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Technical Notes

Hydrogen Elimination by Aging

by C. E. Sims

IN an earlier paper by Sims, Moore, and Williams,¹ data were given to show that hydrogen contents of 0.3 relative volume (0.00033 wt pct), existing at the center of 4-in.-square cast-steel coupons, could be removed by aging at 400°F for 125 hr. At the end of that time, complete restoration of normal ductility for the steel was obtained. Replicate specimens of the same steel were aged at room temperature up to 555 days or 18½ months. At the end of that time, the hydrogen content at the center had fallen to 0.13 relative volume or 0.00015 wt pct, but there was no perceptible change in the ductility.

On the basis of experience with accelerated aging of 1-in. and 4-in. coupons and room temperature aging of 1-in. coupons, it was predicted that, some time after two years and when the hydrogen content has been reduced to about 0.10 relative volume, there would be some recovery of ductility. One set of three bars remained, and these were held for 1310 days, or more than three years. Then tensile test bars were cut from the center, and these bars were sampled for hydrogen analysis at the time they were broken. The sample specimens were cylinders ⅝ in. in diam x 1¼ in. in length. The data showed that in this time the average hydrogen content had fallen to 0.096 relative volume or 0.00011 wt pct, and the ductility had increased sharply. Elongation had risen from 10 to 17.3 pct, while reduction of area increased from about 16 to 27.5 pct. On the basis of these data, fig. 1 was drawn to replace fig. 15 of the earlier paper. Extrapolation of the curves of fig. 1 indicates that it would require a period of about 2200 days or approximately six years at room tem-

Fig. 1—Change in hydrogen content and ductility with time for center of 4-in. coupons aged at room temperature. Data plotted are averages of three tests.

perature to reduce the hydrogen to the minimum value and to recover full ductility in the center of the coupons.

The aging process apparently involves the movement of hydrogen from the interior to the surface of the bar and evaporation at the surface. This flux of gas presumably follows some diffusion mechanism, and an effort was made to use the aging data, obtained at room temperature and at 400°F, to calculate coefficients of diffusion, in the hope that they might indicate the nature of the diffusion. The conclusion was reached, however, that the data were inadequate for such a purpose.

C. E. SIMS, Member AIME, Battelle Memorial Institute, Columbus, Ohio.

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