Briefing: Relevance of Iron Ore to OBMs

- Iron ore is the fifth most abundant element in the earth's crust.
- Global resources of iron ore in 2017 were estimated by the USGS at more than 800 billion tons, containing 230 billion tons iron.
- Production of iron ore in 2017 was estimated by USGS at 2.4 billion tons with 1.5 billion tons Fe content.
- The most significant suppliers of iron ore to the global market in 2017 were Australia and Brazil with a combined market share of >50% in terms of production. Other important producer countries included China and India.
- In terms of cross border trade, Australia and Brazil accounted for almost 80 % of the total volume of about 1.6 billion tons.
- Between them, the four major producers Rio Tinto Iron Ore, BHP, FMG and Vale accounted for just over 70% of cross border trade in 2017.

Mineral	Chemical formula	Max. Fe content %
Hematite	Fe_2O_3	70.0
Magnetite	Fe_3O_4	72.4
Martite	$xFe_2O_3.yFe_3O_4$	70 ≈ 72
Goethite	$Fe_2O_3.H_2O$	62.9
Limonite	$2Fe_2O_3.3H_2O$	59.8

Iron ore production steps

- Pre-mining: stripping, drilling, blasting.
- Mining: iron ore is generally mined in open pits although there are underground mines, notably in Sweden and China.
- Beneficiation: direct shipping ores, i.e. those with sufficiently high Fe content (at least 55-58% Fe), require only crushing and screening to produce lump ore and sinter feed fines.
- Concentration: lower grade ores need additional beneficiation steps to achieve acceptable Fe content, whereby the iron oxide minerals are liberated through grinding and separated from the gangue by gravity separation, magnetic separation or flotation to produce iron ore concentrates.
- With very fine concentrates, agglomeration is required to render them suitable for use in ironmaking processes (the BF or DR shaft burden needs to be permeable enough to enable even gas flow through it which would not be the case if fines or concentrates were charged directly to the furnace): pelletizing is the most common method of iron ore agglomeration where the product has to be handled and shipped over long distances, due to the greater physical strength of pellets in comparison with sinter. Except for a few cases, sintering takes place adjacent to the blast furnace.

Types of iron ore

- The most commonly used type is Iron Ore Fines (generally known as Sinter Feed) which is sintered at the receiving steel mill, prior to being charged to the blast furnace. Iron Ore Fines typically have particle size up to 6.3 mm. Fluidised bed direct reduction processes use Iron Ore Fines as their feedstock.
- Having been ground, Iron Ore Concentrates are finer than sinter feed with a particle size in the range below 2-5 mm and are used as feedstock for both sintering and pelletizing (sometimes regrinding is required to produce pellets).
- Even finer still is Pellet Feed which has average particle size <75 µm with a significant proportion >45 µm and a high specific surface area.
- Iron Ore Lump, a direct shipping ore is typically sized between 6.3 and 25-30 mm and is charged directly to the blast furnace, usually after screening. Iron Ore Lump is a also a primary feedstock material for production of sponge iron in rotary kiln furnaces in India and certain high grades are also used in gas-based shaft furnace direct reduction plants.
- Iron Ore Pellets typically have particle size distribution of 9-16 mm with a high compressive strength and resistance to abrasion. Due to the possibility to blend various additives with the pellet feed, e.g. limestone, dolomite or olivine, pellets can be both acid and basic in terms of their chemistry. The majority of pellets are used in blast furnaces (BF grade), but certain grades of pellets, with high Fe content (≥ 67%) and low acid gangue content (≤ 2%), (DR grade), are the main feedstock for production of DRI in gas-based shaft furnaces.


Pellets


Lump


Sinter fines


Concentrate

Chemical analysis of iron ore: relevance to OBMs and EAF steelmaking

- Pig Iron: the blast furnace is a flexible chemical smelting reactor and many unwanted impurities will report to the slag. However, certain impurities, such as phosphorus and part of the sulphur, will carry through to the liquid iron and hence the pig iron, so careful selection and control of iron ore, coal/coke/charcoal raw materials is essential to achievement of the desired pig iron analysis.

- DRI and HBI: the direct reduction of iron ore is a solid state reaction, so apart from oxygen, what is fed to the DRI plant is contained in the DRI product, including gangue components and impurities. Thus, careful raw material selection and control is critical to the achievement of the required DRI and HBI analysis. High reducibility results in high metallization of the iron ore feedstock and is important to minimise the content of residual unreduced iron oxides entering the EAF.