Continuous Wave Ultrasound Testing Techniques

Krassimir Stoev[1], Teguewinde Sawadogo[2]

[1]Inspection and Monitoring Technolohies, Canadian Nuclear Laboratories, Canada, [1]FE, Canadian Nuclear Laboratories, Canada

Currently, the primary method employed for ultrasound inspection is based on sending and detecting ultrasound pulses. Typically, pulse-based methods are essentially time-domain back-reflection methods, and the time-of-flight is the main measured parameter. Recently, continuous-wave methods have been developed in the radar and the fiber optics fields, which demonstrate significantly better spatial resolution, higher signal-to-noise ratio, and ability to detect reflecting objects at very short distances. It is proposed to use the same approach to develop continuous-wave ultrasound inspection systems. The two main differences between the proposed continuous-wave ultrasonic testing and the classical pulsed ultrasound inspection method are: (i) in the continuous-wave ultrasonic testing method, the transmitted and received signals overlap in the time domain, while in the pulsed ultrasound inspection method the transmitted and received signals are separated in the time; and (ii) in the pulsed ultrasound inspection method the most important parameter is the time delay between the transmitted and received signals, while in the continuous-wave ultrasonic testing method the most informative parameters are the frequency and phase changes in the received signal in respect to modulated transmitted signal. This allows for additional flexibility in the continuous-wave ultrasonic measurements, because we can control the frequency modulation. Also, the continuous-wave ultrasonic method can potential offer improved detection range and detection resolution, improved signal-to-noise ratio based on better use of signal energy and the possibility to filter only the useful frequency of the signal, reduced requirements on the voltage applied to the transducer, and possibilities to use simplified low-cost electronics. The theoretical basis of several continuous-wave ultrasound inspection technique will be explained, and the advantages and limitations of these techniques will be discussed. Implementation of several prototype continuous-wave ultrasound testing systems will be presented. Examples of the use of the systems for non-destructive testing will be described