In the name of God

Mechanical properties of materials II Homework set 1

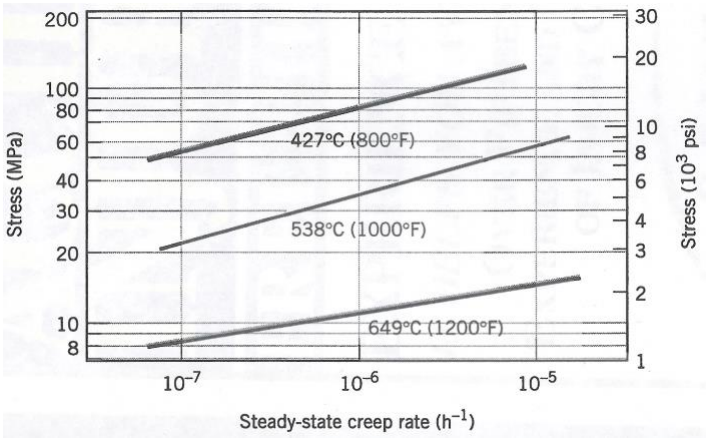
#1 The fracture toughness of Ca-stabilized ZrO_2 ceramic is $K_{IC} = 7.6\left[MPa\bullet\sqrt{m}\right]$. The tensile strength is 140 [GPa].

a) After a non-destructive test of the ceramic found no cracks larger than 1 [mm] in length inside the ceramic part, you can be certain that any crack must be smaller than 1 [mm]. Calculate the lowest stress at which this sample could fail.

b) On testing, the Ca-stabilized ZrO_2 was loaded to the full tensile strength before failure. What is the size of the largest crack that could have been present?

c) Is it possible to detect such a crack? Explain

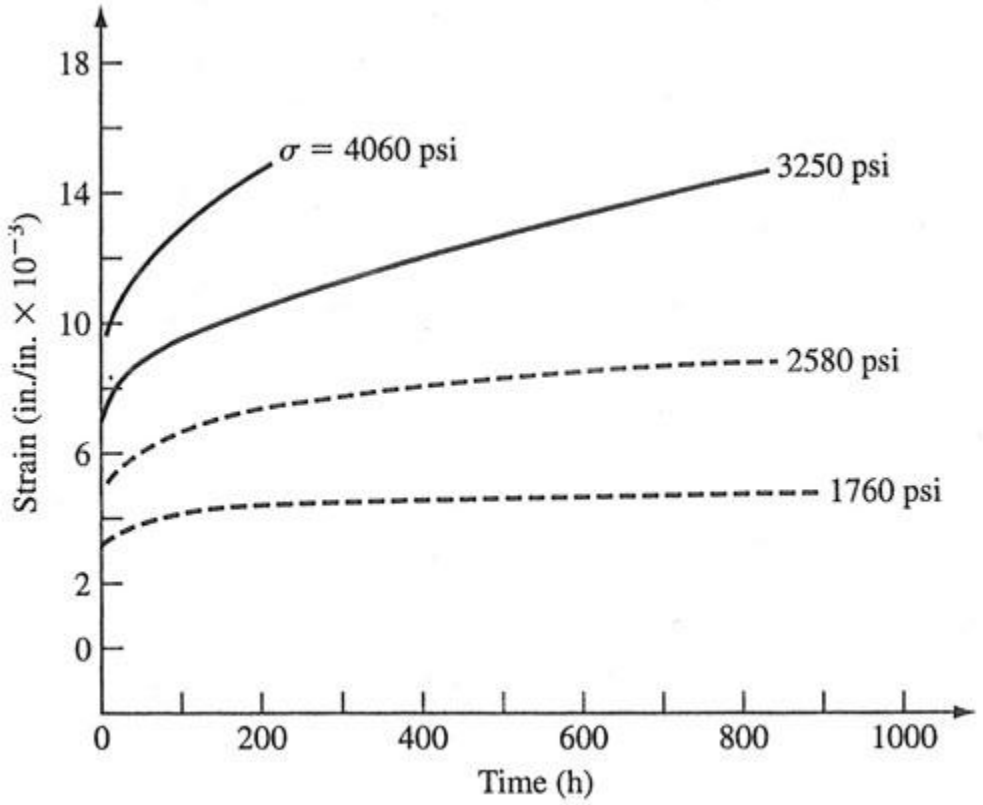
#2 A cylindrical cross section sample of low C- Ni alloy has an initial diameter of 19 [mm] and an original length of 635 [mm]. Testing produces the creep data shown in the plot below.



a) Assume that the sum of the instantaneous and primary creep elongations is 1.8 [mm]. If the maximum total elongation after 2,500 [hours] at 538 [° C] is 17.7 [mm], what is the maximum tensile load on the sample?

b) How much longer would the same bar, carrying the same load from part (a), last at 427 [° C]?

#3 The figure below shows the creep behavior of polystyrene at several different stress levels at a constant temperature of 25 [° C].

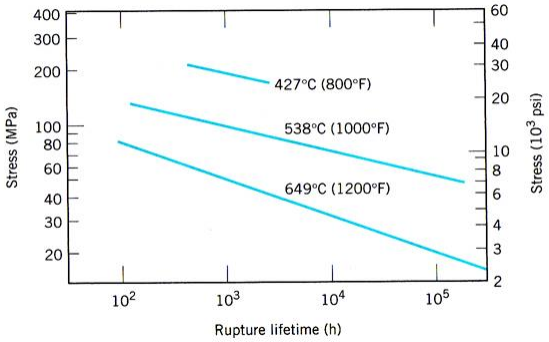


a) Determine the minimum creep rate, in units of [1/s], at an applied stress of 3250 [psi].

b) Polystyrene typically has a failure ductility of about 2% elongation. What would be the expected lifetime for a polystyrene sample loaded in tension as in part (a)?

c) What is the elastic modulus of polystyrene? Explain

#4) a) A square cross section bar constructed from a low-carbon nickel alloy has a size of 20mm on each edge. Using the stress rupture data in the figure below, what is the maximum load that the bar can carry in order to survive for 10,000 hours at 538 ° C?



b) How long would the same bar, carrying the load from part (a), last at 649 ºC

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