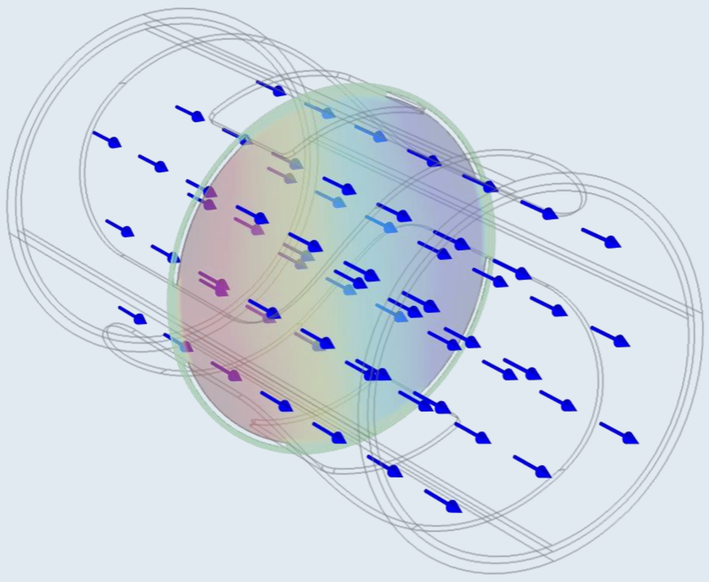

Electromagnetic flowmeter coil design

Optimizing coil design of the electromagnetic flowmeter for superior performance.

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1 ABB

Abstract

Working on the principal of Faraday's law of electromagnetic induction [1], the electromagnetic (EM) flowmeter measures flowrate of conducting fluids like water, based on the generation of induced electric potential within the fluid resulting from its interaction with an imposed magnetic field. The performance or signal quality of the meter is primarily dependent on the strength of the magnetic field generated by the coils [2]. Hence optimizing the design of the coils is of paramount importance in the overall design of the flowmeter. COMSOL multiphysics software was used to develop a high-fidelity model of the electromagnetic flowmeter. The model was validated with experiments and used to evaluate the efficacy of several modified coil designs. Based on the computed signal quality, the best coil design, was selected for fabrication and test verification. Testing revealed a significant 12% improvement in the signal strength of the flowmeter. Due to the project the largest flowmeter of diameter 3 m, was supplied to an important customer.

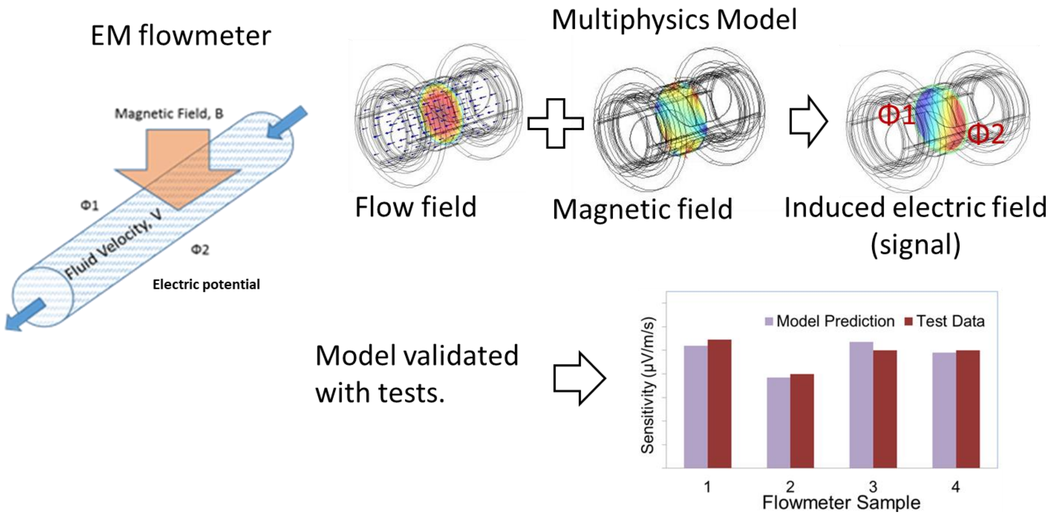

FIGURE 1: Left: Working principle of EM flowmeter
Right: Multiphysics modeling of flowmeter and validation

Methodology

Using the COMSOL multiphysics code, a multiphysics model of the EM flowmeter was developed. The geometry of the flowmeter was replicated and meshed. Relevant equations were solved in steady state. The model solved the fluid flow and magnetic flux fields within the domain and then computed the induced electric potential based on which which the flowrate is measured. The primary equation which solved the interaction between the magnetic and flow fields is the Lorentz force equation:

$$J_i = \sigma E + \sigma u \times B$$

The model was validated using test data (> 95% agreement with tests)

Results

Using the validated flowmeter model, several coil designs were proposed and simulated. The original coil was elliptical in shape. The coil shape and size which yielded the maximum magnetic field strength and generated the maximum signal was selected for fabrication and testing. Testing revealed a 12% increase in the overall signal strength of the flowmeter.

The modified coil was rectangular in shape, and was incorporated in the largest EM flowmeter of diameter 3 m. This was supplied to an important customer of ABB.

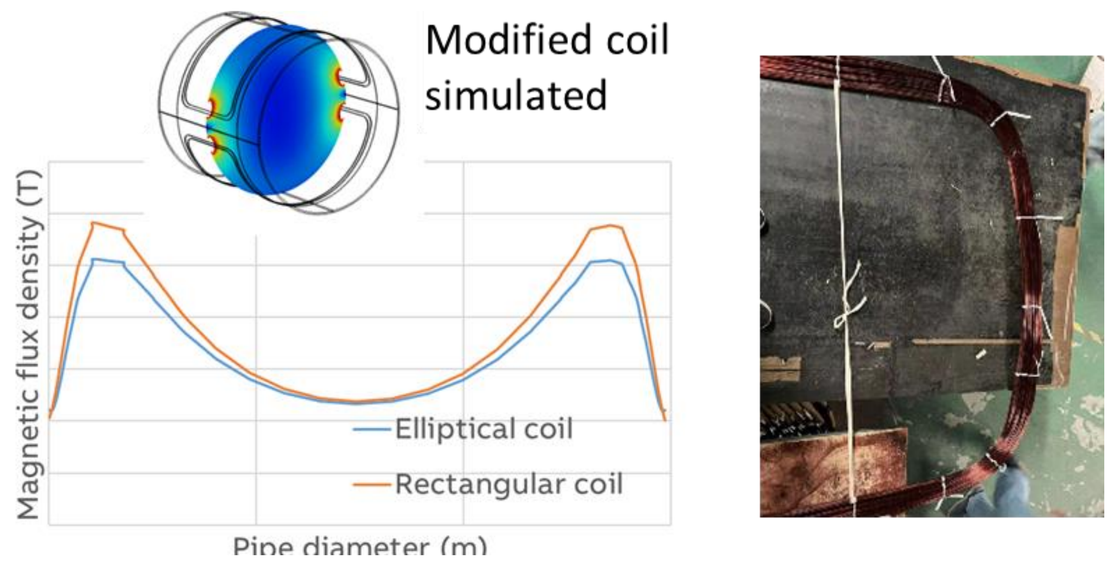

FIGURE 2: Left: Modified coil simulated showed increase in field strength. Right: Coil fabricated for testing. Almost 12% increase in signal found.

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[1] J.A. Shercliff. "The Theory of Electromagnetic Flow Measurement." Cambridge University Press. 1987.

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