CO_2 Reduction by Combining Methanation With the Blast Furnace

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As a method for remarkably reducing CO_2 emissions from the blast furnace, a method combining carbon recycling technology (methanation) and the blast furnace was proposed, and theoretical examination was carried out by Rist diagram. The results showed that by synthesizing methane from CO_2 in the blast furnace gas and blowing it through the tuyere, CO_2 emissions could be reduced by more than 30% compared with conventional blast furnaces. At that time, it was also clarified that oxygen blast and pre-heating gas blowing from the shaft upper part were effective for the increase of CO_2 reduction.

The 21st Conference of the Parties to the United Nations Framework Convention on Climate Change (COP21), held in November 2015, adopted the Paris Agreement on emissions of greenhouse gases (GHG), beginning with CO_2.[1] Steel works that use mainly the blast furnace process produce large amounts of steel by consuming coal as a primary energy source. In 2019, the Japanese steel industry emitted 150 million tons of CO_2, or approximately 14% of the country's total annual CO_2 emissions of 1.1 billion tons (actual results for 2019).[2] Thus, reducing CO_2 emissions is an urgent challenge for the steel industry as a CO_2 emission-intensive industry. Although various energy-saving technologies for reducing CO_2 emissions have been developed to date, including burden distribution control techniques and small coke mixed charging, CO_2 emission reduction by operational technologies is approaching its limit.[3,4] With this background, moves to convert energy sources from coal (carbon) to hydrogen, which doesn't discharge CO_2, in order to realize a drastic reduction in CO_2 emissions can be seen all over the world. As examples, a one-tuyere hydrogen injection test at thyssenkrupp's Duisburg No. 9 blast furnace and the COURSE50 project in Japan may be mentioned.[5,6] In recent years, carbon capture and utilization (CCU) has attracted attention as a method for effectively utilizing CO_2 by producing products using CO_2 captured from the atmosphere or from industrial exhaust gases as a feedstock. Utilizing captured CO_2 to produce products that were originally made from fossil fuels will contribute to low carbonization, and CO_2 will not be emitted while it is fixed in the product. Although CO_2 emissions from manufacturing process are allowed in CCU, there is currently an imbalance between the demand for products that can be produced using CO_2 emitted by the steel industry and the amount of those emissions. For example, Japan imports an average of about 1.7 million tons of methanol each year but considering the fact that 0.7 ton of methanol can be produced from 1 ton of CO_2, conversion of all the CO_2 emitted by the steel industry to methanol is not realistic, since the supply of methanol would vastly exceed demand.[7]

Therefore, the authors attempted to solve the above-mentioned market problem by reusing a product produced by CCU as a reducing agent in the steel industry; in other words, by "carbon recycling" to the steel manufacturing process. It should be noted that this approach has the advantage of not contributing to CO_2 emissions, as the carbon