

Environment Effect on Fatigue of AerMet 100 Steel

E. U. Lee*, K. Sadananda**, and R. E. Ricker***

This study was conducted to identify the environment effect on the near-threshold fatigue crack growth in AerMet 100 steel at various load ratios ($R = 0.05 - 0.9$) and frequencies ($0.1 - 10$ Hz). The test environments were vacuum, gaseous dry nitrogen, distilled water, and four NaCl solutions of different concentrations. Three of them had an identical electrical conductivity. The test results were analyzed in terms of threshold stress intensity range ΔK_{th} and maximum stress intensity at threshold K_{max} .

Increasing R-ratio enhanced the near-threshold fatigue crack growth rate and reduced the ΔK_{th} in respective environments.

In vacuum and NaCl solutions, ΔK_{th} decreased linearly with increasing R-ratio. In dry gaseous nitrogen, ΔK_{th} decreased initially with increasing R-ratio, and then leveled off at high R-ratios. For $R < 0.5$, ΔK_{th} is highest in NaCl solutions, intermediate in vacuum, and lowest in dry gaseous nitrogen. On the other hand, for $R > 0.7$, it is highest in vacuum, intermediate in dry gaseous nitrogen, and lowest in NaCl solutions.

K_{max} changed little at lower R-ratios but it increased rapidly at high R-ratios in respective environments. For $R < 0.5$, K_{max} is highest in NaCl solutions, intermediate in vacuum, and lowest in dry gaseous nitrogen. On the other hand, for $R > 0.7$, it is highest in vacuum, intermediate in dry gaseous nitrogen, and lowest in NaCl solutions.

According to the fundamental threshold curves of ΔK_{th} vs K_{max} , the resistance to fatigue crack growth is highest in vacuum, intermediate in dry gaseous nitrogen, and lowest in NaCl solutions for $K_{max} > 9 \text{ MPa}\sqrt{\text{m}}$. For 3.5% NaCl solution, the extrapolation of the fundamental threshold curve intersects the K_{max} -axis for $\Delta K_{th} = 0$ at a value close to the K_{ISCC} for AerMet 100 steel, $25.6 \text{ MPa}\sqrt{\text{m}}$.

The fractography, crack path and crack-tip geometry were also examined for the tests in different environments.

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