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Investigation on Thermal Fatigue

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Thermal fatigue is not only important practically, but also very interesting scientifically, and many investigators have so far studied on this problem.

This paper will report about the mechanical and temperature factors which are mainly controlling thermal fatigue fracture.

For the purpose of knowing mechanical and thermal influences on the fatigue fracture, the author made various experiments on thermal fatigue tests, changing the constraint conditions at various temperature conditions.

As a results, it was found that under the same temperature conditions the relation between plastic strain range ($\Delta\varepsilon_p$) and number of cycles (N_c) to macroscopic crack does not always independent to stress ranges ($\Delta\sigma$). Though the strain energy per cycle which is related to $\Delta\sigma$ and $\Delta\varepsilon_p$ has been used by some investigators, the author's experiment resulted in the fact that even if strain energy per cycle is the same, N_c depends remarkably upon temperature conditions. Therefore,as an attempt, the author normalizes the temperature dependence of strain energy contributing to fatigue failure by using the following relation

$$\delta U^* = C'(T, t)\ \delta U$$

and re-arranges the original experimental data through the effective energy per cycle represented by the following equation

$$U^* = A \oint_T e^{-\frac{C}{T}}\ \sigma \frac{d\varepsilon(T)}{dT} dT$$

Thus, an interesting result was obtained, that for the same U^* the macroscopic crack initiates under same numbers of cycles, independent on temperature conditions.

For 18-8-T_i stainless steel used in present experiments the following relation between U^* and N_c was held;

$$(U^*/A)\ N_c^{0.49} = 3.31 \times 10^{-2}$$

U^* : Kgmm/mm^3

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