**On the Magnetic Design of High Temperature Electromagnetic Acoustic Transducers**

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ABSTRACT

The use of Electromagnetic Acoustic Transducers (EMAT’s) is attractive due to their non-contacting transduction, allowing them to be easily installed on engineering assets and work through coatings. Additionally, the non-contacting nature is particularly important on safety critical assets where EMAT installation is considered to be minimally intrusive. Many engineering assets operate at elevated temperatures where there is a risk of a range of thermally activated damage mechanisms, and consequently it is necessary to design EMAT’s that withstand the operating temperatures. This paper will focus on the design of permanent magnet EMAT’s.

Frequently, EMAT’s are designed to maximize the bias magnetic field, to achieve compact designs, or to achieve particular targeted ultrasonic modes; unfortunately, such designs may be vulnerable to, or even promote, reversible and irreversible magnetic losses. In this study the importance of considering the magnetic design to avoid reversible and irreversible magnetic losses associated with high temperature exposure is highlighted. The magnetic design constitutes the geometry of the magnet, the configuration with respect to neighboring magnets (as in with permanent magnet arrays), and ferromagnetic materials in the vicinity of the magnet (including the material under test).

The basic theory of irreversible magnetic losses and analytical methods to estimate magnetic losses are presented, together with the resulting design guidelines. The analysis also highlights desirable attributes for the selection of magnetic materials. Experiments have been carried out to illustrate the theory and a variety of prototype permanent magnet EMAT’s are tested to further elucidate the importance of magnetic design on temperature tolerance; significantly improved temperature tolerance capabilities are shown to be achievable by considered magnetic design. Experiments conducted on Neodymium magnets and specialist high-temperature magnets will be presented. Other factors that may be beyond the EMAT engineers control such as the operating environment and test medium are also important and given consideration.