HBI C-Flex

NEWSLETTER

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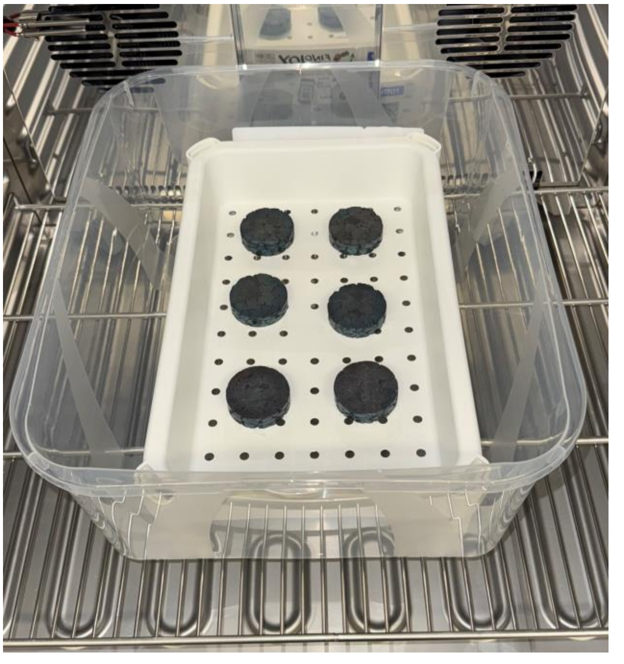

HBI C-Flex

The HBI C-Flex project has the goal to determine the reoxidation behaviour and stability of direct reduced and hot briquetted iron (HBI) with variable iron and carbon content to promote safe handling and transport for future decarbonisation of the steelmaking process.

The project in a nutshell

HBI C-Flex is a 3.5-year project funded by the European Union's Research Fund for Coal and Steel research programme. It demonstrates the direct reduction of iron ore using various qualities (including lower-grade ores typically not used for direct reduction) followed by hot briquetting. The consortium consists of 10 partners and includes steel producers, RTOs, technology providers, and universities from Austria, Germany, Belgium, France and the Netherlands, each of which has specific knowledge, skills and equipment to achieve the project objectives. A Supportive Advisory Board, consisting of 13 globally operating companies along the supply chain and led by the International Iron Metallics Association, assists with their knowledge and expertise regarding HBI production and handling.

Sneak peak

Grant agreement ID: 101112479

Start date: July 1st, 2023

Duration: 42 months

Budget: 2.4 Mio. €

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This project is co-funded by the European Union under grant agreement number 101112479.

T2.1: Desing and erection of the lab-scale fixed bed reactor for direct reduction

ArcelorMittal fixed bed reactor, better known as Boris furnace (shown in Fig. 1), was designed to study the properties of the iron burden reduced under operating conditions of the upper part of a blast furnace. Nowadays it is used also to perform tests to investigate the direct reduction process.

It is based on a movable furnace downwards on a tube of 4 meters in length filled with iron oxides. The furnace is a multi-zone heating system (800 mm length) able to reproduce a wide range of thermal profiles. The reducing gas, with a controlled composition and flow rate, is injected at the top of the tube to generate reduction reactions in the heated zone. The gases available to perform the tests are currently: CO, CO_2, H_2, N_2.

Fig. 1.: Current installation of Boris furnace

The requirements of the HBI C-Flex project include the production of DRI under conditions similar to the industrial process. To better represent these conditions, some adaptations are required in the current installations.

The two main adaptations to be carried out in the Boris furnace will be the addition of CH_4 and H_2O as part of the reducing mixture. To carry out these changes in the process, it is required to acquire new flowmeters and piping for the two new gases mentioned above. To add the H_2O, a humidification system is required. This equipment should be adapted with the correct conditions of pressure and temperature to achieve the percentage of humidity in the gas mixture. Finally, after several studies on how to adapt the equipment, it was decided to have a fully integrated gas mixing station.

For this modification, the activities already done include:

- Engineering design
- Specifications of parameters of the elements
- Risk analysis of the design
- Purchase of the equipment

Currently, the equipment is under fabrication and the activities required for the reception and fast beginning of operation once it is delivered are being carried out.

Work package 2: Design of the HBI production and reoxidation processes

This newsletter focuses on the different tasks within work package (WP) 2 of our project, providing detailed insights into the work and objectives. Each WP leader descri-bes the work currently ongoing in their task.

The main goals of this WP include T2.1: the design of a laboratory direct reduced iron (DRI) reduction facility using an existing reactor at the ArcelorMittal Maizières Research Center (AMMR), T2.2: the development of a lab-scale briquetting system by TU Berg-akademie Freiberg (TUBAF) to produce HBI of consistent and certain quality, and T2.3: the creation of a lab-scale corrosion system for reoxidation studies by the Chair of Ferrous Metallurgy at Montanuniversität Leoben (MUL-CFM).

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T2.2: Desing and erection of the lab-scale briquetting system

At the Institute of Thermal, Environmental and Resources' Process Engineering of TU Bergakademie Freiberg (TUBAF), Germany, a lab-scale briquetting system for direct reduced iron (DRI) was designed and adapted to avoid any re-oxidation of the sample during the mechanical refinement not only at hot stage. Therefore, a sample handling, processing, characterisation, and storage under inert atmosphere is essential, which is realised by a glovebox, an adapted muffle furnace for heating-up and an injection grouting lance for the forming tool at the hydraulic piston press.

In the first step, the received sample of sealed DRI-pellets is unpacked and weighed into ingots which are covered by lids in the rendered inert glovebox. Consequently, the filled ingots are transferred to the nitrogen-purged muffle furnace at a previously defined heating pattern. After the samples reached set temperature, the ingots are placed on the top of the forming tool which has also been purged by inert gas beforehand. The heated DRI is layered once more with nitrogen after being released to the tool. The hot briquetted iron (HBI) is put back directly to the glovebox for characterisation, especially apparent density. In the last step, the HBI is vacuum-packed and shipped to MUL for reoxidation tests. During the commissioning of the briquetting system the evidence of the method was provided successfully. Fig. 2 depicts the scheme of briquetting tests on the left-, and the experimental setup on the right-hand side.

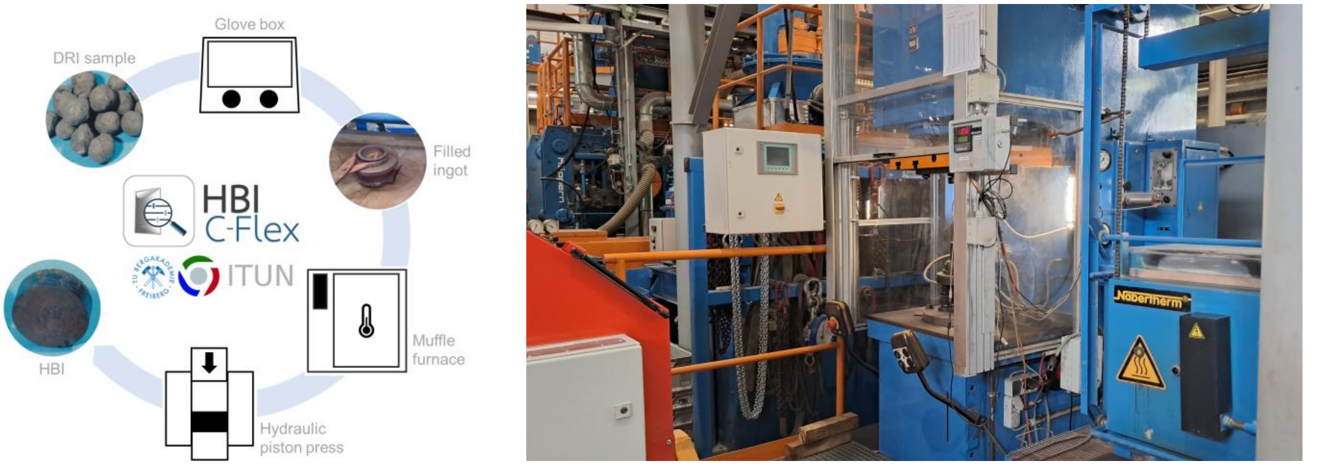

Fig 2.: left: scheme of briquetting tests, right: experimental setup

T2.3: Design and erection of the lab-scale corrosion system for reoxidation studies

The Chair of Ferrous Metallurgy at Montanuniversität Leoben (MUL-CFM) is responsible for the design of the hot briquetted iron (HBI) production and reoxidation (ReOx) trials in Work Package 2. This includes the following key tasks: coordination of the development of some new equipment at ArcelorMittal/CRM/TATA Steel, TU Bergakademie Freiberg and Montanuniversität Leoben in order to map the entire process chain, which encompasses ore reduction, briquetting and ReOx tests.

Additionally, the main goal MUL-CFM is the investigation of the ReOx behaviour of HBI and carbon content during the Task 2.3 of WP2 in order to derive regulation for safety handling and transport. The MUL-CFM designed some climate boxes with different climatic conditions to investigate the impact of climatic conditions on ReOx of HBI C-Flex samples, which is displayed in Fig.3 on the next side. The design of the lab-scale corrosion system for ReOx studies is practically ready and many additional control tests proceeded in September-November this year.

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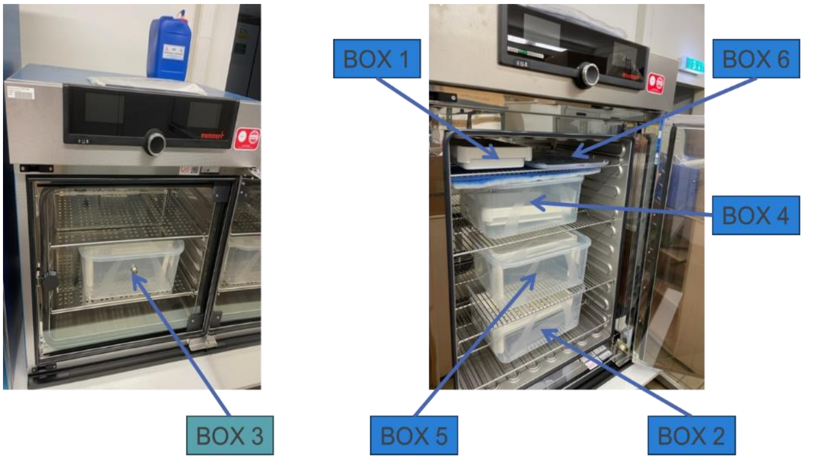

Fig 3: Climatic cabinets Memmert HCP 105 and HPP260eco for the investigation of the reoxidation behaviour of HBI

Six boxes were chosen and determined for different ReOx conditions for HBI C-Flex samples in climate chambers. Planned ReOx tests will start in dry atmosphere air (Box 1), moist air (Box 2 - sealed box), moist tempered air (Box 3 - sealed box in furnace at a temperature of 70 °C), immersed in deionised water equipped with air pump (Box 4), immersed in salt water equipped with an air pump (Box 5), and immersed in deionised water for 1h 1-2 times a week (Box 6).

The MUL-CFM will characterise and analyse HBI C-Flex samples during and after the ReOx tests: mass balance, true density, morphology and microscopic images, scanning electron microscope (SEM), Raman spectroscopy, chemical composition & metallisation degree (help of voestalpine laboratory). The hydrogen generation will be monitored too with the measurement of the pH and additionally, sensors for hydrogen detection.

The aim is to conduct application-orientated highly qualified basic research in order to understand and describe the fundamental mechanism of ReOx.

1st peer-reviewed paper published

In July 2024, Lina Kieush from K1-MET published the 1st peer-reviewed paper of the HBI C-Flex project.

The paper, titled “Reoxidation Behavior of the Direct Reduced Iron and Hot Briquetted Iron during Handling and Their Integration into Electric Arc Furnace Steelmaking: A Review” studies how direct reduced iron (DRI) and hot briquetted iron (HBI) are integrated into the steelmaking process using electric arc furnaces. It provides an overview of various DRI production techniques distinguished by different reactor types.

The paper is open access, and you can download a copy here.

What’s up next?

We are excited to announce that planning is ongoing for the mid-term workshop of our project. Schedulded for February 2025, this online event will bring stakeholders together and invite other projects to share updates on their progress, exchange insights, and engage in meaningful discussions on the reoxidation behaviour and stability of direct reduced and hot briquetted iron. Stay tuned for more details!

Follow us

Check out our project website and follow us on LinkedIn to find out the latest news from the project!

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