Application of an Activation-function modified Norton law to predict the two-step minima creep deformation observed in Incoloy 800H

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For some temperature-stress loading combination, the steady-state creep stage exhibited by alloy UNS N08810 is preceded by an initial viscoplastic hardening regime. This results in a two-step creep rate minima that conventional creep models fail to reproduce. In this work, we address this issue by coupling the well-known Norton creep law with an activation function. The Activation Function \times Norton (AFN) model is implemented as a viscosity function within a Chaboche-type unified viscoplastic constitutive model in the Lagamine finite element software. The implementation follows an implicit integration algorithm. The parameter identification procedure follows a direct methodology. The creep data used was generated after a thorough in-house experimental campaign combined with a comprehensive postprocessing of results, where both creep minima are correctly recovered. Finite element simulations allow to accurately recover the experimental data, thus validating the Chaboche-type constitutive law coupled with the AFN viscosity function to model the non-classical creep regime of the alloy.
The explanation of the two-step creep rate phenomenon can be found in the microstructure. The first creep rate minimum is attributed to the pinning of dislocations induced by a combination of solid solution and precipitate hardening.

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