Microstructural analysis and kinetics of internal nitridation of Incoloy 800H

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The austenitic stainless steel alloy Incoloy 800H is widely used in industrial high-temperature applications, due in part to its good corrosion resistance. However, high-temperature corrosion in the form of internal nitridation due to nitrogen uptake from air has been observed in this alloy, and is believed to be a life-limiting factor in creep deformation of Incoloy 800H reformer furnace outlet tubes, known as pigtails. Published literature on nitridation of 800H appears to be limited, with the consequence that the effects of this phenomenon on the properties of 800H are uncertain. Assessment of such effects, through both physical testing and microstructural analysis, requires manufacture of nitrided material; consistent and controlled production of such material requires some knowledge of the kinetics of the process.

Ageing specimens of 800H at temperatures 800-900°C in a nitrogen/hydrogen atmosphere for times up to 1000 hrs is used to induce internal nitridation, whilst minimising the inhibitory effects of surface oxide formation that may be encountered when such an alloy is exposed to air at high temperatures. Examination of the resultant internally corroded microstructures using optical and SEM techniques allows determination of nitriding kinetics through measurement of nitride penetration depth. The expectation is that the observed relationship between time and penetration depth will be approximately parabolic. This will enable devising of an appropriate ageing treatment for production of nitrided specimens to be used in further work assessing physical effects of nitridation in 800H.

Microstructural analysis may also provide indications of how nitridation will affect the properties of 800H. A combination of optical, SEM, and TEM techniques allows a range of precipitate characteristics such as size, morphology, crystal structure, and matrix/precipitate orientation relationships to be described, as well as effects of precipitation on the matrix.