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Correlation of ultrasonic echo amplitude with flaw depth and probe angle in Non Destructive Testing of metals

Ultrasonic waves are effectively used for the testing of metals and can be categorized as one of the most important non-destructive testing method for materials. An ultrasonic sound beam is generated by an electronic device and transmitted through a probe to the metal. The wave will be propagated through the metal, reflected by internal defects, known as flaws and returned to the probe. By calculating the time of propagation of the beam the depth of the flaw from the surface can be determined. During traveling through the metal the ultrasonic beam losses certain amount of its energy. This loss of energy, known as attenuation, is due to absorption and scattering in the material, which are influenced by the characteristics of the material. The other important parameters that affect the attenuation are beam divergence and flaw parameters such as type, size and orientation of the flaw to the axis of the beam.
The aim of this work was to find a way to eliminate the influence of material parameters, such as absorption and scattering on the flaw echo amplitude and to develop a correlation between echo amplitude and flaw depth for different probe angles to the testing surface.

To achieve these objectives flaw parameters were kept constant by using artificial defects, which were circular type side-drilled holes that had the same size and orientation. Echo amplitudes were measured with respect to 20% Distance Amplitude Correction (DAC) level by changing the depths of the flaws. Three different probes with angles of 45°, 60° and 70° were used.

From the observations it is concluded that attenuation loss could be eliminated by correcting for the test material parameters due to depth variations, which is dependent on signal amplitude. Observing echo amplitude of the flaw for different depths with respect to 20% DAC level is a successful way to achieve this objective. It was also concluded that the echo amplitude with respect to 20% DAC level from a side-drilled hole (circular type) is not affected by the probe angle and it was 20±1 dB for all probe angles tested. If the amplitude difference with respect to this level for an unknown defect is 20±1 dB for the three-probe angles 450, 600 and 700 , the flaw is identified as a side drilled hole.