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Ultrasonic Study for the Flaw Detectability in Ferritic Butt Welds at High Temperatures

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Abstract

Ultrasonic testing is one of the powerful tools for condition monitoring and in service inspection of critical welds in thermal and nuclear power plants. Normally the testing is carried out at ambient temperatures during shut down. However there are number of occasions wherein the ultrasonic testing of the welds has to be performed at elevated temperatures or in areas where the temperature is not controlled. The components under examination might be carrying fluid /steam at temperatures ranging from 50 °C to 500 °C. Unfortunately there are many problems associated with testing of welds at high temperatures. There are various factors that affect the ultrasonic test results at high temperatures. The temperature changes cause ultrasonic velocity changes, which in turn causes a change of beam angle thereby improper location of the defects. The testing of welds at high temperatures requires highly specialised and costly transducer for continuous scanning, which are not easily available. In the absence of such transducers an attempt has been made by the authors to examine the welds in the high temperature zone up to 300 °C by using conventional angle beam probes and scanning from the region (beyond 5th V path) at ambient temperature. The experimental study involved embedment of natural defects like cracks, incomplete penetration, porosity etc., in the ferritic butt weld (16 mm thickness) at predetermined locations. The comparative study was carried out between the responses obtained from the defects at ambient temperature and elevated temperatures. An innovative method was adopted to restrict the weld zone at high temperature and testing from the cold zone. This permitted the use of conventional angle beam transducers. The analysis of the results have shown that the attenuation of ultrasound increases as the temperature at the weld zone increases. However up to 100 °C there is a variation of maximum 1.5 dB whereas above 200 °C there is a significant variation in signal amplitude ranging from 3dB to 6 dB compared to the amplitudes at ambient temperatures. The signal amplitude at elevated temperatures also varied for different defects. (For example, 3 dB for cracks and 5 dB for porosity and 6 dB for incomplete penetration).

This paper describes the problems encountered during ultrasonic testing of welds at high temperatures, the overall assessment of sound propagation at high temperatures and a technique to circumvent the problems using the conventional probes. It can be seen from the results of the experiments that by making the attenuation corrections at elevated temperatures it is possible to inspect the welds below 300 °C without substantial performance loss at test frequencies less than 4 MHz.