A Performance Study of Various Piezoelectric Crystals based Through Wall Data Communication Systems at Elevated Temperature

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The capability to communicate through thick metal walls without physical penetration has great potential applications in hazard environments. Traditional wireless techniques are ineffective at communicating through metallic enclosures because of shielding effect of electromagnetic signals and piezo behavioral changes at high temperature. Acoustic communication techniques using ultrasound eliminate the need for such feedthroughs.

This paper presents a performance study of ultrasonic through wall data communication system designed using different types of piezoelectric crystal. The traditional one to one data communication technique is established by attaching two piezo transducers to the 75mm thick metallic wall. The first transducer transmits a ultrasonic wave into the wall. The second transducer is mounted on the opposite side of the wall receives the transmitted signal. 5 MHz ultrasonic frequency is used to send data across solid walls. Four types of piezo crystals likely: PZT (Lead zirconate titanate), PVDF (Polyvinylidene fluoride), and commercial-available ultrasonic transducer are taken for high temperature through wall data communication analysis. The entire ultrasonic system with piezoelectric crystal is placed inside the high temperature oven and temperature is varied from 0 to 120^0C. As an initial comparison analysis, normalized pulse echo output voltage Vs time with respect the various temperature is measured experimentally for all three type piezo crystals. The entire ultrasonic data communication system is modeled in the electrical domain by means of electro-mechanical analogies and results were compared with experimental analysis. The proposed study is very much useful in high temperature ultrasonic through wall data communication application (especially nuclear reactors).