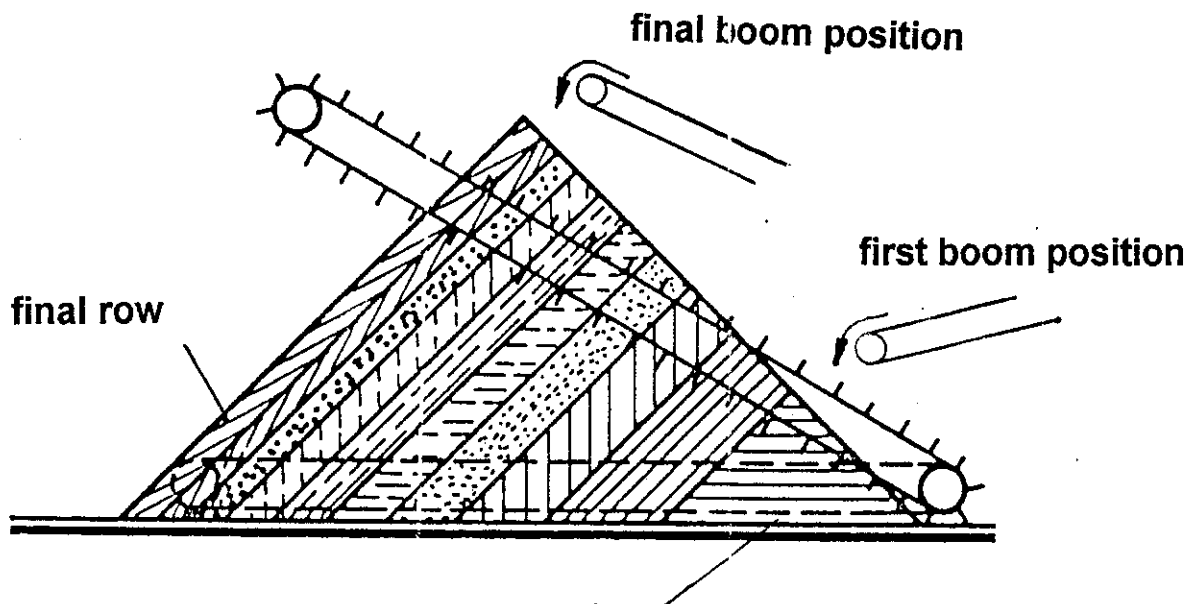


Fig. 6.2 Strata stacking

1. row

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**Stacking Methods
Developed for Portal Reclaimer**

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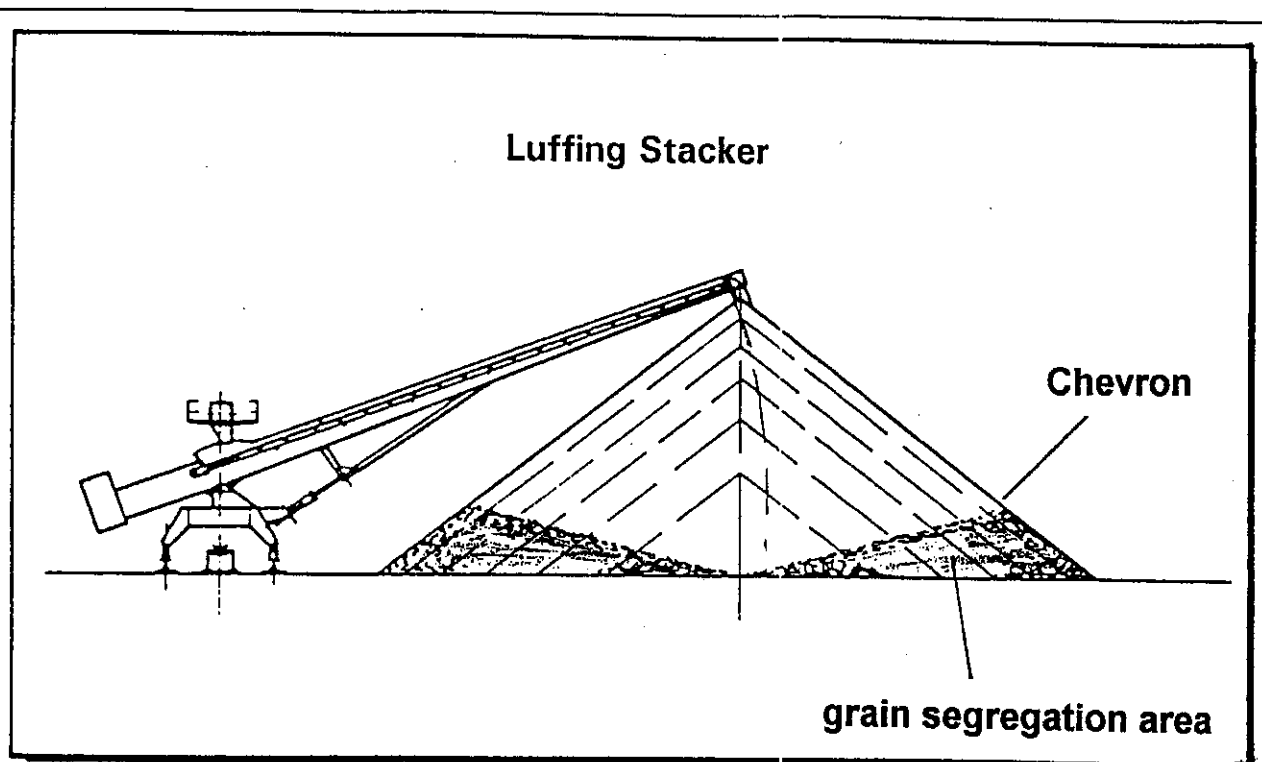


Fig. 7.1 Chevron stacking

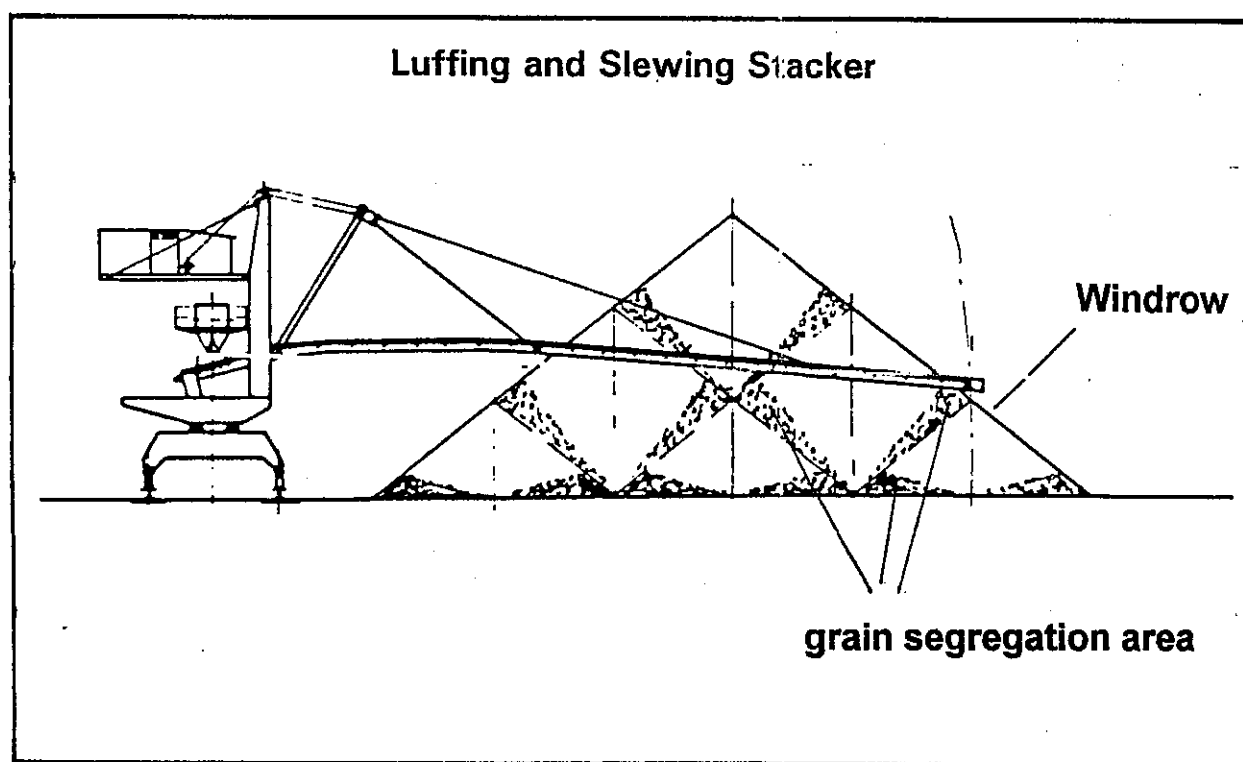


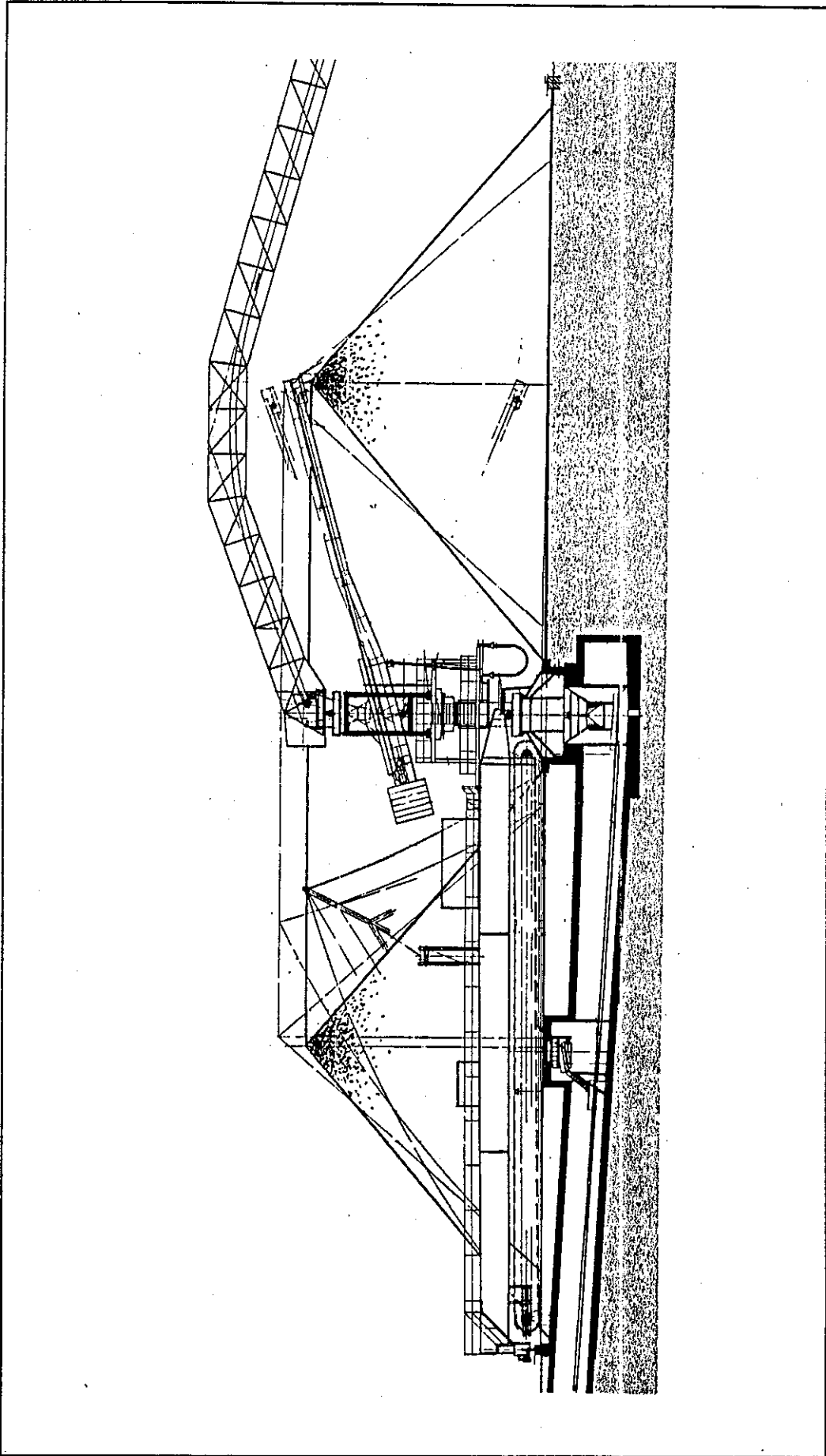
Fig. 7.2 Windrow stacking

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Stacking Methods Chevron and Windrow



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Circular Homogenization System

1. Lower investment costs for equal "live storage volume". (20 - 30 %)
2. High "live storage volume" of approx. 75 % compared to 50 % of a two pile longitudinal system.
3. Compact circular design with shorter belt lines.
4. Flexibility in layout design (direction of inflow and outflow conveyors).
5. Continuous "first in / first out" stacking and reclaiming.
6. No repositioning of the reclaimer.
7. Reclaiming always from a full cross section (constant material stream).
8. Fully automatised.
9. Equal layer thickness.
10. The number of layers cut is higher for the same bed cross-section, stacker slewing speed and stacking rate.
11. The power consumption of a circular system will be lower than for a longitudinal system :
 - shorter conveyor length
 - no cable reel motors
 - no travel drives for the stacker
12. Disadvantage of a circular system :
Future extension of the stockpile is not possible !



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**Advantages/criteria of a
circular stockpile system**

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