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Development of a fuel-flexible ladle preheating system

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The Paris Climate Agreement and the European Green Deal are two of various agreements and climate plans that all aim to reduce global greenhouse gas emissions. With around 7% of total emissions from the energy sector, the steel industry plays a decisive role in the realisation of global climate targets. Reducing CO2 emissions is possible through innovation and the development of new technologies. One important approach here is technologies for burning hydrogen-based fuels instead of fossil fuels.
An essential process step in steel production is the preheating of the transport ladle in so-called ladle preheaters. In electric steelmaking plants, e.g., the transport ladles carry the molten steel from the electric arc furnaces (EAF) to the ladle furnaces and on to the casting plant. They consist of a crucible-shaped steel shell and are lined with multi-layer refractory. The lining varies depending on the plant. For example, it can consist of a layer of permanent bricks with a refractory concrete layer sprayed on top. The concrete is exposed to constant thermal and mechanical stress and abrasion. Therefore, the concrete needs to be relined after around 100 use cycles. Only after drying and preheating in ladle preheating systems the newly lined ladle can be returned to the plant. Preheating of the ladle reduces temperature losses of the molten steel and the thermal shock of the refractory. Currently, ladle preheating stations with natural gas/oxygen burners are state-of-the-art, which are operated with outputs in the megawatt range.
As part of the project, a ladle preheating system is being developed whose fuel-flexible oxyfuel burner can use hydrogen and ammonia and their mixture to preheat transport ladles in an electric steel plant. Innovative burner technology, digital process models and optimised control and regulation systems are designed to achieve high process stability, safety, energy efficiency and low NO_x emissions despite the fluctuating availability of hydrogen-based fuels. In addition to setting up a demonstrator system in a steelworks environment, a detailed process model is being developed on the basis of computational fluid dynamics (CFD) simulations. In the first phase of the project, reference measurements were carried out to analyse the status quo and to collect validation data. Initial model configurations for the flow simulations were tested to support the development process of the new burner. In addition to the vision and approaches of the project, the first experimental and numerical results will be shown in the presentation.

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