ADDING VALUE TO STEEL MAKING PROCESSES AND ENVIRONMENTAL PROTECTION BY OPTIMIZATION OF THE MATERIAL HANDLING SYSTEMS

BY

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SYNOPSIS:

Considering worldwide overcapacities in steel production and increasing necessity to improve working and living conditions have led to a major focus in cost optimization and environmental protection in the steel making industry. Looking at the influence of material handling systems operating costs can be significantly reduced by lower maintenance cost and minimized energy losses. The demand on the environmental conditions can be managed and reduced by the suppression of dust development in closed systems at material transfer points and dust control. AUMUND material handling technology provides state-of-the-art solutions in various applications of the iron and steel making processes.

Different examples are being presented: Maintenance requirements and therefore operational costs are substantially decreased by using Hot Sinter Conveyors to transfer sinter into modern heat-recovery sinter coolers or replacing maintenance intensive existing conveying systems.

Open raw material yards require wide space and dust control management. Due to this reason closed storage buildings or silos have come more into focus within ASEAN Steel Industry. Rotary Discharge Machines allow for cost efficient material extraction from underneath open or closed stockpiles or low footprint silo batteries. Considering different storage areas or single silos an individual blending or mixing of various raw materials can be achieved.

Keywords: Environmental Management, Cost and Energy Savings, Material Handling Systems, Hot Sinter Conveyors, Enclosed Storage, First-in First-out

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Introduction:

Material handling systems are often only seen as the necessary transport equipment from one place to another. But these systems can help improving the overall steelmaking process as well in cost efficiency as in the environmental influences.

Already several countries in Asia such as Japan, South Korea, China or Taiwan have started to look into their possibilities to improve environmental conditions by reducing the dust load on the atmosphere resulting from open raw material storages. Besides limiting dust release by an appropriate water spray management the solution to avoid the release of dust from stockpiles is to build enclosures around the raw material storage. This can be achieved either by building sheds around surface stockpiles or by using silos.

Cost efficiency in material handling can be influenced especially when there is a high demand on the respective equipment which can lead to wear and resulting maintenance and repair costs. A typical area of such demand is conveying of sinter, especially in hot condition. Sinter material is known to be very abrasive which results in enhanced wear of the equipment being in contact with it. A way to minimize such wear is to avoid relative movement and velocity between sinter and the equipment in contact.

Enhancement of environmental protection by material handling solutions:

In order to minimize the costs for buildings as stockpile enclosures the requirement for the open space around the stockpiles needs to be minimized. This can be achieved e.g. by the application of a Discharge Tripper Car for piling in an Longitudinal Storage and Portal or Semi-Portal Scraper Reclaimers of which AUMUND Group of companies, with the SCHADE subsidiary, supplied the world’s biggest machine to South Korea. Whereas for Semi-Portal Reclaimers capacities of more than 3,000 t/h are available, reclaim rates for up to 6,000 t/h are possible with Portal Reclaimers.

Fig.1: Arrangement of Baosteel closed material storage (Source: Baosteel / MCCI)
Fig. 1 shows an example of the new stockyard in China which is currently being under commissioning. It shows a combination of large storage sheds using Semi-Portal Reclaimers for iron ore storage and a series of silos. As the space availability was limited in comparison to the expected storage capacity the coal storage is now realized by means of multiple large size silos. Extraction from the circular silos is now carried out by AUMUND Rotary Discharge Machines (BEW) as described in the following.

Generally, reducing the necessary footprint for the raw material storage the use of circular storage or silos comes into focus. Whereas circular storage can already reduce the footprint to less than 50 %, the use of silos can achieve several times more storage volume on the same footprint. The best and most cost efficient solution to extract the raw material from such silos, especially when composed of a larger number of silos is the use of rotary discharge machines.

Such Rotary Discharge Machines are utilized for the continuous material discharge from slot bunkers underneath piles or a series of silos. The discharge or paddle wheel conveys the material from the bunker table of a concrete bunker onto a belt conveyor arranged underneath. The drives for the discharge wheel and the travelling gear are separately arranged.

The Rotary Discharge Machines have four travelling wheels being provided underneath with a guiding system. It can be travelling along the bunker track by means of rails arranged on the belt conveyor frame.

Fig. 2: Silo arrangement using rows of AUMUND Rotary Discharge Machines.
Fig. 3: Silo arrangement including hopper design

All mechanical parts are mounted on the chassis designed as a welded metal structure and structural steelwork. The discharge capacity can be varied by means of a frequency converter for the drive of the discharge wheel. Discharging capacities of up to 6,000 m$^3$/h per each machine with diameters of the discharge arms up to 5 m are possible (please refer to technical data in Table 1).

<table>
<thead>
<tr>
<th>Rotary Discharge Machine type BEW-BL</th>
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<tbody>
<tr>
<td>discharge wheel diameter (mm)</td>
<td>discharge opening height (mm)</td>
<td>penetration depth (mm)</td>
<td>cone-shaped tunnel width (mm)</td>
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<tr>
<td>2,000</td>
<td>200</td>
<td>350</td>
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</tr>
<tr>
<td>5,000</td>
<td>500</td>
<td>1,150</td>
<td>2,700</td>
</tr>
</tbody>
</table>

Table 1: Technical data for AUMUND BEW Block Model
(depending on raw material type, table AUMUND)
Travelling length, depending on stockpile length or number and size of silos can be provided up to 400 m and is defined by the type of the power supply system such as power chain, cable reel or festoon system. Depending on the type of raw material to be conveyed also a water spray system supported by respective water hose can be combined with the power supply in order to further reduce possible dust development at the machine itself.

The travelling speed of the discharge wheel is typically constant. A steel chute or material guide which terminates approximately 20 mm above the belt conveyor running below the rotary discharge machine delivers and guides the material scraped from the bunker table by means of the discharge wheel and also serves as dust cover. The distance between the chute and the belt conveyor is provided with rubber strips which can be adjusted in case of wear to avoid material spillage.

The use of multiple silos with rotary discharge machines leads to more options for blending the different material qualities from different silos. Potential problems with solidification of stored raw material or bridging are avoided due to the first in – first out principle being applied. The rotary discharge system further allows extracting raw material also in a stationary position. By this way, mixtures of different raw materials, types of coal respectively can blended as per individual requirement which could not be achieved by a longitudinal storage only.

Generally there are different types of rotary discharge machines available depending on individual boundary conditions such as type of hopper / bunker / silo, space availability, required capacity, type of raw material etc.:

- **AUMUND Block Model type BEW-BL** – high extraction capacity and low width dimension, designed for double side discharge with all drive components located in a solid casing (Fig. 5), available with explosion protection ATEX 21/22 also

- **AUMUND Block Model frame type** – cost optimized solution with 6 or 2 (allowing travelling to defined areas along bunker in high speed travel mode without discharging but with lower and pulsing material discharge) discharge arms (Fig. 6)
Fig. 6: AUMUND BEW Block Model frame with 2 discharge arms

- AUMUND Low Profile / Flat Model type BEW-FL – installed on the belt conveyor supporting structure, easy access
  with single side discharge – with or without swivel drive for one or both sides of a respective bunker design, with the discharge wheel swiveling between the shelves to allow a high speed mode in the travel drive to reach these areas quickly without material extraction (Fig. 7)

Dust development within the covered system can be further reduced by water spray as explained above or alternatively by using compact filter units on the machine or as separate satellite system travelling with the rotary discharge machine.
Adapted and optimized sinter conveying solution:

Bulk material handling can mean substantial mechanical demand on the respective equipment which consequently might lead to considerable wear and resulting maintenance costs. Such costs can be reduced by adapting the most suitable material handling solutions which can easily result in a very short return on investment. Such solution is shown with the example of the application of AUMUND Hot Sinter Conveyors for replacement of maintenance intensive vibrating feeders.

After the sinter machine the hot sinter is being crushed in the subsequent sinter crusher followed by a sinter cooler. The cooler can be directly installed underneath the crusher but quite often a hot screen and / or vibrating feeders are being used to screen and convey the sinter at temperatures between 900 and 1,000 °C to the following process step (Fig. 8).
With increasing sinter capacities also the demand on the related equipment gets higher resulting in increased wear and maintenance requirements and reduced lifetime of the vibrating conveyors. Not only the high temperatures but also the very abrasive behavior of the sinter material is the reason for such wear on moving parts. Furthermore vibration supports a disintegration of the sinter material which enhances the requirement of material recirculation, reduces the capacity respectively.

Such material wear and disintegration can be significantly reduced by reducing the relative movement between the sinter material and the conveyor. For this purpose the AUMUND Hot Sinter Conveyor featuring a metallic pan conveyor with special wear protection caps in the areas of highest demand has already proven long lifetimes of more than 10 years in various applications (Fig. 9).

In order to customize to the existing situations of each individual installation situation the supporting structure is adapted and the feeding and unloading of the conveyor is modified as per requirement.

The comparison of the installation with vibrating feeders before and the AUMUND Hot Sinter Conveyor after is shown in Fig. 10 as a typical example. The return of sinter fines can be eliminated as the sinter disintegration resulting from the vibrating effect is avoided.
Fig. 9: AUMUND Hot Sinter Conveyor fully assembled in workshop

Fig. 10: Sinter discharge area with vibrating feeders (left) – AUMUND conveyor (right)

The improvement in this material handling situation can significantly reduce maintenance requirement and cost as well as increase the capacity of the sinter making process. The return on investment depends e.g. on the individual maintenance and repair requirements, the re-usability of existing structures, the space requirements and the sinter production requirements.

Another major advantage of using such hot sinter conveyor is in case of a replacement of an existing sinter cooler due to inefficient operation of existing equipment, e.g. due to increased sinter cooling capacity or to install latest state-of-the-art sinter coolers with optimized heat recovery. Those heat recovery sinter coolers normally have to be
installed at a different location than existing installations and can have an increased height requiring lifting the hot sinter material to a charging point on a higher level (example installation Fig. 11). Besides the aspect of energy recovery from the hot sinter material such closed systems further improve the environmental situation of the sinter plant by reducing dust emissions.

Different types of metallic pan conveyors can be used for such purpose, enabling inclinations of up to 60° using the Bucket Apron Conveyor type which has been applied for high temperature conveying of hot Direct Reduced Iron (DRI) under inert atmosphere in numerous applications already for charging directly from the Direct Reduction shaft furnace into the Electric Arc Furnace. This wide experience can be well used to avoid heat losses also in sinter transport to optimize the heat recovery in a subsequent heat recovery cooler.

Lately, a 3,000 mm wide conveyor with a capacity of around 1,500 tons of sinter per hour has been developed by AUMUND especially for applications in the international steel industry. The individual components of the machine, which have proven their reliability for decades in other branches of industry, have been adapted for this particular use (Fig. 12).

The latest design of hot sinter conveyors is now using new permanently lubricated rollers after having tested them successfully in actual working conditions in other sinter
plants. This further increases the efficiency and reliability of the machine. Before the machines are put into operation, long trial sequences are implemented, at first tentatively and then building up to test the machines in fully operating situations.

Fig. 12: Sinter conveyor with 3,000 mm width for around 1,500 t/h

As the replacement of a sinter cooler always means a major investment, such modification is sometimes not the applicable solution especially considering the current difficult market conditions. In such cases the sinter after the cooler is often found to still be partially red hot and consequently leading to destruction of subsequent belt conveyors. A frequent requirement of replacing such belts leads to high operating costs as well as additional downtimes of the sinter plant. In those situations the replacement of the first belt conveyor by a hot sinter conveyor can eliminate this problem and can be enhanced by an additional / secondary cooling step.
Conclusion:

Even in times of difficult market situations environmental protection remains a major part of concern for the steel making industry. Material handling systems need to be taken into consideration for potential improvements as dust generation and development is an integral part of such processes and can be minimized by using the best applicable systems as described in this paper.

But not only environmental aspects are influenced by material handling systems but also energy recovery and steelmaking costs. Minimization of wear and tear on the one side and reduced heat losses on the other side are the ways to optimize the material handling in different applications.

The described examples show AUMUND material handling solutions which will be customized for each individual situation and therefore adding value to the steelmaking process although typically being an area with little focus on as such systems only support the main process lines.