Improving the fatigue strength of 7075 alloy through aging

Experience, Personal Experience

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In this article, the properties of 7075 aluminum are studying for varying aging times. 7075 aluminum is an important material in the aerospace industry. Due to the small safety factors used to design aircraft, it is important that the material properties are properly investigated. The properties investigated were hardness, yield strength, tensile strength, elongation, fatigue strength, and precipitation spacing. Correlations were developed between tensile strength and fatigue strength. This is significant because tensile strength and fatigue strength do not always follow a direct correlation.

The general procedure for this study was to age 7075 aluminum at 120 ^{o}C for varying time limits between 8 and 48 hours and record the resulting properties. The samples were obtained from sections of rolled plate with cross sectional dimensions of 4 mm x 6 mm and 5 mm x 7 mm, with respective gage lengths of 35 mm and 15 mm. The samples were aged in an electric heating oil bath furnace and air cooled. Hardness values were determined using Vickers hardness testing with a weight of 200 g and a dwell time of 13 s. TEM images were taken on 3 mm diameter disks to determine precipitate form and spacing. The yield strength, tensile strength, and elongation were found using the standard stress-strain curve method. Fatigue strength was measured using the staircase method.

The number of cycles until failure were observed. Surface observations were performed post fatigue testing to investigate crack initiation points.

Interesting, parabolic relationships were found in the results of this experiment. They discovered that as aging time increased, the precipitation spacing first decreased then increased. The precipitation spacing correlates directly to strength, which first increased then decreased. As commonly observed with metals, the hardness followed a direct relationship with tensile strength. The elongation followed an inverse relationship with tensile strength. Interestingly, however, the fatigue strength increased with aging time for the full range of aging times. Accordingly, the correlation between tensile strength and fatigue strength is parabolic.

This experiment is significant to me because it proves that tensile strength and fatigue strength do not always follow a direct correlation. By applying the fatigue analysis described in most machine design literature, we would have found a maximum fatigue strength in the material aged at 24 hours. Experimentally, the material exhibited the highest fatigue strength after being aged for 48 hours. This study validates the importance of testing to determine fatigue properties. By performing similar studies, engineers can gain insight on the fatigue strength of materials treated at various conditions. Having data to support fatigue numbers allows engineers to decrease weight without reducing their design factors.

References:

1. Leng, L., Zhang, Z. J., Duan, Q. Q., Zhang, P., & Zhang, Z. F. (2018). Improving the fatigue strength of 7075 alloy through aging. Materials Science & Engineering A, https://doi. org/10. 1016/j. msea. 2018. 09. 047