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Converting Blast Furnace Gas to Hydrogen: Field Demonstration Plant Update

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ABSTRACT

This paper discusses the commissioning and operational results of the first H2Gen® demonstration plant at a North American integrated steel facility. The project successfully demonstrated the use of blast furnace gas to produce hydrogen from water using the H2Gen® technology. This offers the steel industry an innovative and cost-effective method for hydrogen production, accelerating the decarbonization of the blast furnace iron-making process. The paper also describes the core technology of H2Gen®, which is a solid oxide electrochemical reactor, and it provides a pathway for scaling this reactor for future commercial deployments.

Keywords: Decarbonization, Hydrogen, Blast Furnace Gas

INTRODUCTION

The blast furnace is the foundation of the integrated steelworks, dating back centuries. The many improvements over time[1], such as utilization of coke over charcoal, addition of a hot blast, advanced controls, bell-less charging along with others have enabled the blast furnace to provide very high, reliable production of molten iron at globally competitive costs. Today, approximately 70% of global steel production[2] is via the blast furnace to oxygen converter route, leaving the balance of about 30% to be produced via the Electric Arc Furnace (EAF) route. However, as the blast furnace is a carbon-based technology, it is the major source of carbon dioxide emissions (CO2) in the steel industry.

Because of this, there is a clear shift underway towards the EAF route. In fact, the US is already at a balance of approximately 68% EAF production. By contrast China produces 83% of its steel output via the blast furnace route and India is a close second at 72%. Although the global shift towards EAF based production is expected to continue, it is difficult to see blast furnace-based steelmaking dipping below 50% of global production for the foreseeable future. At this point, drivers for the shift to EAF will become marginal. For example, suitable scrap will become scarce and extremely costly (if available at all). Further, DRI quality iron ore will also become scarce. At the same time, operators of cost-effective blast furnace production will find ways to further reduce emissions to maintain competitiveness.

It is therefore imperative to develop technologies that will contribute to the decarbonization of the blast furnace. Hydrogen has been identified as a pathway to potentially decarbonize the blast furnace iron making process. Since hydrogen is a non-carbon-based reductant, it can partially replace carbon as a fuel in the blast furnace, lowering emissions while maintaining efficient iron production. A number of integrated steel companies have conducted small scale, limited trials of hydrogen injection into the blast furnace to reduce carbon in the process. Longer term, to achieve significant carbon reductions in the blast furnace large quantities of hydrogen are required. For example, recently Nippon Steel achieved 43% reduction of CO2 as part of their testing in its Super Course50 technology[4]. Achieving hydrogen production at a scale necessary for blast furnace decarbonization is challenging. Hydrogen from conventional sources such as steam methane reforming and electrolysis have some inherent barriers. For instance, although steam methane reforming is a well-established and comprehensively understood technology, it produces hydrogen by reforming natural gas. This process can be prohibitively expensive in many global markets and emits a substantial amount of carbon dioxide. Specifically, for every kilogram of hydrogen produced, approximately 10 kilograms of carbon dioxide are also generated. The other conventional method is electrolysis which uses electricity to crack

