

Question 1:

A sample was examined using NDT and found to have a 2 mm long surface crack. The sample material has m and A values of 3.4 and 2.0×10^{-7} respectively for stress in 'MPa' and crack length in 'm' yielding crack propagation rate in 'mm/cycle'. The sample would be repeatedly subjected to a maximum stress of 150 MPa in tension and a minimum stress of 50 MPa in compression.

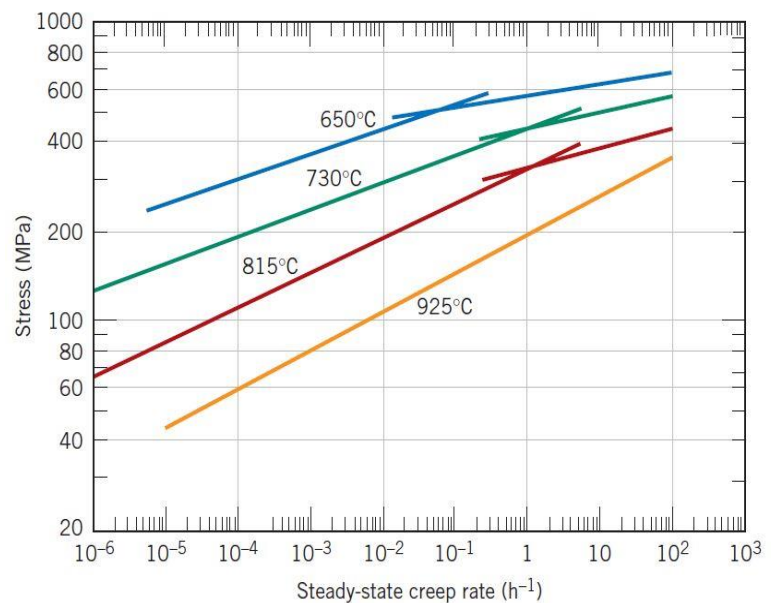
- Determine the fatigue crack propagation rate in mm/cycle for the given stresses.
- Would the crack propagation rate be the same if the sample was subjected to a minimum stress of -20 MPa instead of -50 MPa? Briefly explain.

Assume that the dimensionless parameter Y has a value of 1.5

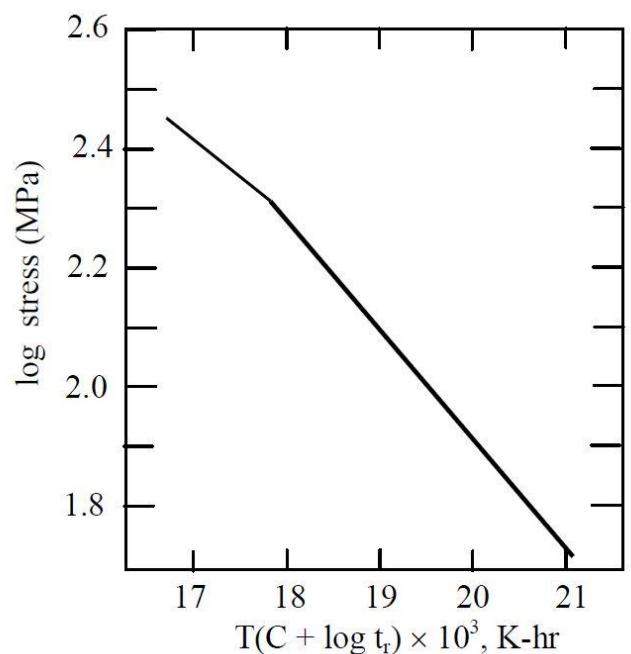
Question 2:

A cylindrical specimen 13.2 mm in diameter of an S-590 alloy is to be subjected to a tensile load of 27,000 N. At approximately what temperature will the steady state creep be 10^{-3} h^{-1} ? Use the data shown in the accompanying figure for S-590 alloy.

Assume the stress exponent, n , to be independent of temperature.

**Question 3:**

A Larson-Miller plot for some hypothetical metal alloy is shown in the following figure. The value of the parameter C is unknown. However it is known that at a stress level of 125 MPa and at 950 K, rupture occurs at 1000 hr. On this basis, calculate the rupture life time at a stress level of 200 MPa and 800 K.



Question 4:

A piece of corroded steel plate was found in a submerged ocean vessel. It was estimated that the original area of the plate was 10 in² and that approximately 2.6 kg had corroded away during the submersion. Assuming a corrosion penetration rate of 200 mpy for this alloy in seawater, estimate the time of submersion in years. The density of steel is 7.9 g/cm³.

Question 5:

(a) Creep is a very slow deformation of materials at elevated temperatures and at stresses well below yield strength. Briefly explain what makes creep different from plastic deformation of metals at room temperature.

(b) What part of a nail after being hammered is more susceptible to corrosion? Assume all parts of this nail are equivalently exposed to moisture. Explain your answer?