NON-DESTRUCTIVE EVALUATION OF HARDNESS OF STEEL THROUGH ULTRASONIC ATTENUATION USING ULTRASONIC FLAW DETECTOR

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Abstract

This research is focused on establishing a correlation between hardness which is one of the most important material property and ultrasonic attenuation in steels with the intention of developing a method to asses the hardness of steel using attenuation measurements using an ultrasonic flaw detector. The conventional methods that are used to determine the mechanical properties such as hardness not only cause impairment to a certain extent to the materials tested, but also require special sample preparations in most instances. Further, it is obvious that such methods cannot be used on finished products. As ultrasonic testing is non-destructive, using such a technique in the measurement of hardness would be a great advantage for those who need to do so.

In this research work five types of steels namely AISI 1045, AISI 4340, AISI 4140, AISI 4142 and AISI 01 were selected. Cylindrical specimens were prepared and subject to various heat treatment processes in order to vary the hardness. Attenuation coefficients were determined using an ultrasonic flaw detector and hardness values were obtained with a Vickers hardness tester.

The work carried out showed a linear variation in the attenuation coefficient with the hardness values of for all the types of steels used. The relationship between attenuation coefficient (a) and hardness (H) of quenched and tempered steels can be generalized as $a = f\,S\!H$, where 'f' is the frequency of the ultrasound used and 'S' is a factor that depends on the composition of steel. The relationships obtained for AISI 4140, AISI 4142 and AISI 01 steels were α=4xO.0245xH, a=4xO.024~xHand a = 4 x 0.0 152 x H respectively, when the frequency of ultrasound used was 4MHz.