Carbon Steel Pipeline Wall Thickness Measurement Using Pulsed Eddy Current Technique

Suvadip Roy[1],T.V Shyam[2],B.S.V.G Sharma[2],S.K Pradhan[1]
1. Atomic Energy Regulatory Board
2. Bhabha Atomic Research Centre

Introduction: Wall thinning of Carbon Steel(CS) Pipelines called "**Feeder Pipelines**" used in Primary Heat Transport Systems of Pressurized Heavy Water Reactors (**PHWR**) due to Flow Accelerated Corrosion (FAC) is a common daily phenomenon. The work started with a motive of designing an Electromagnetic Sensor which can be used during In - Service Inspection (ISI) of the PHWR's to monitor the wall thickness of the (CS) Carbon Steel Feeder Pipes.

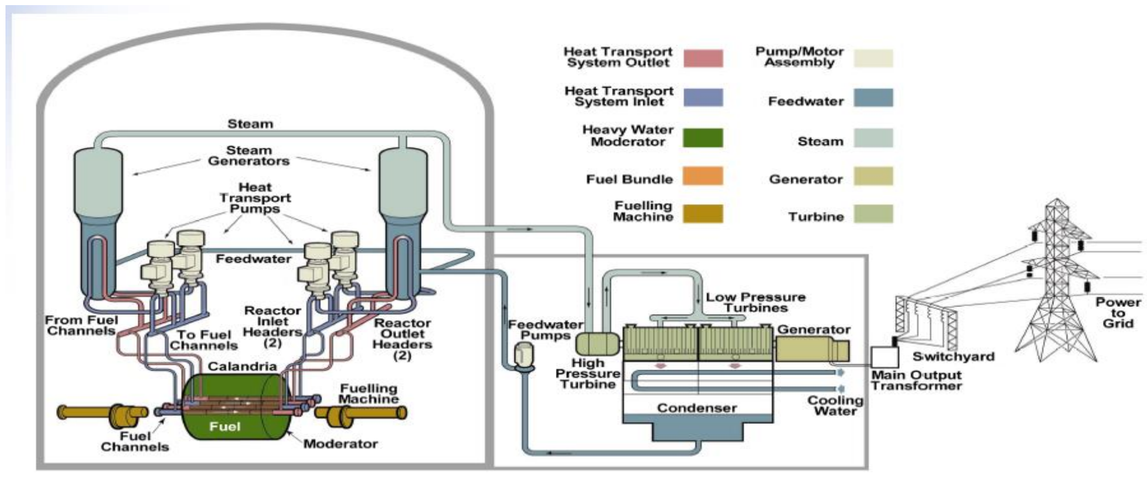

Figure 1: Structure of PHT system of PHWRs

Computational Methods :Pulsed Eddy Current Technique (PECT) has been used to design the sensor. The sensor has two coils , one Excitation and one Receiver (internal) and a Ferrite core. AC/DC module has been used to design the sensor & Coarse Tetrahedral Meshing has been used. A Pulsed Current Source (rect1(t)) has been used as an input to the Excitation coil. The pulsating current has on-time of 10 ms (0.010s) which has been chosen depending on the time constant of the excitation coil. The optimization of the coil parameters like number of turns of coils, size of sensor ,size of Ferrite core to get the desired response has been done using COMSOL Multiphysics®. Moreover the effect of "**LIFT Off**" on the response curves have also been studied.

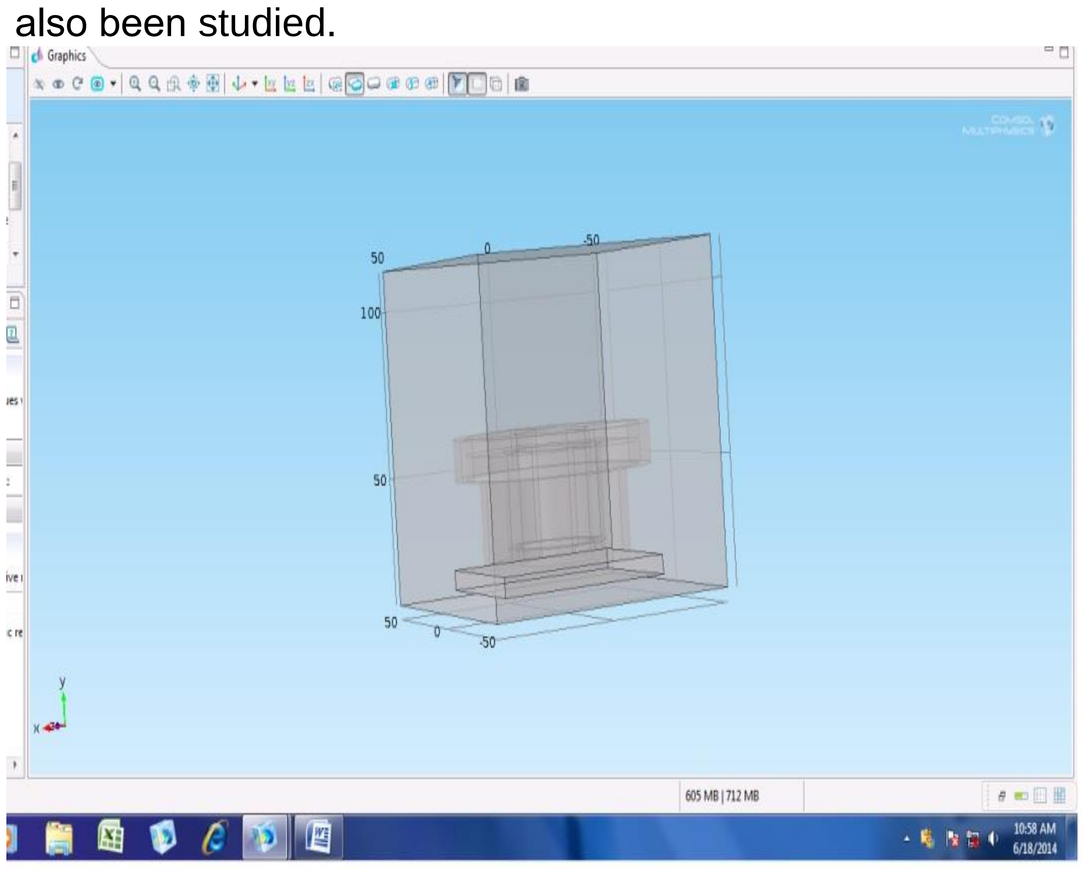

Figure 2 :The 3-D Computational Model.

Results : The Logarithm of voltage induced in the Receiver coil due to net difference in magnetic field of Excitation coil and from the specimen is used as the attribute in finding the thickness of specimens. The **Decay Coefficient** defined as inverse of the Decay rate of waveforms is used to distinguish between thickness of various CS specimens.

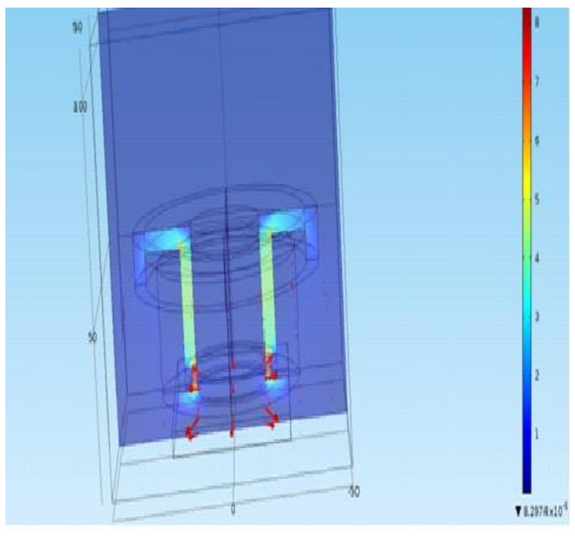

Figure 3 : Magnetic Flux Distribution

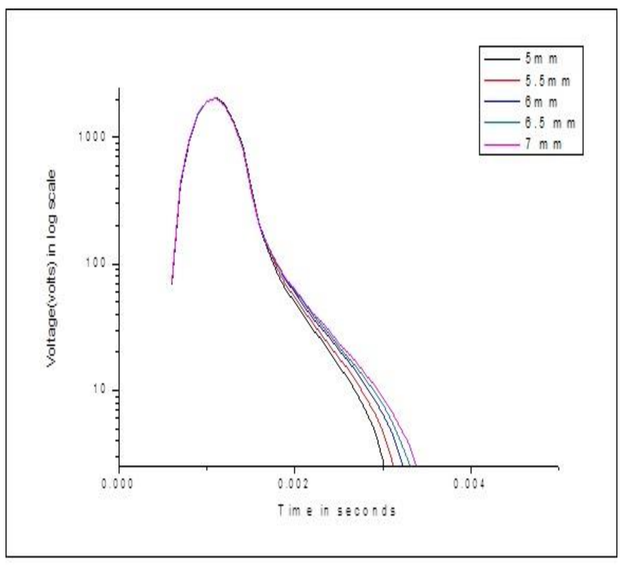

Figure 4 : Decay Curves

Conclusion: It was found out that the **Decay Coefficient** showed an increasing trend with thickness of the Carbon Steel specimens . So , if the Decay coefficients for a specific thickness is known from beforehand then during ISI from the decay coefficients the Thickness of the specimens can easily be correlated. Moreover it was found that with increase in **Lift – Off** up to 0.5 mm there is no significant effect of the Decay waveforms. The Resolution of the sensor was found to be **300 microns**.

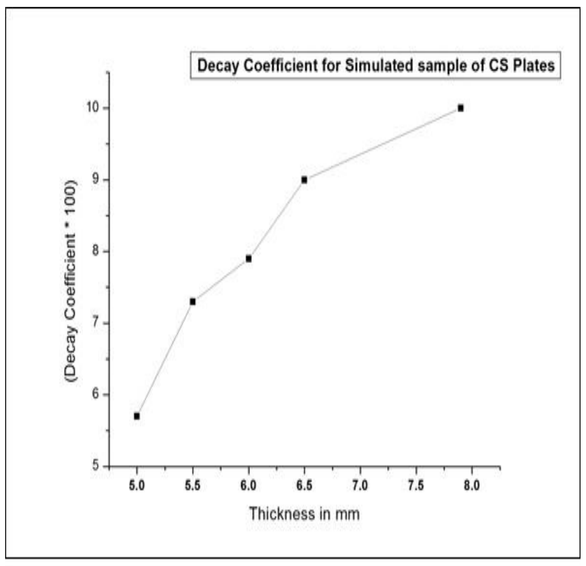

Figure 5 : Decay Coefficients

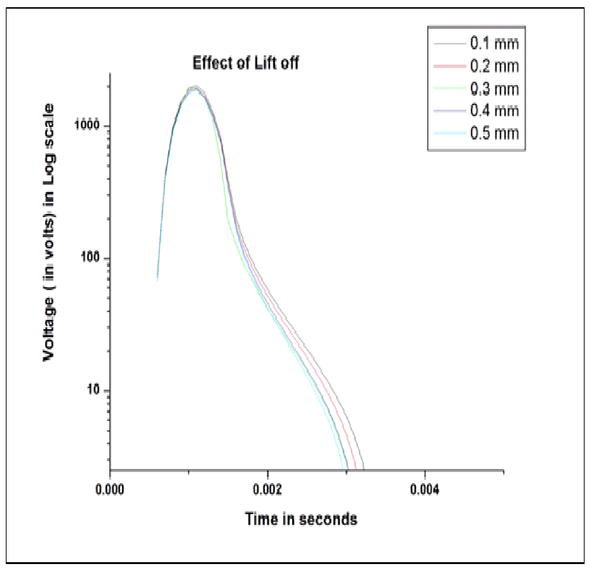

Figure 6 :Effect of Lift - Off

References :
1. Vijay. K. Babbar , Paul.P.Whalen , " Pulsed Eddy Current Probe Development to detect cracks in Innner Layer Fasteners using COMSOL" Proceedings of COMSOL Conference Boston , 2010
2. Evan Westrate **, "** COMSOL Multiphysics Modeling For Design of Eddy Current Crack Detectors" , Proceedings of COMSOL Conference Boston , 2010