The improvement of reactivity of an iron-based oxygen carrier via the addition of bivalent metal in three-reactor chemical looping process

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The cyclic operation of steam-iron process is capable of generating very pure hydrogen allowing simultaneous capture of a pure steam of CO2. This process involves the use of iron oxide (Fe2O3) as an oxygen carrier and a three-step water-splitting cycle. One of the key issues in this process involves the development of oxygen carrier. This paper reports the improvement in the reactivity of the iron oxide supported by ZrO2 (FZ) by adding 2 wt% bivalent metals (Ni, Cu, and Mo). Cu-added FZ (CFZ) and Mo-added FZ (MFZ) showed the lower activation energy and higher pre-exponential factor. CFZ and MFZ produced high steam conversion during the oxidation period and FZ and CFZ showed low carbon deposition on the surface of oxygen carrier. In summary, CFZ showed the best reactivity for its sufficient reaction rate, high steam conversion and low carbon deposition on the surface possibly due to forming CuxFe3-xO4 and dispersed Cu oxygen carriers on ZrO2 under high and low O2 partial pressures, respectively.