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Study of Metal Magnetic Memory (MMM) Technique Using Permanently Installed Magnetic Sensor Arrays

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The Metal magnetic memory (MMM) technique is marketed as a non-destructive testing method to evaluate stress concentration for ferromagnetic materials by measuring variations of the self-magnetic leakage field (SMLF) distribution on the specimen surface. This method has been implemented as a periodic screening inspection tool by several companies, and has been reported to be capable of detecting stress concentration in some instances. However, recent literature has suggested that the performance can be unreliable, with many false-calls; however, the reason for the false calls has not been satisfactorily investigated. In this paper, the normal and tangential components of the stress induced SMLF on the surface of specimens made from L80 steel, which is commonly used for pipes in the petrochemical industry, were measured by two permanently installed magnetic sensor arrays under the earth's magnetic field. The results show that the SMLF changes are very small (about 10 ~ 30 A/m) in all cases for the material tested and occur mainly in first elastic load cycle. A Finite Element (FE) model has been used to predict the spatial distribution of the magnetic field due to localized MMM. The FE studies show that the defect size and the applied background magnetic field will influence the SMLF signal; however, the signal due to MMM could be swamped by any ferromagnetic material near to the magnetic sensors. The simulation and experimental results demonstrate the high probability of false calls with the MMM technique even if there were a significant MMM effect in the material used.

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