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DISCUSSION

H. O. Fuchs [1] (*written discussion*)—Please explain the significance of ΔK_0.

R. L. Tobler and Y. W. Cheng (*authors' closure*)—An ideal fit to Eq 2 means that the da/dN-versus-ΔK curves for a given body of data will intersect at the pivot point (A, ΔK_0). Then if the data conform to Eq 2 independently of test temperature, the da/dN curves will intersect and fan out as a function of n, as Fig. 14 indicates.

In practice, however, data collections for alloy systems invariably show numerous examples of specific materials with da/dN curves that fail to intersect at the calculated "pivot points". Under these circumstances Eq 2 only approximates the entire data base, which contains nonconforming material behaviors, and the pivot point becomes a measure of the center of gravity of the data scatterband.

Given a linear correlation between log C and n, there are at least two implications of significance. First, it is implied that the power-law constants reduce to one independent variable, C or n; this justifies seeking correlations with other properties using n alone, as in the text. Second, it is implied that alloys with high n values offer superior fatigue crack growth resistance compared to alloys with low n for $\Delta K < \Delta K_0$, whereas the opposite is true for $\Delta K > \Delta K_0$. In other words, low n is desirable at high ΔK, whereas high n is desirable at low ΔK. Optimum alloy selection therefore depends on the ΔK range of engineering applications.

In the text, we were careful to emphasize that judgments concerning the relative merits of individual alloys based on pivot point calculations must be interpreted with caution in view of the approximate nature of such representations.

H. S. Reemsnyder[2] (*written discussion*)—The authors have fitted the simple power equation

$$da/dN = C\,(\Delta K)^n \tag{4}$$

to their crack growth rate versus ΔK data through the determination of the regression parameters C' and n in the linear equation

$$y = C' + nx \tag{5}$$

where C', y, and x are the logarithms of, respectively, the parameters C,

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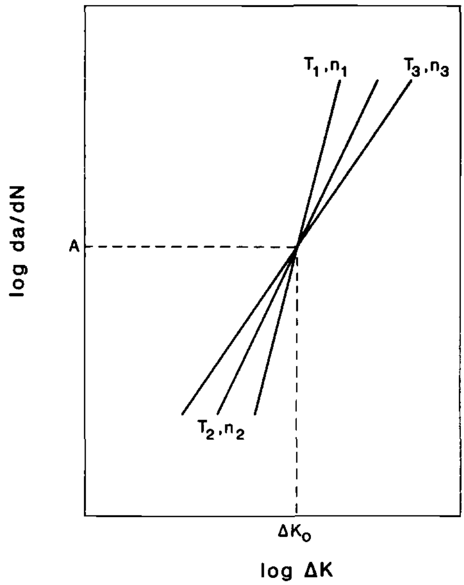

FIG. 14—*Explanation of pivot point.*

da/dN, and ΔK. In such a regression, the parameters are *always* related by

$$C' = y_0 - nx_0 \tag{6}$$

where x_0 and y_0 are the mean values of x and y, that is, the coordinates of the center of gravity of the data to which Eq 2 is fitted. Expressing Eq 6 in a form analogous to Eq 4 results in

$$C = (da/dN)_0 \, (1/\Delta K_0)^n \tag{7}$$

where the subscript 0 denotes the antilogarithm of the mean of the logarithms of *da/dN* and ΔK. In other words, the authors' parameter A is nothing more than the antilogarithm of the mean value of the log (*da/dN*) values for a given material-temperature combination.

If one were to draw many sample sets of x,y from a population of x,y, determine the regression parameters C' and n (Eq 5) for each sample, and plot C' versus n, a scatter diagram would result with variability in both the C' and n (that is, vertical and horizontal) directions. Therefore, when one is plotting C' versus n for various material-temperature combinations, one should recognize that apparent trends reflect, to some undefined extent, sampling variability and not necessarily real relations among fatigue crack growth, material, and test temperature.

In conclusion, there is nothing subtle about the correlation between C and *n*, which is instead intrinsic to regression parameters. Perhaps multivariate regression analysis would yield an empirical model relating crack growth, material (composition), and temperature that is superior to the present scheme—for example, fitting a simple power relation to each data set and then seeking relations between the regression parameters and experimental factors.

R. L. Tobler and Y. W. Cheng (authors' closure)—We appreciate your helpful suggestions and points of clarification.