

**THE STEEL DECARBONIZATION IMPROVE SOLUTIONS CONTINUOUS-CASTING GREEN STEEL**<sup>1,2</sup> Paul OLARU<sup>1</sup>SCO-Expert Luzern, Switzerland<sup>2</sup> Deutsche Materialkunde e.V., EU, [polaru70@yahoo.com](mailto:polaru70@yahoo.com)<https://doi.org/10.37904/metal.2024.486>**Abstract**

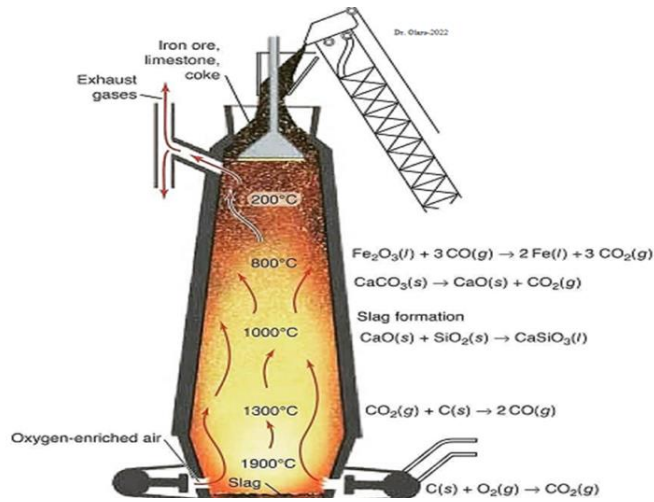
The metallurgical aspects typical of this process, the high freezing rate provides an extremely refined solidification microstructure characterized by dendritic ramifications, improves segregation and increases the mechanical properties of metal. The aim of this work is develops the, CastMag Oscillation (CMO) technology. By multiphysics approach which combined fluid dynamics, heat transfer, process metallurgy, solidification, it is possible now to define new innovative processes with the integration of new design of Double-Helix CMO system. Future development of DH-CMO applicability is in agreement with energy savings and CO<sub>2</sub> reduction demand. DRI produced at high temp. (> 777°C) with metallization up to 90-95% and controlled carbon ≤ 5%, and which is pneumatically transported from the reactor discharge to the meltshop for direct feeding to the EAF shop. The DRI is capitalized in the EAF. The typical configuration of DR-based EAF steel-shop involves moving bed reduction reactor producing cold discharged direct reduced iron, which could be either stored / sent directly to the electric furnace shop by means of conveyors. The DRI typically has a metallization level of up to 95% and carbon levels in the range of 1.75%-2.3%. The DH-CMO is anti-bulging technology is an innovative solution transforming continuous casting to make it safer, faster, and more reliable. EM processing can be classified by type of magnetic field involved: from AC to DC field. These processes are suitable for heating, melting, flow, shape control, solidification control (stirring, pumping), for each application a specific configuration needs to be defined, selected and optimized continuous-casting. [1],.

**Keywords:** steel, c. casting, anti-bulging, DRI, EAF**1. INTRODUCTION**

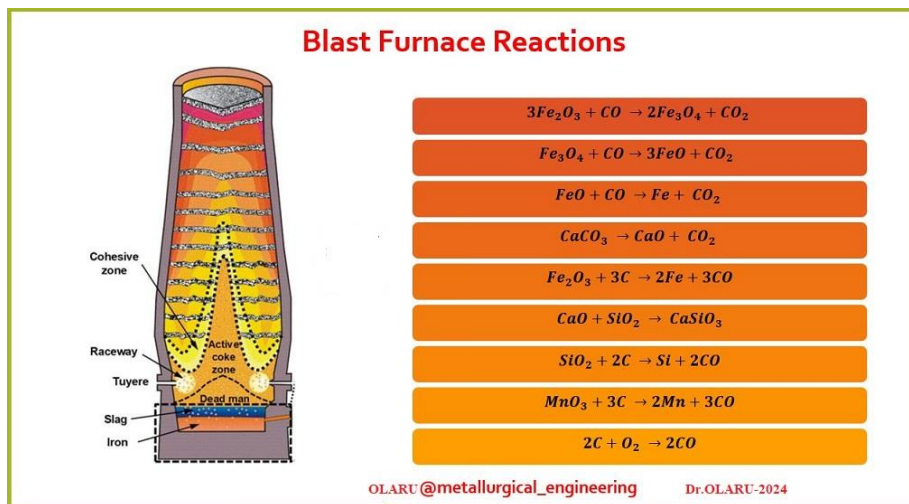
The metal solidifies just before reaching the bite of the rolls and is then rolled as it passes through the rolls. Regarding the metallurgical aspects typical of this process, the high freezing rate provides an extremely refined solidification microstructure characterized by dendritic ramifications, improves segregation and increases the mechanical properties of metal. The purpose of this work is to study, analysis and develops a heat-transfer mathematical model which must be able to analyze the metal/roll thermal behavior during the C. Casting station case In Non-EU material steel vs. EU material steel T.C.1 (C. Casting) station case, using a finite difference technique. The model has input parameters such as the strip thickness, the gap between rolls, the roll speed, and the thermophysical properties of the rolls and the metal.[7-9].

**2. STATE OF THE ART**

**“GREEN” steel** - by applying green hydrogen in the direct reduced iron (DRI) “GREEN” steel - by applying green hydrogen in the direct reduced iron (DRI) production process using electric arc furnaces (EAF)—powered by renewable energies—to melt it.



**Figure 1** Blast furnace –TENARIS SIDERCA CDRI-MIDREX Plant, [6]



**Figure 2** Blast furnace Kinetics & Thermodynamics reac. MIDREX Algeria [4-6]



**Figure 3** General views: (1) MIDREX Plants :TENARIS-SIDERCA's CDRI ; ( 2 ) TOSYALI ALGERIA, [10-13]

## 1-TENARISSIDERCA

Tenaris-Siderca's CDRI module in Argentina, (Figure 1, Figure 3), started production in February 2022 to satisfy the DRI demand from its steel shop. The module's DRI metallization percentage was the second highest of all MIDREX Plants, (1), at 95.64%.

## 2-TOSYALI ALGERIE

Tosyali Holding's 2.5 million tons/year combination (HDRI/ CDRI) module, (2), located in Bethioua, near Oran, Algeria, (Figure 2, Figure 3), set a new annual production record for the third consecutive year (more than 2.28 million tons in 2021), while operating just under 8,000 hours. Over 69% of production went to the adjacent steel shop as HDRI. Together with Algerian Qatari Steel (AQS), this is the largest capacity MIDREX Module built to date, with a 7.5 m diameter shaft furnace.

## 3. TECHNOLOGY NEWS

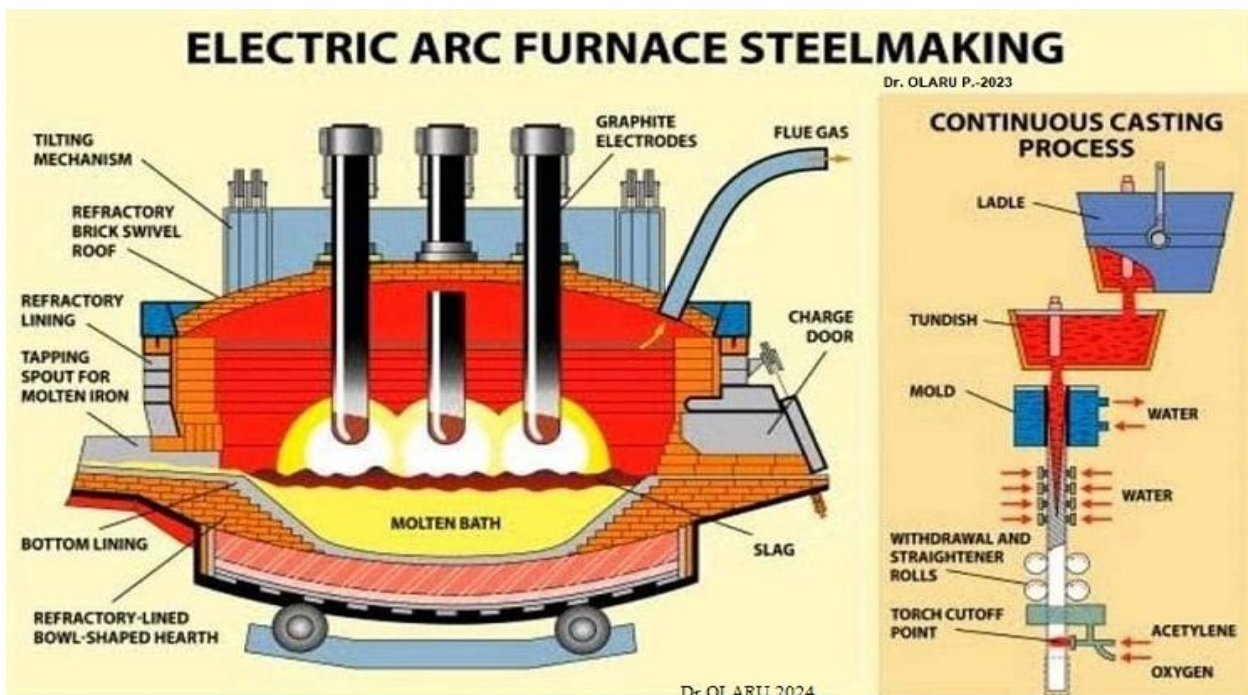
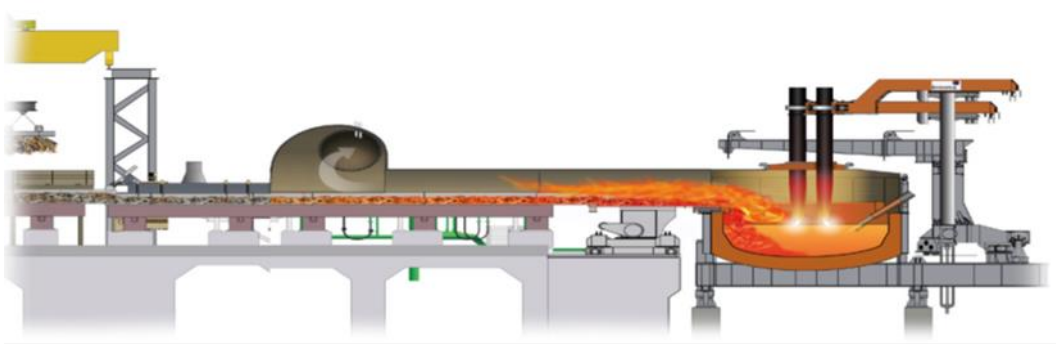


Figure 4 New EAF furnace my project in use and C-CASTING process applied, [1]

### 3.1. The anti-bulging technology is to reduce unsteady bulging

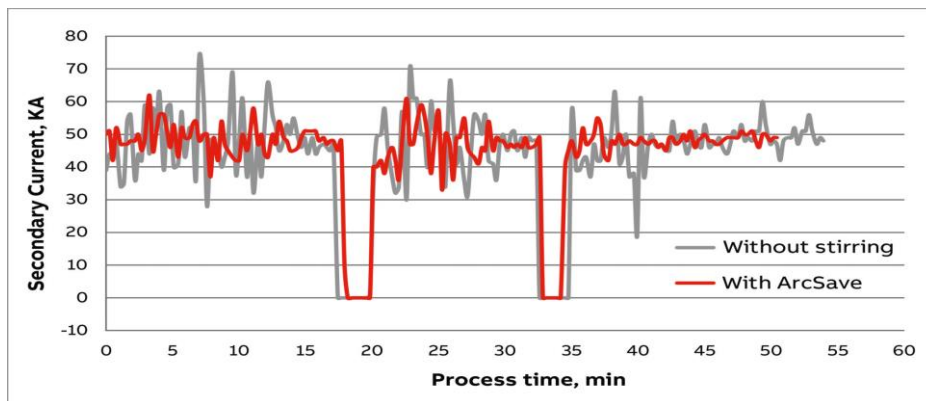
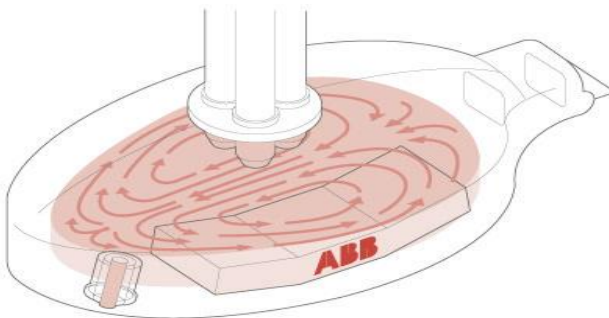
#### Main benefits

- High degree flexibility charge materials, high reliability availability
- Proven and profitable technology for any steel route (flat/log)
- Highest productivity resulting in dilution of fixed costs
- High-impedance furnace, Arf voltage up to 1,650 V
- Proven low values for energy, electrodes, refractories
- Minimum maintance use of heavy mill-type components



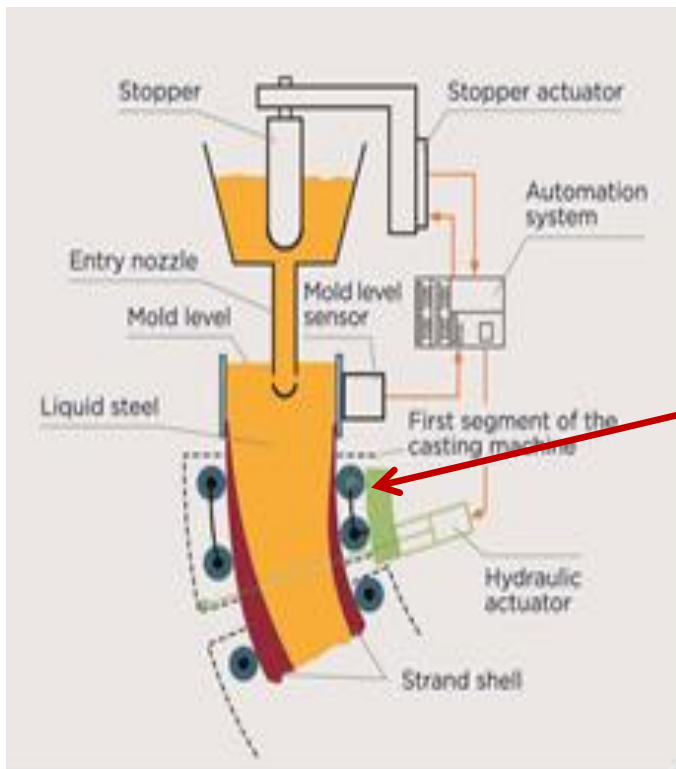
**Figure 5** “LevCon Bender Anti-Bulging” is a process control for continuous casters and prevents fluctuations of the mold level caused by unsteady strand bulging,[1].

**3.2. Magnetic bearings apply Anti-Bulging Technology**



**Figure 6** The Anti-bulging technology is furthering the capabilities of mould level control by Double-Helix-CMO system > DH-CMO by Smart Bender and it is an innovative solution for continuous-casting to make it safer, faster, and more reliable, [2].





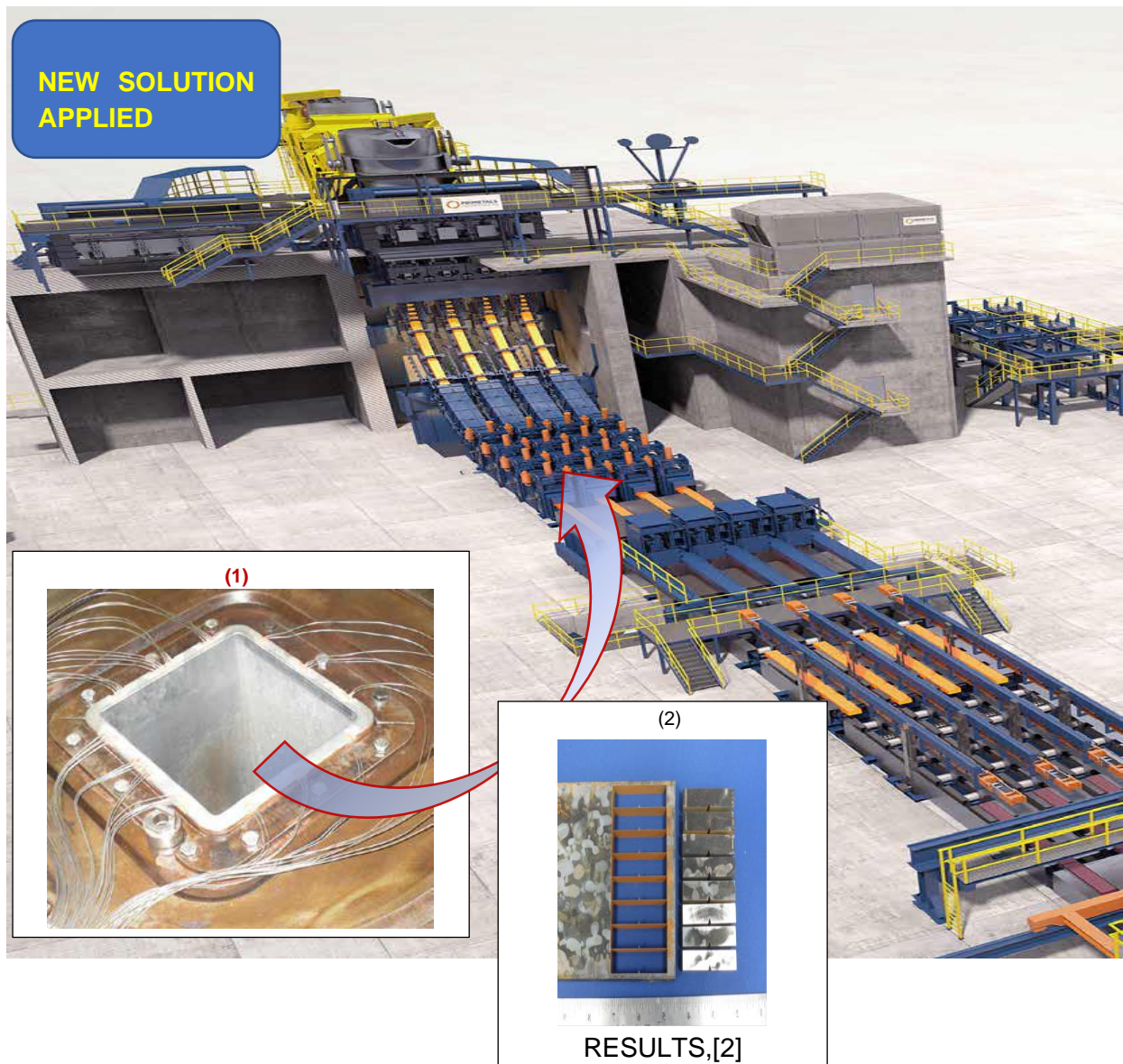
The bulging occurs in the casting machine, the “shape” and occurrence of bulging appear as waves in the form of changes in thickness in the shell of the strand. Due to their periodic nature, bulging is measured in terms of wavelength. The initial wavelength of a bulge can cause various problems for a continuous casting machine down the line due to its harmonic occurrences. So, controlling the impact of the initial disturbance and subsequent harmonics is essential to prevent breakouts

**Figure 7** The primary focus of anti-bulging technology is to reduce unsteady bulging. As bulging occurs in the casting machine, the “shape” and occurrence of bulging appear as waves in their periodic nature, bulging is measured in terms of wavelength. The initial wavelength of a bulge can cause various problems for a continuous casting machine down the line due to its harmonic occurrences. Thus, controlling the impact of the initial disturbance and subsequent harmonics is essential to prevent breakouts, [8-10].

#### 4. INNOVATIVE STRENGTH MAXIMUM PRODUCTIVITY BY NEW CASTER MOULD-CASTMAG OSCILLATION

##### • Double-Helix (DH-CMO) system

The Continuous-Casting new machine [15-17], will produce 700,000 tpy of steel 42 MoCr 11 rebar grades in a 120x120 mm section and feed in hot-charge mode, the high-speed rebar mill.



**Figure 8** The New solution applied Continuous-Casting new machine will produce 700,000 tpy of steel 42 MoCr 11 rebar grade to 120x120 mm section, windows (1) new model of mould and (2) results like short final structural-profiles steel section

## 5. CONCLUSIONS

### 🚧 HPR- Hydrogen Plasma Reduction- RESULTS / ADVANTAGES

1. The iron conversion kinetics is dependent on the balance between the initial hematite mass and the arc-power. The reduction kinetics of the 9 g hematite specimens is relative sluggish during the final 25% of reduction. The Kinetics of this process is not well understood, particularly during the wüstite reduction step, which is nearly an order of magnitude slower than the hematite reduction

2. The reduction rate of hydrogen plasma-based reduction, using only a small H<sub>2</sub> partial pressure of 10%, is comparable with those ones observed in solid-state direct reduction of hematite conducted at temperatures currently employed in shaft furnaces (850–1000 °C)..
3. The crystals elements of the hematite are gradually removed during reduction, due to their high vapor pressure. Silicon enrichment was identified in the interdendritic *fayalite*, at the *wüstite* /bcc-iron hetero-interfaces and in the oxide particles inside iron. Since silicon oxide reduction is not readily feasible, it is majorly evaporated in the form of SiO gas. P-Phosphorus and S-sulfur concentrations were also remarkably

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