AUMUND conveying technology for green steel

AUMUND Fördertechnik is supplying two bucket apron conveyors for transporting hot direct reduced iron (DRI) to the thyssenkrupp Steel Europe direct reduction plant at Duisburg in Germany. For this hydrogen-based green steel production process, the two hot material conveyors are the direct connection between the direct reduction plant and the smelting furnace. Delivery of the conveying equipment to the steelworks is planned for the end of 2024. This paper outlines some of the key design considerations when selecting conveying technology for DRI plants, and the importance of selecting reliable technology.

Author: Frank Reddermann, *AUMUND Group*

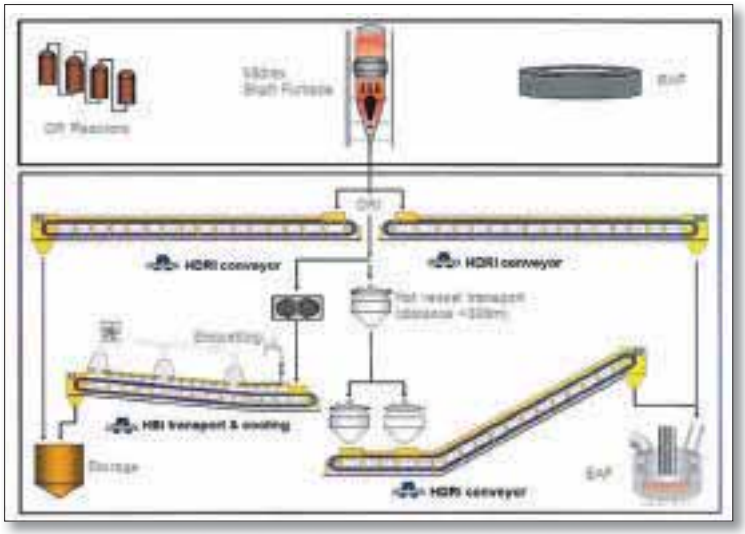

Fig 1 **AUMUND applications for hot DRI transport, cooling and charging**

CRITICAL SUCCESS FACTORS

The AUMUND Group is a longstanding supplier of technology in the field of bulk materials handling. AUMUND specialises in equipment for the safe transportation of hot, abrasive materials, and for the optimised cooling of the conveyed material, alongside storage and blending bed technology, and mobile loading and unloading systems. For demanding industrial environments, such as in the steel industry, it is important to be able to combine solutions that are at the same time innovative and technologically mature enough to be reliable. Recognising that almost all steel sites are in some way unique, the technology also must be adaptable enough to be integrated into existing customer locations and infrastructures. This is where a knowledge of the key design parameters, and how to deploy them successfully, is vital.

Another important factor in the successful delivery of a materials handling project is the trust-based partnership between plant manufacturers and plant operators, whether in the construction of new plants, or the conversion of existing plants. This partnership approach is particularly vital when considering the productivity and throughput implications of a conveying system on the overall plant installation, both in terms of design and reliability. AUMUND applications for hot DRI transport cooling and charging are shown in *Figure 1*.

For the thyssenkrupp plant both conveyors are to be installed beneath the shaft furnace of the direct reduction unit, and their function is to feed the smelting furnace directly with hot DRI. The direct reduction shaft furnace has been designed by Midrex Technologies and is the core element in the process. The thyssenkrupp Steel installation is a significant project in the transition to green steel in Germany and the conveying system is a key enabler in ensuring the success of the green transformation. The AUMUND technology has already been proven for use in direct reduction plants. To be successful, this installation relies upon a close working relationship between the equipment supplier, Midrex, the steel plant operator, thyssenkrupp, and AUMUND

Fig 2 **Schematic of the proposed DRI plant in Duisburg with the conveyors shown in red (©thyssenkrupp Steel Europe AG)**

as the supplier of the conveying technology.

Figure 2 shows a schematic of the planned conveyor installation at the thyssenkrupp Steel plant in Duisburg, with the conveyors indicated in red. The conveyors are a key arterial route, connecting the direct reduction furnace and the steel plant.

FUNCTIONALITY OF THE CONVEYORS

The design of the AUMUND hot material conveyors is a patented technology, with a closed system for continuous material feed. A particular issue in the transportation of DRI, as compared with conventional raw materials, is the challenge of reoxidation. This is a serious issue, as reoxidation can lead to critical safety incidents caused by ignition. To prevent this, the conveyors transporting the DRI do so within an inert atmosphere, which prevents the material from coming into contact with air, so that the →

Fig 3 **AUMUND conveyor system for DRI in the Middle East, in continuous operation for over 15 years**

Fig 4 **AUMUND cooling conveyor**

re-oxidation process does not occur.

An alternative approach to transporting the material could have been to select a pneumatic conveying system. However, the mechanically enclosed conveyor system which is being installed offers a significant advantage over pneumatic conveyors, in that the energy consumption is significantly lower. Unlike with pneumatic conveying, on a mechanical conveyor there is no relative movement between the equipment and the transported material on the conveying route. This gives a relative reduction in the mechanical degradation of the material being conveyed, reducing yield loss and preventing any additional fines being generated during transportation. Fines are a potential source of problems with dust generation, leading to environmental concerns. The overall design concept of the conveying system is to have an inert gas protecting the conveyed material from contact with outside air, such that the dust remains inside the system. The conveying system as supplied is fully automated. Sensors monitor the temperature and the condition of the material on the conveyor.

KEY DESIGN PARAMETERS

The DRI conveying system relies on technologies which have been proven in industrial environments for a period exceeding 20 years, adapted to the required capacities and installation conditions at the particular site. *Figure 3* shows a conveyor system that is currently in operation at a DRI plant in the Middle East and which has been in continuous operation for more than 15 years.

Design considerations must include the physical restraints of location, which to some extent dictate the angle of inclination of the conveyor and processing throughput requirements, which in turn help to define operating temperatures. Temperatures of up to 1,000°C and an angle of inclination of up to 60° are among these design features. The largest lifting height so far achieved with a bucket apron conveyor for hot direct reduced iron is 110m, and the maximum conveying capacity is 480tph.

These aspects of lifting height and conveying capacity are not only crucial determinants of the ongoing productivity of the plant when in operation, but they also relate to the capital cost of the final installation. Finding the optimal design within the constraints of what is

technically achievable is where the expertise of a company such as AUMUND can be deployed. For instance the lifting height and conveying capacity of the conveyor are both characteristics which are mutually dependent on one another, and they in turn are limited by the strength of the conveyor chains. The structural integrity of the chains and their fundamental design is critical to the design of the overall system, and at AUMUND the development of the chains for the conveying system has been done in house. The tensile strength is up to 3,000 kN per chain.

CONTRIBUTING TO ACHIEVING GREEN STEEL GLOBALLY

Whilst a strong focus on design and protection through patenting is important, the real proof of new technology is in its application. To date the AUMUND conveying technology has been proven in installation and operation at more than 700 plants in the iron and steel industry internationally. As an example, the first hydrogen-based plant of the Swedish company H2 Green Steel will be equipped with AUMUND technology, and is set to produce green steel from 2025. In addition to the hot material conveyor, two cooling conveyors, as shown in *Figure 4*, will also be installed and become operational at this same plant.

The conveyors are critical to the success of new green steel plants and conversions of existing steel plants, but environmental considerations have also been paramount in the design of the conveyors themselves. The principles behind the development of all equipment at AUMUND are consistent with the overall aims of green steel, putting the environment first, producing less waste, conserving resources and supporting re-use. The amount of water which the conveyors consume is quite low and even that can be recycled and reintroduced back into the water system. The waste heat which is generated can also be recovered and reused, reducing the overall energy demand in running the material handling system. AUMUND equipment operates according to the ideas behind producing green steel: less toxic waste, conservation of resources and re-use. MS

Frank Reddemann is Senior Sales Manager in the Metallurgy Division for AUMUND

CONTACT: metallurgy@aumund.de