

High Temperature Supercritical CO₂-induced Material Degradation

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Abstract Supercritical CO₂ (S-CO₂) is CO₂ in high temperature, high pressure state (>304.13 K / 7.377 MPa). When working as heat transfer fluid in energy-related fields like fossil fuel power plants, nuclear power, concentrated solar power systems as Brayton cycle, S-CO₂ offers several advantages, including high energy efficiency, simple layout and compact turbomachinery. At elevated temperatures, S-CO₂ will induce coupled oxidation and carburization to the metallic components like Fe- and Ni-based alloys, causing potential threat to the safe operation of the system. And the coupled oxidation and carburization would be further complexed by the variation in other physical and chemical factors from both the environment and materials aspects. Therefore, this study tries to provide an overview on the degradation mechanisms of alloys in S-CO₂. The effects of environment temperature, applying pressure, impurity type and amount, alloying elements, thickness, welding, coating and surface conditions on corrosion are summarized. Besides, the stress-accelerated corrosion in the forms of SCC, creep, fatigue are also scrutinized. A material selection guideline is provided based on the summary of corrosion mechanism and predicting models. And the future research directions are pointed out in the end.

Keywords Supercritical CO₂, oxidation, carburization.

Reference

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