Abstract

"Ultrasonic Characterization of Hydrogen Induced Stress in 4140 Steel"

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L_{CR} ultrasonic waves are a tool that offers considerable potential for nondestructively evaluating reversible hydrogen buildup in steels since their travel path is through a layer just below the surface, and their speed is affected by stress. This study used three blocks of 4140 steel cut from a longer sample. Two of the blocks were subjected to hydrogen environment (48 hours at 850^0 F and 1691 and 2061 psia, respectively). The third block was held as a control block. After removal and cooling at 100^0F/hour, the blocks were analyzed using L_{CR} velocity measurements over an 80-day period. Frequency spectrum data also were collected. The assumed model was of hydrogen occupying the vacancies in the steel block during the high temperature high-pressure period in the autoclave, and then being purged upon removal as the block contracted, creating a residual tensile stress in the block. As the hydrogen is purged, the tensile stress should decrease. The L_{CR} results confirmed this trend, although it was more strongly seen for the 1691 psia block. Photomicrographs confirmed no cracks in the surfaces, although there was considerable decarburization. Frequency analysis showed that the decarburization did not affect the L_{CR} wave speed.

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