AISTech 2021 — Proceedings of the Iron & Steel Technology Conference
29 June–1 July 2021, Nashville, Tenn., USA
DOI 10.33313/382/024

Hydrogen-Based DRI EAF Steelmaking — Fact or Fiction?

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ABSTRACT

This paper will present a provocative rumination of the challenges to be considered and overcome before hydrogen-based direct reduced iron (DRI) steelmaking becomes a reality, or not. Considerations such as technology needs (H2 generation, DRI carbon content, electric arc furnace needs and overall carbon balance) and economic viability (as understood currently) will be posed and discussed, along with the impact of carbon taxes.

Keywords: Hydrogen, DRI, EAF, Zero Carbon, CO_2 mitigation

INTRODUCTION

Let me say at the outset, as far as the technology for hydrogen (H_2) based Direct Reduced Iron (DRI) Electric Arc Furnace (EAF) steelmaking, there appear to be no significant issues with operating the DRI shaft furnaces at 100% H_2. Operating an EAF with zero carbon DRI (0%C_{DRI}) will be a major challenge at any charge rate (15% use by 2050), never mind the envisaged, long term. 95% charge rate [1]**.** However, as an "outsider looking in" from a country already operating with 69.7% EAF steel production (2019 figures per AISI), therefore technically one of the "cleanest steelmaking" nations, I am wondering how the undeniable push to convert future steelmaking (EU especially) to the H_2 DRI/EAF route will impact product cost and market share.

The extreme capital cost for this conversion, never mind development and sustainability of Green Hydrogen and Green Power, without which CO_2 mitigation goals will not be achieved, will challenge the worldwide competitiveness of compliant steelmakers/countries.

Considering this, and the probable need to significantly modify EAF technology (or find a replacement thereof), begs the question why is not more consideration of CO_2 mitigation from the BF/BOF route being addressed given this route constitutes 92% of CO_2 generation for 72% of steel production.

Let's look at the status quo, the challenges to overcome and technology required to make this direction an economically viable (as understood currently) reality, or not?

THE ISSUES

CO_2 Generation and Required Mitigation

The world steel industry uses 8% of the overall energy demand and contributes 7% of the total carbon dioxide (CO_2) generated by humanity (2.6 GigaTonne [GTe] CO_2 2020; 2.8 GTe CO_2 2015) [1, 2, 3] **(**Figure 1**)**. Global CO_2 emissions by country **(**Figure 2**)** [4] show China producing 28% whilst the EU, which is mandating more reduction, is only 10%. Coal, 75% of the energy demand, accounts for most of the CO_2 generation as it provides carbon (C) for iron oxide (FeO) reduction in the ironmaking process, process fuel, and, in the Blast Furnace (BF - as coke) provides structure and mechanical support to the bed of materials in the reactor shaft.

