The making of steel: EARTH, AIR AND FIRE

From coarse and rocky iron ore to tough and shiny steel — the making of the magic alloy is a fascinating journey that starts from the crust of the earth, involves complex metallurgical reactions and processes, and demands technological expertise of a high degree. Tata Steel’s Jamshedpur plant, the very first steel plant in India (production started in 1912), is today among the country’s largest integrated steel-making facilities, producing 10 million tonnes of steel every year. We walk through the modern Tata Steel plant, much changed from its original manifestation, to witness the birth of red hot molten steel in its multiple forms and its casting as the radiant champion of industrial development.

By Shubha Madhukar
For more than 3,000 years, humans have known how to make tools, weapons and ornaments from iron. Known as a metal of antiquity, iron is one of the building blocks of modern civilisation. Indeed, there was a time when iron was more valuable than gold.

The basic process of making iron and its tougher alloy — steel — have not changed in the last three millennia. First, the ore has to be found. Then it must be reacted with other elements at very high temperatures. Third, the liquid steel must be collected and cast into shape. And, finally, the steel must be treated to give it the properties needed for end use.

Steel is considered a green product because it is 100-percent recyclable and has an infinite life cycle. Tata Steel is among the top 10 global steel companies and one of the world’s most geographically-diversified steel producers, with operations in 26 countries and a commercial presence in more than 50.

At Tata Steel’s Jamshedpur plant, the steelmaking process starts at the mines. Iron ore is brought in by trucks from Noamundi in Jharkhand and Joda in Odisha, and coal comes from West Bokaro and Jamadoba in Jharkhand and even as far away as Australia. The Jamshedpur plant uses approximately 25 million tonnes of iron ore and coal/coke blend every year to produce about 10 million tonnes of steel.
The Tata Steel plant lights up the Jamshedpur skyline at twilight.

The iron ore mine at Noamundi in Jharkhand.
Untreated ore cannot be used to make steel as it reduces the quality of the metal. Therefore, the raw iron ore is processed at the sinter (or processed iron ore) plant. The coal used in the plant is cleansed of impurities in coke ovens. Conveyor belts carry metallics — pellets and sinters — to the heart of the steel plant, the blast furnace.

The blast furnace is a six-storey tall reactor where the seemingly magical transformation of dark iron ore into glowing hot liquid iron takes place. The ore is charged into the blast furnace along with fluxes and limestone. Temperatures in the blast furnace reach up to 1,500°C and the resulting metallurgical reaction converts iron oxide into molten iron. The blast furnace works round the clock.
The red hot liquid metal produced in the blast furnace is collected in the hearth and ‘tapped’ on a near continuous basis through day and night. The process is called casting and, typically, the steel plant does 10-12 casts in a 24-hour cycle. Tata Steel has eight blast furnaces and six of these are operational.

Hot metal or molten iron from the blast furnace is transferred into vessels called torpedoes and transported on rail tracks to the LD, or Linz Donawitz (named after the towns in Austria where the technology was commercialised), shop. Here the molten iron is refined into steel using the ‘basic oxygen furnace’ method. Tata Steel has three LD shops — one dedicated to making steel for long products (used mainly in the infrastructure and construction sectors) and two others for flat steel products (typically used in automobiles and appliances).
At the LD shop the process begins with charging scrap into the furnace, where temperatures reach 1,700°C. Large ladles, capable of holding 170 tonnes of liquid metal, pour the molten iron into the furnace. A water-cooled lance is lowered into the furnace to blow in pure oxygen. Iron ore (as coolant) and burnt lime and raw dolomite (as flux) are added from the top. The oxygen removes carbon, silicon, sulphur and phosphorus content from molten iron and converts it to steel, an alloy that is tougher than iron. One ‘heat’ (a cycle of steelmaking) takes 45-50 minutes and produces an average of 158 tonnes of molten steel.
The properties required for steel depend on the end use. And so, from every heat, a sample of the molten steel is analysed to see if it meets the requirement. If there is any variation, a ‘correction blow’ is ordered. Once perfected to specification, liquid steel — still aglow at about 1,630-1,690°C — is tapped into a ladle car positioned under the furnace. During tapping, ferro-alloys and aluminium are added directly into the steel ladle for alloying and deoxidisation.
This steel goes through further refining, depending on requirement, at the online purging station, ladle furnace station or RH degasser. Ladles with a holding capacity of 160 tonnes carry the liquid steel to the continuous caster machines. Here the liquid steel finally takes solid form and is shaped into what are called long products or flat products.
The long products are processed at the wire mill to produce wire rods and rebars. Tata Steel makes a range of long products, including TMT rebars branded as Tata Tiscon, and steel wires that sell under the brand name Tata Wiron.

Flat steel is further processed at the hot rolling mill or cold rolling mill, depending on end use. Cold rolling mills have a continuous galvanising line and produce the galvanised steel used in the automotive, engineering and appliances sectors. Tata Steel’s branded flat steel products — Shaktee, Galvano and Steelium — are known for their world-class quality.

You may not be aware of it, but there just could be a bit, or more, of Tata’s steel in your life. □

Photographs: The Tata Steel archives, Jamshedpur