Corrosion of Fe-(Cr, Al) alloys in H₂S-H₂O gases at 600-800°C

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Integrated coal gasification combined cycle (IGCC) power plants have been considered as a key technology for the 21st century in order to realize high efficiency and good environmental performance for electricity generation. IGCC has high potential to replace existing coal fired power plants, and is one of the clean coal technologies. However, the structural components of IGCC are exposed to the H₂O–H₂S gases environments at high-temperatures, suffering sulfidation and oxidation at the same time. Such hot gas corrosion also occurs in many high-temperature equipments operated in petroleum-refining plants.

In this study, Fe-(5, 10, 15)%Al, Fe-(10, 20, 30, 40)%Cr alloys were corrosion-tested in the N₂-H₂O-H₂S gas atmosphere at 600 and 800°C. Fe-15% Al and Fe-40% Cr alloys displayed the best corrosion resistance, because of their high Al and Cr content. By contrast, the Fe-5% Al alloy displayed the worst corrosion resistance, because there was not enough Al. The amount of Al and Cr greatly affected the ability of an alloy to form the protective scales. The oxide scales formed consisted primarily of the outer (Fe+S) scale + inner (Al+S) scale for Fe-5% Al, the outer (Fe+S) scale + inner (Al+S, Al+O) scale for Fe-15% Al, the outer (Fe+S) scale + inner (Cr+S) scale for Fe-10% Cr, and the outer (Fe+S) scale + inner (Cr+S, Cr+O) scale for Fe-40% Cr. The corrosion mechanism of test alloys is discussed based on SEM/EDS, XRD, and EPMA.

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