

Sanicro 25: A promising austenitic stainless steel alloy for Advanced Ultra Supercritical Steam (AUSC) oxidation environments

C. Sundaresan, Bhagwat Ghule, Dandapani Vijayshankar and V.S. Raja

Department of Metallurgical Engineering and Materials Science, Indian Institute of Technology Bombay, Mumbai 400076, India

Presenter's e-mail address: csundar92@gmail.com

Abstract Advanced Ultra-Supercritical (AUSC) Power plants which operate at steam temperatures and pressures as high as 710 °C and 31 MPa respectively have significantly high thermal efficiency which indirectly lower the carbon dioxide emission. The alloys meant for these operating conditions need to withstand creep and oxidation in steam-side and fire-side of the boilers. Ni-base alloys which exhibit high creep strength and superior oxidation resistance are preferred for the highest temperature zones of the AUSC plant. However, they are quite expensive and hence heat-resistant austenitic stainless steels are being considered as alternatives to bring down investment costs. Sanicro 25 (Fe-22.1Cr-25.7Ni-3.4Cu-3.0W-1.9Co-0.5Mn-0.4Nb-0.2Si-0.2N-0.06C) is one such alloy that is being considered as a potential material for usage above 650 °C in the AUSC plants. While the superior creep properties of Sanicro 25 has been well established, its oxidation behaviour in the AUSC steam environment has been hardly explored.

In this work, oxidation behaviour of Sanicro 25 was investigated in a simulated AUSC test loop at 710 °C temperature and 31 MPa pressure for 100, 300 and 600 hours. Ultrapure feed water with electrical conductivity less than 0.1 µS/cm and dissolved oxygen content less than 10 ppb was used at a flow rate of 20 ml/min. Sanicro 25 was found to exhibit parabolic oxidation kinetics with very low weight gain values (0.12 mg/cm² after 600 h) that are comparable to those of Ni-base superalloys reported in literature [1]. It formed a thin, protective, external Cr₂O₃ scale with (Mn,Fe,Ni)Cr₂O₄ spinel growing on top. Unlike other stainless steels, Sanicro 25 was found to resist the chromia scale breakdown and the subsequent iron oxide formation in AUSC steam environment. The detailed oxidation mechanism is discussed. The superior steam oxidation resistance of Sanicro 25 at 710 °C offers scope for its use in the AUSC plants.

Keywords Oxidation; Supercritical; Alloy Sanicro 25; High temperature and pressure

References

- [1] B. Ghule, C. Sundaresan, S. Ningshen, V.S. Raja, Oxidation behaviour of Ni-base superalloy 617 in simulated Advanced Ultra Supercritical (AUSC) steam, Corros. Sci. 224 (2023) 111503. <https://doi.org/10.1016/j.corsci.2023.111503>.