Raw materials improvement in the steel industry

The World Steel Association has recently completed a major technical study: ‘Raw Materials Improvement in the Steel Industry’. This article gives a summary of the report especially for Millennium Steel.

Author: Henk Reimink

Current and long-term raw materials supply scenarios for the iron and steel industry have a significant impact on raw materials resources, both in the development of new reserves and the level of quality made available. The increasing demand for steel has gradually diminished easy access to new, quality raw materials. Meanwhile, the use of lower grade iron ore in the blast furnace (BF) process requires additional energy and coal, produces more slag and emissions at a proportionately higher rate than with quality materials, and reduces productivity.

The economic situation in iron ore supply has changed the focus for the steel industry. Now, it seeks a wider supply base for raw materials in terms of quality and multiple sources and is turning towards blending, beneficiation and agglomeration processes.

The World Steel Association has recently completed a major technical study: ‘Raw Materials Improvement in the Steel Industry’. The report is currently available to worldsteel members only, but will be available on worldsteel’s website from 1 February 2014. The project on raw materials improvement deals with the issues of using lower grade raw materials that have been improved or upgraded (beneficiated) using existing raw materials handling and iron-making processes (cokemaking and sintering).

The sharing of operating experiences, especially with companies that use lower grade materials in India, China and Russia, as well as those that use traditional sources from Australia and Brazil, has identified a wide operating envelope in the industry. For organisations with their own raw materials resources, this report will assist in outlining sound strategies for raw materials management, appropriate selection of investment in mining and beneficiation equipment, while maintaining ironmaking efficiency. By upgrading existing facilities, installing proven technology and creating appropriate beneficiation and agglomeration techniques for both iron ore and coal, most organisations can unlock quality materials from their supply routes.

Background

With the increasing demand for steel, the need for raw materials rises proportionally. However, there are limited immediate sources of high-quality raw materials, and increased use of these for steelmaking will deplete them over time. This forces the industry to use lower grade raw materials to meet the demand for steel, for instance for the building of infrastructure to improve living standards in developing countries.

Also, the use of lower grade materials affects BF productivity, due to increased processing of non-metallic components that are turned into byproducts (slag). This leads to the need for strategic raw materials management, to use either lower grade materials or employ beneficiation techniques to ensure ironmaking processes remain at their high level of efficiency and create the lowest level of byproducts, energy use or emissions. This is summarised in Figure 1.

Global crude steel production

Global crude steel production is likely to continue with a growth rate of ~3.4%, as identified by the Raw Materials Group, Sweden. Accordingly, the requirement for key raw materials will also be growing at a proportional rate. China’s steel demand growth...
ways to use the available raw materials sources, while taking care of environmental factors, i.e., slag, emissions, water and energy consumption.

To clarify the status of technology for beneficiation of low grade materials (different types of ore requiring specific type of beneficiation equipment or stages).

This will expand the understanding of steel producers concerning raw materials sources, quality levels and technologies using low grade raw materials, and allow pressure to be applied to raw materials providers to beneficiate or improve the quality of the remaining raw materials and avoid reducing the efficiency of the coke, sinter and ironmaking processes.

The scope covers the following materials and processes:

- Materials: Iron ore, coking coal
- Processes: Mining, improvement (how, for what type of material and what is practical), agglomeration (sintering, pelleting), coking operation, BF operation, new processes and ironmaking technology under development.

Project members and data collection

The project team comprised 21 project members from 18 steel producing companies and one association, which split into three sub-groups: iron ore, coal and ironmaking. Individual group members decided to collect...
the information in two ways, first by means of survey data received from member companies, and from a few major raw materials suppliers and, second, by information available in the public domain.

**FINDINGS**

**Raw materials management** Based on survey results, information made available, and the experience of the project team and their colleagues, the following observations were made:

- Global reserves of iron ore and coal are plentiful, however, the higher quality materials are being mined now and so quality will reduce as stocks deplete
- Global availability of iron ore and coking coal is balanced with market demand, as expected
- The quality of iron ore in 'run of mine' is decreasing and installed beneficitation processes do not yet compensate for this change entirely. However, increased use of these processes will make this possible
- Fe content is decreasing, while silica and alumina content are increasing
- The quality of metallurgical coal is decreasing, especially with an increase of ash and moisture
- Without beneficitation, increased use of low grade raw materials will lead to higher slag rate, lower productivity and higher Reaction Agent Rate (RAR) consumption
- Depending on the cost of low grade raw materials, investment should be either in the beneficitation process at the mine site or in steel plants to increase production capacity. Installing or improving beneficitation processes at the mine site is more effective as capital investment is significantly lower per unit of production, reducing the transportation of non-metallic components only to smelt them and turning it into slag.

**IDENTIFIED GOOD PRACTICES**

The following recommendations have been made by the project team with specific examples of good practice for raw materials management.

**Use of low grade raw materials**

- Large capacity BFs would provide better flexibility in being able to use a wider range of raw materials effecting productivity
- The successful use of various types of low quality resources can bring great economic benefits. The usual practice is to have one weeks’ requirement of blending stockpile capacity to enable the use of various lower grade materials. A dedicated stock yard to store different grades of raw materials is needed in this case
- Allows extensive use of low quality fine material in sintering. Australian fine materials are low quality with an SiO2 content of more than 7%. In one plant, 20% fines are sintered with standard quality ore, with no significant deterioration of sinter quality
- Use of low grade coal can be optimised by proper blending. Examples are: use of pet coke and semi-soft coking coal.

**Blending and material handling**

The project team recommend a blending model and facility to maximise the recycling of reverts (recycled material) and to achieve finetuning and better consistency.

- For example, a plant has a dedicated secondary blending yard (300,000t capacity x2) reclaimed by a full width barrel reclaimer
- To prevent dumping or external treatment of plant reverts and to minimise input of fresh materials, plant reverts are recycled as much as possible. In another
plant, the sinter blend consists of around 20% of recycled plant reverts.

**Beneficiation of raw materials**
- To deal with the beneficiation processes and its impact, the right technology options should be considered.
- The beneficiation process cost should be balanced with the market price of equivalent quality iron ore.
- Iron content in sinter from beneficiated material must reach at least 60% Fe with SiO2 content less than 7%.
- This level of beneficiation resulted in increased iron content in sinter, decreased lime consumption, reduced coke consumption and increased BF productivity.

**Environment issues**
- Technologies to treat sinter plant waste gases such as ‘activated char packed bed filter’ or ‘bag filter’ are associated with high capital and operational expenditure, but are able to meet the existing environmental requirements of local authorities.
- Activated char packed bed filter implemented by a plant cleans all sinter plant waste gas, managing the dioxins and chloride emissions.
- Beneficiation processes do have an impact on the local environment due to process needs, of tailing storage and water treatment and recycling plants. The choice of the process and design has to be made carefully to meet both general local and mined material conditions.

**PROBLEMATIC AREAS**
The project team also identified major areas of concern for steel companies.

**Raw materials handling**
Logistics and transportation are very important and could have an impact on the use of low grade raw materials.
- Port facilities (at place of export) need to consider blending of materials, as products from many different mines are brought together in one area.
- Selective crushing and homogenisation need to be established at the mine site, and equipment needs to be modified or upgraded as the materials change from different parts of the mine as mining progresses.
- For ferrous materials, blending yards tend to be small to provide enough space for storage, but not for multiple material blending. Hence, blending should be done at source so only high grade materials are shipped ready for use.

**Coking coal quality issues**
Current and potential coking coal supply sources are shown in Figure 4.
- High coal moisture: The retained moisture in coal can pose problems. For instance, moisture levels of 9-10% can have a negative impact on coke density.
- Shortage of hard coking coals: Low coke quality has a negative impact on consistency in iron production, iron quality and the technical condition of the blast furnace lining.

**CONCLUSIONS**
Raw materials have an overwhelming impact on the profitability and productivity of the steel industry. Therefore, an efficient raw materials management procurement strategy is critical. Those responsible for procurement must have a clear understanding of the impact of lower-grade materials (just because it is cheap it does not mean it is good business). They should also
understand that mining companies can deliver the required quality of 65-68% Fe with minor impurities by means of simple beneficiation equipment. World reserves are not at risk of reduced availability of Fe or carbon sources to meet expected steel production needs. The quality of raw materials has a direct impact on the technical performance of iron and steel plants as well as an impact on the environmental performance of the production process. The use of lower grade materials has a direct and proportional impact on throughput, slag rate, energy intensity, material use and consequential emissions. Thus, steelmakers are concerned about the resource base and encourage implementation of beneficiation investment at mine sites or ports to maintain their operating efficiency.

The steel industry has a very wide operating envelope, which it can use to its advantage. Information from 19 companies has shown there is great flexibility in ironmaking processes that can take many differently sourced materials and levels of quality. However, there is a price to pay in efficiency and effectiveness if low grade materials are used.

The change in supply contract period from one year-plus to quarterly in the iron ore industry can provide steelmakers with an excellent opportunity to source materials from many different suppliers to suit the quality and economic delivery of the raw materials. The ability to negotiate with more suppliers will create a competitive market that will give an economic advantage. This means that this level of flexibility allows steel plants and organisations to create a supply route that is more flexible and relevant for the industry, depending on the economic climate.

The outcome of this project is that it has been successful in removing some of the perceived constraints about the industry. Consequently, the industry should be able to take advantage of the flexibility given by the abundant resources that will be available economically to them for centuries to come. MS

Henk Reimink is Director Safety, Technology and Environment at worldsteel, Brussels, Belgium

CONTACT: Reimink@worldsteel.org