TATA STEEL

TATA

HISARNA: GAME CHANGER IN THE STEEL INDUSTRY

Taking care of the community and environment is one of Tata Steel's core values. We are committed to help create innovative process and product research & development.

Reducing energy consumption and carbon emissions are essential for our company, because they not only help combat climate change, but also significantly reduce production costs, thus improving our global competitive position.

Carbon emissions are inevitable in the steel production process, because you need carbon to produce liquid iron, which is produced in a chemical process. The carbon atoms bind the oxygen atoms present in iron ore (which is basically iron oxide), to produce pure liquid iron and carbon. The European steel industry has made significant progress reducing carbon emissions to a minimum. Currently Tata Steel emits 1.7 tonnes of carbon dioxide per tonne of steel produced in IJmuiden. That is a world class performance. In other parts of the world up to 4 tonnes of carbon dioxide are emitted per tonne of steel produced.

Though it is still possible to find ways of further reducing energy use and carbon emissions, in Europe, we are reaching the limits of current technology. Achieving further significant reductions is only possible by developing revolutionary breakthrough technologies.

ulcos

In 2004 a group of European steel companies and research institutes formed ULCOS, which stands for Ultra-Low Carbon Dioxide Steelmaking. Its purpose was to identify technologies that might help reduce carbon emissions of steelmaking by 50% per tonne by 2050. HIsarna is one of those technologies, shows great promise and is the most advanced of the ULCOS technologies.

HIsarna:

- Shows commitment of European steel industry to radically and structurally lower CO_2 emissions
- Lowers process costs
- Reduces energy use by at least 20%
- Reduces carbon emissions by 20%
- Enables a more resource efficient process
- Is ideally suited for Carbon Capture and Storage

World class

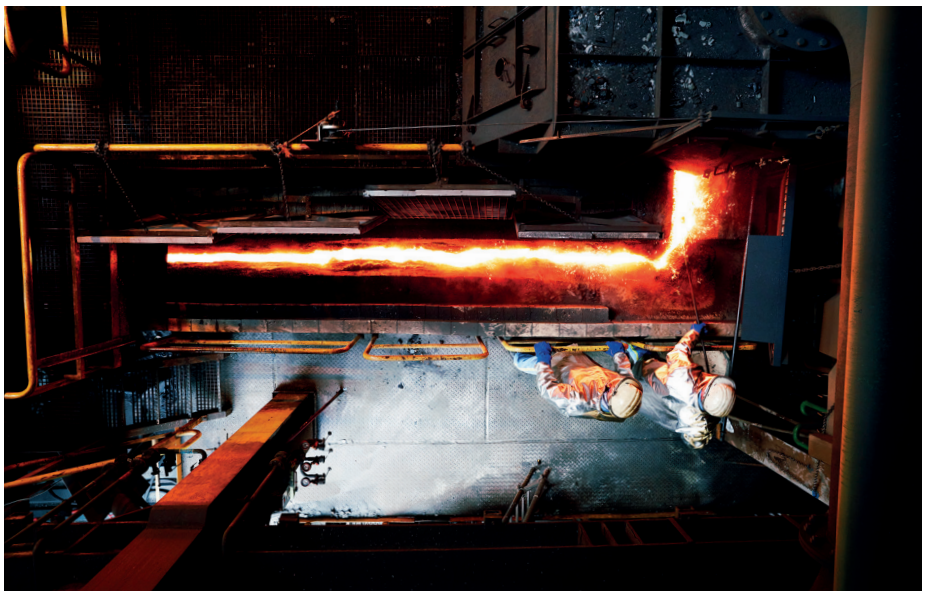
Tata Steel in IJmuiden is a world class performer in making sustainable steel, with the lowest possible energy use and CO_2 emissions. Tata Steel is also leading the way in the field of developing new breakthrough technologies to make significant future progress in further improving production sustainability.

Game changer

HIsarna is a new technology, designed and developed at Tata Steel in IJmuiden, which will allow for future steel production with at least 20% lower CO_2 emissions. This technology can become a game changer that significantly improves steel production sustainability performance. Scientists and steel companies from all over the world are closely monitoring the development of HIsarna.

Up to 80% CO_2 reduction

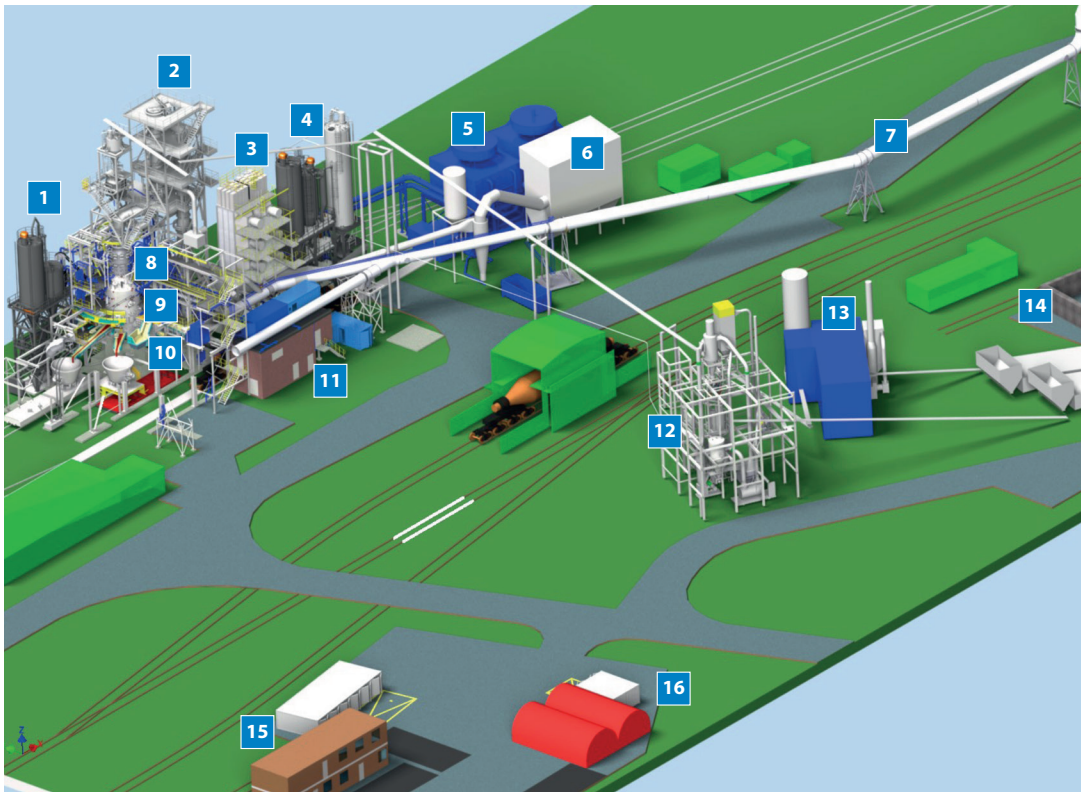
HIsarna is a substitute for the blast furnace process. To make liquid iron in a blast furnace iron ore and metallurgical coal (the raw materials) need to be preprocessed into sinter (lumps of iron ore) and pellets (small balls of iron ore) and cokes. The HIsarna process will make this obsolete. In the HIsarna installation the raw materials can be injected as powders, directly converting them into liquid iron. If HIsarna can be successfully developed at an industrial scale, future production of steel with a 20% smaller carbon footprint will be possible. Using Carbon Capture and storage or Carbon Capture and Use can lead to a 80% smaller carbon footprint.



To develop and test this technology a pilot plant has been built at the IJmuiden site. Since 2011 this pilot plant has been through four test campaigns. The tests so far have been promising.
Tata Steel and its project partners have succeeded in proving that the process works. The pilot plant has produced liquid iron, which has successfully been processed into steel.

PILOT PLANT

1. Alternative raw materials storage silos
2. Off-gas duct
3. Gas cooler
4. Coal and lime storage silos
5. Cooling towers
6. Bag filter
7. Secondary dedusting
8. Smelting cyclone
9. Smelting reduction vessel
10. Fore hearth
11. Control room
12. Coal grinding, drying and screening
13. Ore drying and screening
14. Raw materials storage
15. Offices
16. Workshop



HIsarna has been jointly developed with mining company Rio Tinto. Currently Tata Steel, Rio Tinto, ArcelorMittal, ThyssenKrupp, Voestalpine and technology supplier Paul Wurth are jointly working on testing and further developing the HIsarna technology.

If the technology can be developed successfully on an industrial scale, it will take ten years to reach the stage of commercial use. Then the technology can be applied in greenfield situations. At exisiting steel production sites the current technology will gradually be phased out.

Need for support

Funding breakthrough technologies is a burden the European steel industry cannot face alone, given the huge sums involved, the tough European economic market conditions and the global competition with companies that are not faced with emission trading schemes, carbon taxes and high energy and labour costs. European steel companies are at a severe disadvantage as long as there is no global competitive level playing field. Financial support from the European Union is indispensable if the European steel industry is to successfully develop breakthrough production technologies.

A six-month HIsarna test campaign has started in October 2017. The objective of this test is to prove that the installation can produce liquid iron for long, sustained periods of time. This campaign will cost about 25 million euros.

Next stage

If this test is successful, the project can enter the next stage: the crucial stage of designing, constructing and testing a large-scale pilot plant. This will need an investment of 300 million euros. Once it has been built, the large pilot plant will have to go through several years of testing. The industrial size plant will be two to three times the size of the current facility, capable of making up to 10 times more liquid iron.

ADVANTAGES OF HISARNA

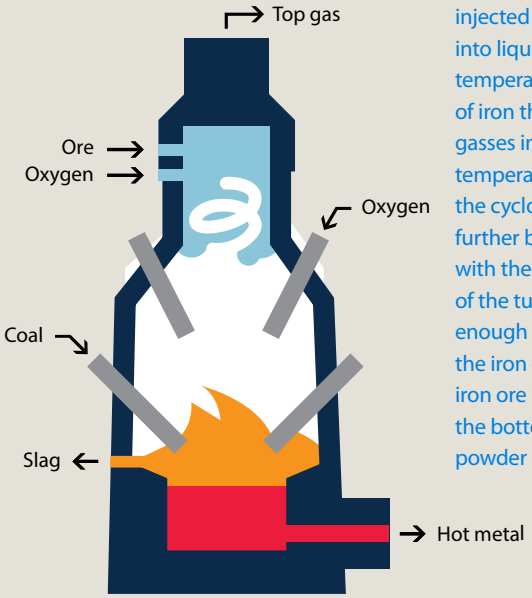
Reduced manufacturing costs

The HIsarna production process is more efficient than the current one, as there is no need to preprocess ores and metallurgical coal. A complete production stage can be phased out: coking plants, sinter plants and pellet plants. This will also save a lot of energy, which is good for the environment and will lower manufacturing costs. HIsarna also enables the use of a wider range of ore and coal qualities, which will allow steel companies to produce the same high quality steels using cheaper and more widely available raw materials.

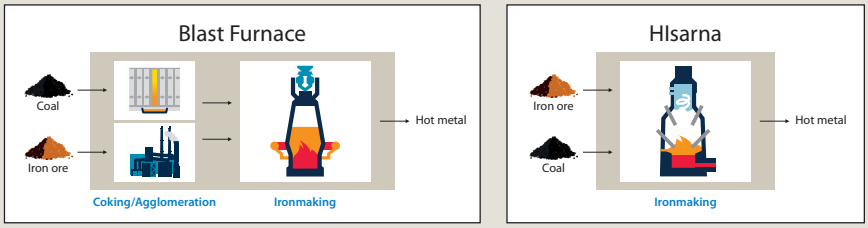
Better for the environment

HIsarna's most important environmental benefits are the reduction of energy use and CO_2 emissions by at least 20%. Since the HIsarna installation produces almost 100% pure CO_2, this CO_2 is ideally suited for immediate capture and storage, without the need for a costly refining process. If governments choose to opt for this strategy, capturing and storing CO_2 could lead to an 80% reduction of CO_2 from the steel production process. HIsarna also allows for a wider range of steel production by-products to be reused, which will further close the loop of the steel manufacturing process. An additional advantage of HIsarna is the reduction of the emission of fine particles, sulphur dioxide and nitrogen oxide.

How HIsarna works



HIsarna consists of a reactor with temperatures above the melting point of iron throughout the vessel, so that the injected iron ore instantly melts and converts into liquid iron. In the HIsarna furnace temperatures are above the melting point of iron throughout the reactor. The process gasses in the melting vessel have a high temperature. At the top of the reactor (in the cyclone) the temperature is increased further by adding pure oxygen, which reacts with the carbon monoxide present. Because of the turbulence in the cyclone there is enough contact time for the hot gas to melt the iron ore (which is injected at the top). The iron ore immediately melts and drips into the bottom of the vessel. That is where the powder coal is injected, causing the oxygen from the iron ore (= iron oxide) to bind with the carbon, thus creating pure liquid iron, which can then be tapped.



FACTS ABOUT HISARNA

Developed by Tata Steel and Rio Tinto

The cyclone part (upper part) of the HIsarna installation has been developed by Tata Steel in IJmuiden. The lower part, the Hismelt vessel, has been developed by Rio Tinto. Tata Steel has full ownership of the patents on the HIsarna technology.

Ancient Celtic word for iron

The name HIsarna is an amalgam of the ancient Celtic word for iron ('Isarna') and the name of the melting vessel ('Hismelt').

75 million euro investment

So far 75 million euros have been invested in developing HIsarna. The partner companies have funded 60% of this investment, while 40% consist of support from the European Union, the Dutch Economics Ministry and the European Research Fund For Coal and Steel.

Revolutionary breakthrough technology

HIsarna is a revolutionary breakthrough technology. Its impact may be compared to the introduction of contiuous casting in the 20th Century, which has made the process steps of ingot casting and rolling redundant (they were virtually completely phased out in the steel industry over a period of 30 years).

Annual production of 60,000 tonnes of liquid iron

The maximum production capacity of the current HIsarna pilot plant: 60,000 tonnes of liquid iron a year. As a comparison: Blast Furnace 7 in IJmuiden produces 10,000 tonnes of liquid iron a day.

Preheating oven to 1,200 degrees Celsius

Before the start of each testing campaign burners preheat the reactor of the HIsarna plant to a temperature of about 1,200 degrees Celsius. Next, a layer of liquid iron is poured into the bottom of the melting vessel, to facilitate the start-up of the process.

1st test: theory into practice

The first HIsarna test campaign: April - June 2011. Objective: showing that theory works in practice, i.e. producing liquid iron without preprocessing of raw materials. Objective achieved. First successful tap of liquid iron: 20 May 2011.

2nd test: stable process

Second test campaign HIsarna: 17 October - 4 December 2012. Objective: producing liquid iron for a longer, sustained period. Objective was met. Production at 80% of design capacity for periods of 8 to 12 hours. In the last run full design capacity of 8 tonnes per hour was reached.

3rd test: HIsarna steel

Third test HIsarna: 28 May - 28 June 2013. Objective: producing liquid iron for sustained periods and running tests with various kinds of raw materials. Objective was met. For the first time ever steel was made from HIsarna liquid iron.

4th test: sustained production

Fourth test HIsarna: 13 May - 29 June 2014. Objective: sustained, stable production during several days on end and tests of various kinds of raw materials. Objective was met.

5th test: 6 month sustained campaign

The fifth HIsarna test, which has started in October 2017, is a six-month sustained campaign. In preparation for this campaign, the installation has seen a significant overhaul. A completely new off-gas duct has been installed, increasing the height of the plant by more than 10 metres (highest point: 37 metres). Next to the pilot plant a complete coal grinding and a drying and screening facility for ore and lime have been constructed. Closed conveyor belts have been installed to transport the raw materials from the storage facility to the installation injection points. The raw materials storage capacity has been doubled. On top of that a gas analysis lab has been added and the electronic monitoring system has been completely reprogrammed.

For more information, go to: **www.tatasteel.nl** or **www.tatasteeleurope.com**