Hot solutions for the iron and steel industry

With the ever increasing costs of raw materials and energy, finding the right equipment to optimise output, quality and costs has never been more important. Aumund provides a variety of conveyor-based DRI and HBI transport solutions to help customers achieve these aims.

Author: Frank Reddemann
Aumund

In 2010 worldwide steel production reached 1.4Bt, the highest level yet, with nearly two-thirds produced in Asia. Regions like the Middle East and North Africa (MENA) or the BRIC (Brazil, Russia, India, China) countries, are becoming more important as technology leaders. The new DRI technologies produced 56.5Mt in 2010 compared to 1.031Bt for the conventional BF. Although this is only 5.5% of the total iron produced, it is rising and greater than, for instance, crude steel production in Germany (43.8Mt, Source: World Steel Association). Direct reduction is no longer merely an exotic or secondary phenomenon. Indeed, the more plants worldwide there are, the more persuasively the advantages will be illustrated.

As the cost of raw materials, energy and environmental control for ironmaking and steelmaking continue to rise, so the choice of appropriate technology is determined, primarily, by cost. First, it is the availability and cost of materials (iron ore, sinter, pellets, briquettes, additives, fluxes, coal, coke etc), second, it is energy (electricity, oxygen, gas, coking coal etc.) and third, it is equipment.

Another determining factor is “Which product, in which amount, and quality, should be produced?” Depending on the technology, equipment and procedure, there are major differences in process capability and equipment cost. It achieves nothing if the new arrangement is cheap yet cannot produce the desired product reliably and in the desired quality.

The internal material flow is also of increasing importance. As we have learned from completed installations, material handling can play an important role in improving operating performance. The whole process can be tailored more flexibly and economically through correctly choosing the optimum transport system. With modern continuous conveyor systems, the tap-to-tap time on an EAF can be significantly reduced and, today, these conveyor systems work successfully and reliably. Figure 1 illustrates the range of Aumund options available.

CONVEYING OF HOT MATERIALS
Thermally insulated transport, eg, from hot direct reduced iron DRI (HDRI) or hot briquetted iron (HBI) in a non-oxidising atmosphere saves a great deal of energy. Today hot charging is expected by customers, and practically all new plants are equipped with this feature, while older configurations are being examined for hot charging upgrades. Batch charging of HDRI to the EAF involves opening the roof and dumping the material into the furnace in batches as an addition to scrap or cold DRI. However, employment of continuous feeding systems like the Aumund bucket conveyor type BZB-H-I does not require opening of the roof so the tap-to-tap time can be shortened. Also, temperature losses during transport in a thermally insulated and sealed environment can be decreased considerably.

The benefits of hot DRI charging using the Aumund conveyor system as compared with pneumatic systems and batch transfer trucks are:

- Availability and reliability, easy handling (no material fluidisation/slowdown required)
- Quick return of investment
- Minimum loss of HDRI temperature, minimum re-oxidation and carbon losses
Less degradation and fines generation
Significantly lower capital and operating costs (vs pneumatic systems)
Significantly lower energy consumption (vs pneumatic systems)

Two pan conveyor options are available depending on the distance between DRI and EAF plants. These are illustrated in Figure 2 (close proximity) and Figure 3 for distances above 200m.

Hot DRI is usually transported either pneumatically or mechanically, however, very few pneumatic systems have been installed. Whereas their big advantage is the flexibility of angles and length of pipes, start and stop procedures are quite complicated, speed is fixed and energy consumption is higher. Maximum conveying temperatures are typically 700°C and maximum capacity is 50t/h.

On the other hand, the mechanical system provides easier and faster material handling with only a simple start/stop button at the drive. Also energy consumption is lower and the whole system has high availability and efficiency. Conveyor capacity depends on geometry - the longer the lift, the smaller is its capacity. With limited space the conveyor is usually designed as steep as possible, but steep slopes have an impact on the ratio of dead to live load so capacity drops proportionately. For instance, in horizontal sections 1,200t/h can be achieved quite easily. Currently, inclined systems run with an inclination of 55-60°, and conveying capacities of 210 t/h with an elevation of nearly 100m and 400t/h up to 80m have already been realised. The design always targets a high filling degree of the conveyor buckets to optimise the ratio of volume to surface. Conveying temperatures are high at up to 1,100°C.

Chain strength is the limiting factor of lifting capacity. Aumund can provide chains that offer strength (specific breaking strength of each single chain) of 3,000kN minimum – the strongest in the world. However, there is a point where you cannot increase strength because the dead weight also rises. Simply adding more chains to the system would not work either, for the same reason.

A very important feature is the air-sealed transport provided by the enclosure with integrated inert gas system so that the dust is contained inside and oxygen kept out. Other basic benefits are: no spillage is generated underneath; sensors monitor the operation; no special tools, special equipment or specialised staff are required.

The option in Figure 3 is suitable especially if the direct reduction facility is not directly beside the EAF or for modernisation of existing melt shops with complex material transport routes. This system is suitable not only for a shaft furnace (eg, Midrex) but also for a rotary hearth furnace (eg, ITmk3 by Kobe Steel) or other direct
reduction technologies (eg, fluidised bed) and can charge the material to EAF, melter gasifiers or other furnaces. Horizontal and inclined systems have recently already been successfully commissioned.

COOLING OF MATERIALS

Another approach to optimise the performance of DRI plants is the enhancement of product quality. Many plants are equipped with briquetting facilities to produce HBI for use internally or for sale. Especially if the HBI is for sale, good quality and shape are required to maximise revenue.

With the patented HBI soft cooling conveyor the final briquettes are in good shape. This is guaranteed by the special soft cooling system (mist cooling). Figure 4 shows a layout schematic and Figure 5 a plant installation. Such installations are in operation and providing good results.

Fig 4 Schematic view of pan conveyor for HBI soft cooling

The key features and benefits are:
- Mist cooling with minimum water
- No sludge
- Totally automated operation
- Proven equipment with high quality standards
- Improved product quality through soft cooling
- No cracks, less fines, no reoxidation
- Significant improvement of HBI quality

RESULTS AND CASE STUDIES

Two case studies illustrate some of the benefits obtained using Aumund pan conveyors.

Megasteel, Malaysia *
- Start-up 2008
- Conveyor capacity 400t/h
- 750°C material temperature at the conveyor feeding point
- 600°C requested material design temperature at the furnace feeding point
- 20% productivity increase
- Power saving up to 90kWh/t
- Saving of 5-10$/t of tapping weight

Hadeed, Module E, Saudi Arabia
- Power saving approx. 20kWh per 100°C DRI temperature increase
- 600°C feeding temperature
- 120kWh/t tapping weight (or more)
- Approx. 20% productivity increase by hot charging
- Saving up to 57M$/US/y vs cold charging

* Source: Midrex

Frank Reddemann is Senior Manager Metallurgy at Aumund, Rheinberg, Germany.

CONTACT: metllurgy@aumund.de