Cooling and transport of hot briquetted iron (HBI)

Production of direct reduced iron (DRI) has increased significantly over the past few decades as new and innovative uses of DRI in the form of pellets and HBI in EAF steel production came into being. Unlike hot DRI, HBI is transported cold and the technology of cooling is of great importance for briquette quality and for operational reasons. Aumund Fördertechnik provides such technology.

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The production of DRI in 2010 was a record 70.1Mt. The proportion of this used in steel plants as hot DRI (HDRI) was also a record at 6.47Mt, reflecting its economic benefits through reduced energy consumption. DRI is produced mainly in areas where cheap high quality gas and/or iron ore deposits exist. Around two-thirds of the processes employed are gas-based, the remainder being coal-based and some specialist applications.

The reasons for DRI production vary considerably; for instance, in many Asian countries, especially India and China, use of domestic raw materials is paramount, whereas in the Middle East, low cost energy sources are available in considerable quantity. In Russia and its bordering CIS states, steelworks modernisations are in full swing and DR is strongly supported politically.

Direct reduction has established itself as a modern technology, a major influence being the use of DRI and HBI in the EAF. The EAF has been very successful in mini-mills over past decades and is now widespread. An initial shortcoming of only being able to produce limited steel qualities using cheap, but hard to classify, scrap were overcome by employing DRI and HBI to provide low residual iron units such that the combination of DR and EAF now gives a full range of competitive steel qualities.

Further improvements are expected in the future through plant optimisation and enhanced linkage of the various process stages. One of these is the direct linkage of the DR plant to the EAF through continuous charging with a hot material conveyor, whereby considerable production increases and energy savings can be achieved. This well-established technology will not be focused on here.

However, a further aspect which has arisen is the handling of DRI after briquetting in the form of HBI. HBI is DRI compacted into a brick-shaped mass (briquette) containing typically 90-92% iron. The amount of HBI used in 2010 was 7.21Mt and represents 10.2% of total DRI production.

The rise in HBI production reflects its good shipping, handling and storage properties compared to DRI. For handling in steelworks or for onward transport to storage for HBI sales, a maximum temperature of 100°C is usually necessary, so the hot briquetted product must be cooled.

The transport and cooling of HBI between the iron production unit and steelworks has increasingly been of interest to many producers over the past few years and it was not until practical experience was gained in equipment operation that considerable optimisation potential was determined. Figure 1 illustrates the methods of transporting DRI and its production routes.

Various methods for cooling HBI are currently in use. Quenching with water immediately after briquetting is frequently used, although this method has shown itself to have significant disadvantages. It is reported that the...
water in the dipping baths vapourises too quickly and equipment damage occurs during dry operation. Also, in some versions, excessive thermal expansion takes place at the boundaries of water quench/bath wall/external wall, leading to reduced availability and maintenance. When dipping HBI into the quench bath, an unavoidable steam cloud is created, sometimes with considerable dust content. As a result, special requirements for pipework, de-dusting and water preparation are needed to avoid steam discharge into the environment and to prevent high equipment wear due to high dust content. Also excessively rapid cooling of the briquettes can cause undesirable cracks, even fragmentation, leading to increased fines.

AUMUND has developed and patented a completely new concept over the past few years and which has operated successfully in two installations. This concept permits a slower cooling of the HBI using water vapour instead of liquid water. The HBI is placed on a metal apron conveyor and evenly distributed using special devices (see Figure 2). Using a thermodynamic model, the required volume of vapour can be adjusted to the capacity of the installation and is drastically reduced (by up to 90%) compared to water baths. This is a decisive factor for plants where only limited quantities of water are available. The hot water vapour is sucked away at prescribed points and can be re-used via closed-loop if desired (see Figure 3).

With the water vapour method an inert protective cloud forms around the HBI, which minimises re-oxidation and loss of metallisation. As there is no shock cooling, no steam cloud is produced, and levels of dust and fine particles are low, as measured in the off-gases. Where there are downstream filter and fan installations, wear is reduced because of reduced dust content. The cooling conveyors are fitted with all necessary components for a safe working environment.

When designing new plants or refurbishing existing systems, AUMUND knowhow can make a valuable contribution. The accuracy of the thermodynamic model especially developed for this application has been confirmed in the completed installations. In conjunction with the in-house calculation software the required geometry (length and width) of the cooling conveyor can be ascertained according to given conditions and the end temperature can already be calculated in advance in conjunction with the conveying speed. With the AUMUND system, the HBI at the end of the cooling zone is completely dry and below the necessary 100°C, and can be transported onwards using standard belt conveyors.

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