

HYDROGEN PRODUCTION VIA CHEMICAL LOOPING USING IRON OXIDES MODIFIED BY CERIUM, ZIRCONIUM AND YTTRIUM OXIDES

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Hydrogen is considered to be clean energy substitute for fossil fuels, given that the combustion of hydrogen is carbon free; however, this does not consider how the hydrogen is made in the first place, invariably starting with a fossil fuel. The chemical looping process for the production of hydrogen, sometimes referred to as the “cyclic, sponge-iron process” or “two-step, water-splitting process”, involves the reduction of an iron oxide and its subsequent oxidation by steam at temperatures above 600°C, operated in a cyclic manner. The reducing agent for the iron oxide is synthesis gas, made by the gasification of a fossil fuel. With a suitable process arrangement, it is possible to capture pure CO₂, for subsequent sequestration, and produce hydrogen with a purity suitable for direct use in proton exchange membrane fuel cells. However, it is known that particles of pure iron oxide lose their reactivity very quickly when subjected to multiple cycles of oxidation and reduction [1]. To ensure constant reactivity of the iron oxide, two possible approaches have been proposed: (i) to limit the extent of reduction of the iron oxide [1] and (ii) to stabilise the iron oxide by the addition of an inert support [2]. In this study, 10 or 30 mol% of cerium, zirconium or yttrium oxides were mixed with iron oxides by means of wet-impregnation or co-precipitation. It was found that the co-precipitated mixed metal oxides remained highly reactive with good physical integrity over 10 cycles of redox reaction in a fluidised bed operating at 850°C. Various particle characterisation techniques were used to investigate the nature of the stabilisation effect, which helps to predict the performance of the candidate oxides over a much longer period of operation.

References

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- [2] Bohn, C.D., Cleeton, J.P., Müller, C., Chuang, S.Y., Scott, S.A., Dennis, J.S., “Stabilising iron oxide used in cycles of reduction and oxidation for hydrogen production”, *Energy Fuels* 24: 4025-4033 (2010)