ICCES, 2024, vol.29, no.2
DOI: 10.32604/icces.2024.012366

PROCEEDINGS

The Effect of Fatigue Loading Frequency on the Fatigue Crack Growth Behavior of a Nickel-Based Superalloy: Experimental Investigation and Modelling

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ABSTRACT

The Nickel-based superalloy is wieldy applied in hot components of aero turbine engine due to its superior mechanical property at elevated temperature. However, the working condition of engine hot components are severe and thus the effect of high temperature, oxidation and time-dependent loading on fatigue crack growth behavior should be considered in structure analysis. In this study, first the effect of environment was experimentally investigated. Stand compact tension (CT) specimens under different temperatures and loading frequencies were tests to evaluate the role of temperature and time-dependent effect on fatigue crack growth. Results show that if the temperature is low, low frequency would not result in significant increase in fatigue crack growth rate. In addition, low frequency at high temperature would result fatigue crack growth rate increase. On the other hand, oxidation layer would induce crack closure and would to some extent reduce the crack growth rate was also reported in other literatures. In this study, a fatigue crack growth rate model considers both positive and negative effect was proposed. This model includes the degradation of material at crack tip and the production of oxidation layer at the crack surface. The influence of environment was changed by changing the fatigue loading frequency which is directly related to the exposure time to the oxidation. The fractography was also analyzed by SEM to reveal the crack growth mechanism. Finally, attempts to apply this modeling in fatigue life prediction was also made.

KEYWORDS

Nickel based superalloy; fatigue crack growth; oxidation; frequency; elevated temperature

Funding Statement: This work was supported by the National Natural Science Foundation of China 52105156.

Conflicts of Interest: The authors declare that they have no conflicts of interest to report regarding the present study.