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DIMENSIONING AND COST EVALUATION OF A MARTIAN STEEL PRODUCTION PLANT

Abstract

Steelmaking is at the core of the human industry and is a key element that, once mastered, constitutes the very foundation of most industries and technologies we use every day. We often take materials for granted, yet everything we build is reliant on these materials. We have even named entire periods after them. From the first use of iron as a metal from heaven to the first development of steel in India, both have shaped human evolution and constructions across the millennia and as we embark on our space fairing journey, the need for steel on the Moon and Mars becomes a salient topic of research.

The construction of a Martian colony will undoubtedly manifest itself as a challenging task, and amongst other things, will require plenty of materials, of which steel is one of the main building blocks. Mars presents a large number of various resources, and so the question is inevitably asked: wouldn't it be easier and more cost-effective to produce steel directly on Mars rather than to send it from Earth? The financial and technical potential of implementing a steel factory would increase our capacity to develop a colony on Mars rapidly and constitute a significant leap in our ability to construct a semi-autonomous colony less reliant on terrestrial resources and shipments. To make this happen, current terrestrial technologies have to be adapted, and processes developed to suit the harsh Martian environment.

This paper analyzes and compares the technological and economical feasibility of different direct reduction iron (DRI) methods, of which both MIDREX® and HYL® processes are considered. It also examines the compatibility of both processes with two techniques for transforming DRI into steel — electric arc furnaces (EAF) and induction furnaces (IF). This paper aims to propose a preliminary design for a Martian steel production plant through the adaptation of Earth steel manufacturing processes, and compares it — financially, technologically, and logistically — to send the metal from Earth via near-future reusable launch platforms.

The project is part of a double affiliation between ESTACA & the Association Planète Mars, the latter being the company tutors for the students who have worked on this project.

Keywords: steel, iron, Mars, Earth, financial