OPINION: Can the Indian steel industry Join the Hydrogen revolution?

If India wants to retain the edge as one of the leading steel producers globally, the Government should provide incentives through policies for adoption of hydrogen.

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Steel has been the backbone of the Indian economy since Independence. India produced 111 million tonnes (Mt) of steel in 2018, becoming the second-largest steel producer in the world after China. According to the National Steel Policy, 2017, India's annual steel production will reach 300 Mt by 2030.

Coal is the primary source of energy for the Indian steel industry. While natural gas is employed across the world to produce steel, India is the only steel-making country that uses coal because of its economic viability and abundant iron ores in the states of Chhattisgarh and Orissa. However, steel produced using coal adds to carbon dioxide (CO_2) emissions.

In 2018 alone, roughly 220 Mt of CO_2 was emitted by the steel industry. Emissions from the steel industry contributes to 8% of India's total emissions and is considered hard to abate sector. With the Government of India pledging to abate 33% of CO_2 emissions by 2030, the steel industry needs to find viable alternatives soon to mitigate emissions.

Alternatives to coal

Iron-ore used for making steel comprises iron and oxygen. The process involves using coal to separate oxygen from iron. Carbon in the coal combines with oxygen to form carbon dioxide, leading to emissions. Several universities and companies across the globe have been trying to find alternatives to either reduce or eliminate the consumption of coal in steel-making. Most short-term commercial projects are currently substituting 20–30% of coal with hydrogen, thereby managing to pull back CO_2 emissions by 20–30%. The different technologies being piloted now include electrowinning techniques such as Boston Metal and SIDERWIN with 99% emission reduction potential and hydrogen techniques such as HYBRIT, Flash, Thyssenkrupp, and H_2 Hamburg with 95% emission reduction potential.

Electrowinning is a breakthrough technology as it is a single-stage process unlike the current process which involves multiple stages. However, it will be a while before electrowinning is commercially available. Meanwhile, HYBRIT, a hydrogen-based technology, is the most promising at the moment; it is currently in the research stage and is expected to enter commercial production in 2026.

Hydrogen-based DRI plants vs rotary kiln DRI plants

The Ministry of Steel reports that about 45% of steel is produced using blast furnaces and 35% using direct-reduced iron (DRI) using coal (20% steel comes from recycling). India has, in fact, been the world's largest DRI producer since 2003.

Due to the minimal capital cost rotary kiln is the most widely used technology for producing steel under the DRI method. It requires a capital investment of INR 17 lakh for every tonne per day (TPD) capacity plant and approximately INR 18,000 to procure iron ore and coal for every tonne of steel produced. Almost 40–45% of the operational expenses in this case are spent on procuring coal. The hydrogen-based DRI (H_2DRI) plants, on the other hand, require high capital investment as water electrolysers are expensive. They also incur high operational costs due to substantial electricity consumption.

H_2DRI plants can be viable if they are integrated with a captive solar PV plant and a waste-heat-recovery system (WHRS) power generator. This will reduce the operational costs significantly as the cost of electricity becomes negligible because of the captive solar PV plant.

For a 200 TPD capacity plant, the initial capital cost for a rotary kiln plant would be INR 34 crore, while an H_2DRI plant, with captive solar PV, would require INR 713 crore. But even with the huge capital cost, low operational costs would make the H_2DRI plant break even with the rotary kiln plant in 10 years.

The road ahead

Abundant in nature, hydrogen is found in water (H_2O), hydrocarbons (such as methane, CH_4), and other organic matter. Thus, the transition to hydrogen would reduce India's geopolitical dependencies by reducing its reliance on imports of coal, natural gas, and petroleum products as energy sources. The switch would also be beneficial in the long run as it can play a significant role in other sectors such as transport, process industry, agriculture, and long-term energy storage—making it easier to achieve economies of scale.

Despite these benefits, the barrier to an H_2DRI plant is the high upfront capital cost. As steel is traded on a global platform, these capital costs are difficult for the industry to absorb. If India wants to retain the edge as one of the leading steel producers globally, the

Government should provide incentives through policies for adoption of hydrogen. As part of Policy for Steel Clusters (Draft), electrolysers with captive PV plants can be included under common facilities and production of hydrogen can be incentivised under the PLI scheme for a period of 10 years. This will attract the attention of independent hydrogen producers and reduce the capital burden on each steel plant, while pushing India towards emission-free steel-making.

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