Conveying systems for hot material transport

The growth of direct reduction processes poses new challenges for hot material transport between DR plant and melting unit. Aumund, which has a proven track record of reliable equipment for conveying hot materials, is able to design and install complex conveyor systems for these new processes.

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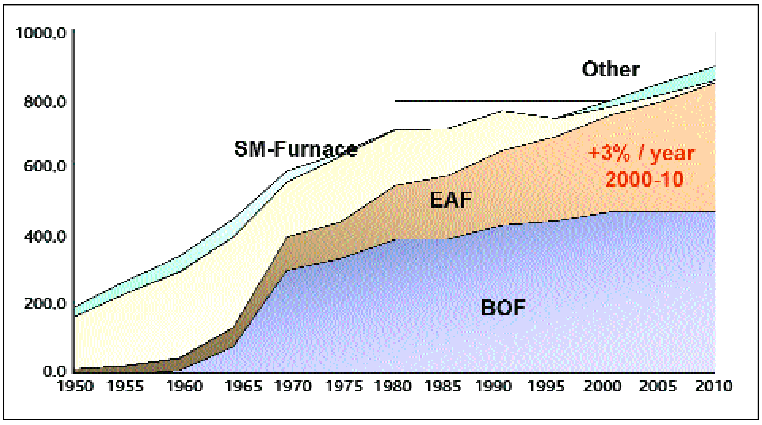
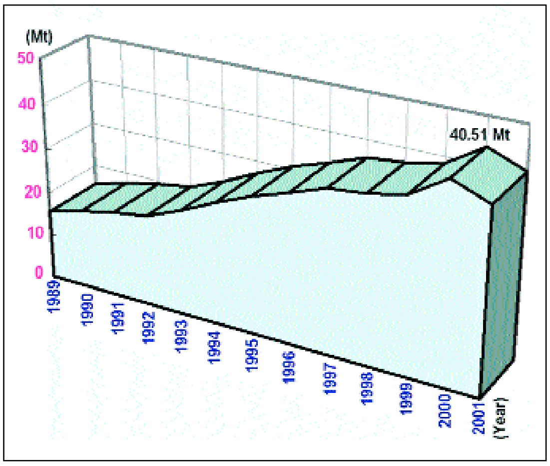


● **Figure 1** ***Development of world steel production up to 2010 (Source MIDREX)***



● **Figure 2** ***Worldwide DRI production (Source MIDREX)***

In recent years, the development of direct reduction technologies has attracted much attention. New processes have been developed which are differentiated by the raw materials and reactors used. Each of these processes leads to direct reduced iron (DRI), although this product comes in different physical states. The iron-based product form varies from a fine to a coarse grained bulk material, which is either pelletised, hot compacted or briquetted (HBI). This not only upgrades the product value, but also ensures the more efficient use of valuable resources.

Steel production is expected to rise by approximately 3% per year to 900Mt/yr by 2010 (see *Figure 1*). DRI production is also expected to increase (see *Figure 2*). In view of the growing importance of direct reduction as a substitute for the conventional blast furnace route, the focus of interest has shifted onto practical issues related to the application of these technologies in the production process. In addition to the development of this technology and its introduction in the market, the method of interconnecting the individual process stages has become an important issue. A truly demanding challenge is the material transfer of the DRI into the process within the steel works.

The percentage of hot charged DRI/HBI in the steelmaking plant is growing. Compared with cold charging, hot charging enables considerable energy savings to be made during the melting stage in an EAF or other melting facilities. This is of vital importance as energy is a major cost factor in steelmaking. Consequently, hot charging operations are becoming more and more attractive for steelmakers.

Pan conveyors for hot materials

The first pan conveyors for hot material transport were installed by AUMUND Foerdertechnik in the August Thyssen steel works in Duisburg during the

1960s (see *Figure 3*). Since then experience in this field of application has been widely extended and, based on further developments, it was possible to design a product that fully complies with today's requirements. The importance of material transport in a steel works is often only realised in the planning stage, however, in recent years, the issue of its practical implementation has gained in importance when it became apparent with the first installations, that a direct link to EAFs was required. Placing more emphasis on the issue of conveying of hot material right from the start of the planning and development stage of metallurgical plants turns it into a requirement of increasing priority.

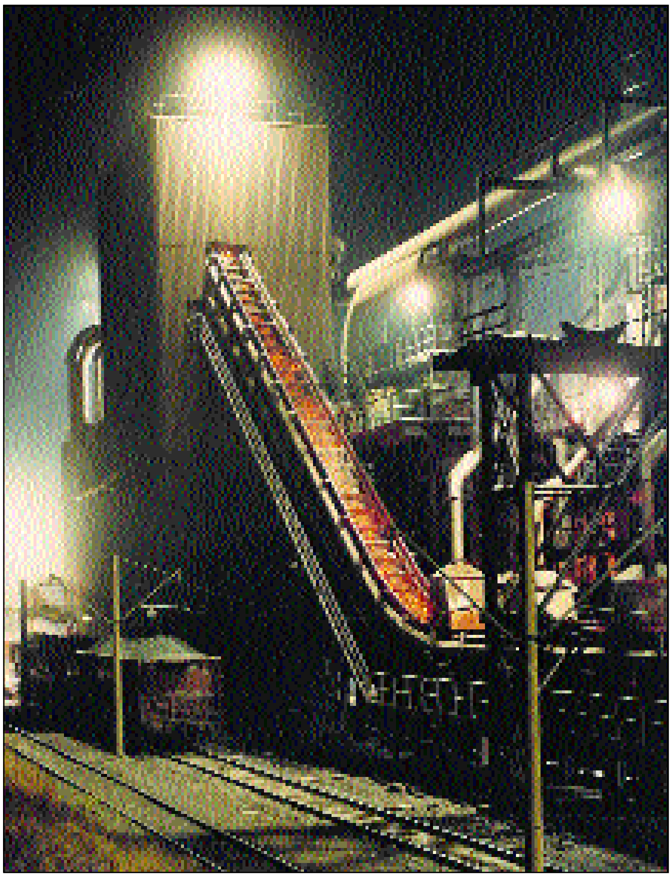
Steel plate conveyors can be classified into pan conveyors mainly dedicated to horizontal conveying, and those featuring buckets which are ideally suited to conveying materials up a steep slope. A wide range of pans and buckets are available for each application. Even ancillary facilities such as heat insulation and inertisation no longer pose a problem. *Figure 4* illustrates a charging point for hot material with heat insulated hood and inert gas purging.

Steel companies place different emphasis on the level of technology, cost efficiency, reliable order processing and safe functioning. By providing custom-designed solutions in the field of material handling and equipment development to suit the specific demands of state-of-the-art process technologies Aumund supplies the steelmaking industry as a know-how partner. As a result of in-house R&D, collaboration with well-known partners such as the Ruhr-University of Bochum, Germany and other specialists, it was possible to develop a conveying system for the metallurgical industry which meets the high technical requirements, while also representing a compact solution for individual needs.

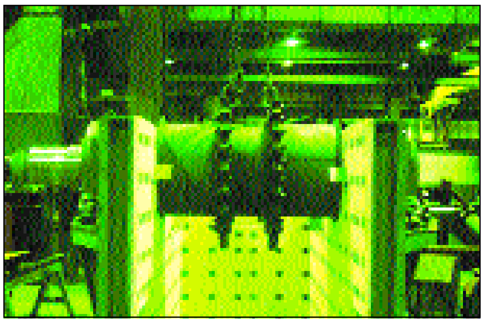
Material handling today is a highly functional, state-of-the-art, technology. It is reliable, totally replaceable, and comes at low cost. As the benchmarking of different options often only focuses on cost, it frequently is shown during commissioning that the alleged 'bargain' is blocking the entire material flow within the overall system. Today, material handling technology in this field of application stands for more than just a mass product purchased by weight or centre distance.

The challenge of the direct reduction process

Initially the task was 'merely' to convey hot material between two points. Since then, requirements have been raised constantly so that today the specifications are characterised by high conveying capacities (up to 400t/h), long centre distances (more than 150m) and, occasionally, considerable lifting heights (up to100m; see *Figure 5*). In addition, the



● Figure 3 ***Example of hot material transport system in the 1960s***



● Figure 4 ***Drive wheel and heat insulated drive station***

conveyor system is expected to fit smoothly into the overall concept and the material conveyed should not be damaged, cool down nor re-oxidise. For instance, hot DRI is protected by inert nitrogen gas, however, this represents a specific challenge. On the one hand, it is needed as an inert gas to protect against re-oxidation, but it is also a coolant which counteracts the effect of heat insulation. Also, for economic reasons, nitrogen losses must be kept to a minimum. As there was no prior practical experience

● Figure 5 ***Charging point for hot material with heat insulated hood and Inertisation***

● Figure 6 ***Largest inclined bucket conveyor for hot material with inertisation***

with the injection of nitrogen into moving enclosures, this issue had to be thoroughly investigated until a functioning system was available.

Thus, as well as design and mechanical properties, consideration has also to be given to thermodynamic processes and requirements for practical operation. Another aspect is dust, possibly generated during charging, which had to be kept within the system. Thus, there is a multitude of factors that have an impact on the design of the conveying system as a whole.

The specifications calling for increasing conveying capacities represent another challenge, as the combination of growing conveying volumes coupled with increasing lifting heights are approaching a physical limit. On reaching a certain lift, the ratio of deadweight to strength of the traction elements (chain) approaches a critical value. Based on many years of experience a chain safety factor of better than 5 is required, however larger traction elements are no solution as the increasing size also means an increased deadweight, so that the benefits cancel out.

Thus, in the future there will be improved coordination to take into account given the constraints during the planning stage. Current projects have shown that it is perfectly possible to find interesting and economically viable solutions, if the material handling requirements are taken into account at an early stage.

The largest inclined bucket conveyor worldwide has recently been commissioned at Posco's Pohang works in South Korea (see *Figure 6*). This AUMUND conveyor, type BZB 800/350, with a total length of 151m and a lifting height of approximately 100m, conveys hot DRI with a temperature of 850°C. Other systems supplied include CAL in Trinidad and Kwinana in Australia.

Concluding remarks

Design studies are currently underway for systems with even tougher specifications for material handling technology that will meet new challenges as further development of direct reduction technology is made. By integrating proven components and practical experience into a custom-designed overall concept, a conveyor system is now available which complies fully with the specific requirements.

AUMUND has a proven track record of providing reliable equipment for conveying of hot material and has gained additional know-how with the design and installation of complex conveyor systems for the new direct reduction processes.

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