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Optimizing the Design Parameters of Acoustic Power Transfer Model to Achieve High Power Intensity and Compact System

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Abstract : The need for bio-implantable devices in the field of medical sciences has been increasing day by day; however, the charging of these devices is a major issue. Batteries, a very common method of powering the implants, have a limited lifetime and bulky nature. Therefore, as a replacement of batteries, acoustic power transfer (APT) technology is being accepted as the most suitable technique to wirelessly power the medical implants in the present scenario. The basic model of APT consists of piezoelectric transducers that work on the principle of converse piezoelectric effect at the transmitting end and direct piezoelectric effect at the receiving end. This paper provides mechanistic insight into the parameters affecting the design and efficient working of acoustic power transfer systems. The optimum design considerations have been presented that will help to compress the size of the device and augment the intensity of the pressure wave. A COMSOL model of the PZT (Lead Zirconate Titanate) transducer was developed. The model was simulated and analyzed on a frequency spectrum. The simulation results displayed that the efficiency of these devices is strongly dependent on the frequency of operation, and a wrong choice of the operating frequency leads to the high absorption of acoustic field inside the tissue (medium), poor power strength, and heavy transducers, which in effect influence the overall configuration of the acoustic systems. Considering all the tradeoffs, the simulations were performed again by determining an optimum frequency (900 kHz) that resulted in the reduction of the transducer's thickness to 1.96 mm and augmented the power strength with an intensity of 432 W/m^2. Thus, the results obtained after the second simulation contribute to lesser attenuation, lightweight systems, high power intensity, and also comply with safety limits provided by the U.S Food and Drug Administration (FDA). It was also found that the chosen operating frequency enhances the directivity of the acoustic wave at the receiver side.

Keywords : acoustic power, bio-implantable, COMSOL, Lead Zirconate Titanate, piezoelectric, transducer
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