

Modeling of Lorenz Force Flowmeter for Molten Metal Flow Application

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Abstract

Flow measurement of molten metals is a formidable task considering the hostile conditions. Many electromagnetic methods have been evolved for measurement of flow of conductive medium. The Lorenz force velocimetry is promising considering its non-intrusive nature. The Lorenz force velocimetry is an electromagnetic flow measurement method that is based on exposing molten metal flow to a static magnetic field, and indirectly measuring the braking force (due to the eddy currents generated in the moving metallic flow medium) experienced by the static magnetic system by means of strain gauge. This braking force is proportional to the velocity of the flowing medium.

In 1832 Michael Faraday attempted to determine the velocity of the Thames River. Faraday's method was based on exposing flow to a magnetic field, and measuring the induced voltage using two electrodes; which has evolved into a successful commercial application known as the inductive flow meter. As inductive flow meters were intrusive in nature, they posed problems due to contact of electrodes with the flowing molten metal medium. The other type of electromagnetic flowmeter is eddy current flow meter which measures flow-induced changes in the electric impedance of coils interacting with the flow.

In this paper, it will be dealt with design methodology of a model of Lorenz Force Flow meter for molten metal application. The molten Lead - Bismuth eutectic mixture, which is proposed to use as coolant for High Temperature Reactor is considered as flow medium for the model. As the braking force experienced is very feeble, the design should be capable to generate sufficient enough strain which can be measured using commercial strain gauges. Magnetic flux density distribution in Horse Shoe type Lorenz force flowmeter is shown in Figure 1. The pattern of eddy currents formed in molten flow medium is shown in Figure 2.

Key words: Lorenz force, velocimetry, Lead - Bismuth eutectic

Reference

P. A. Davidson, An Introduction to Magnetohydrodynamics (Cambridge University Press, Cambridge, 2001).

Figures used in the abstract

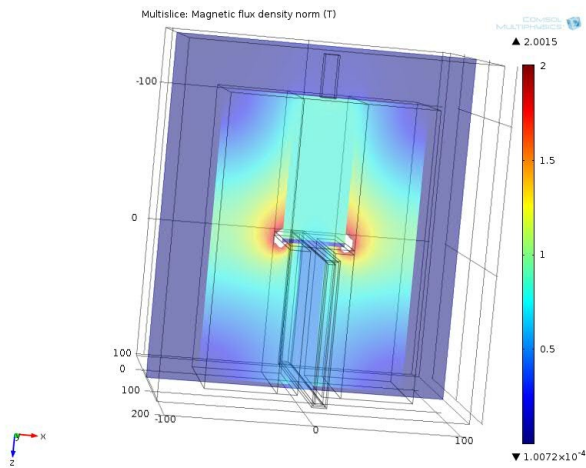


Figure 1: Horse Shoe model of Lorenz Force Flowmeter

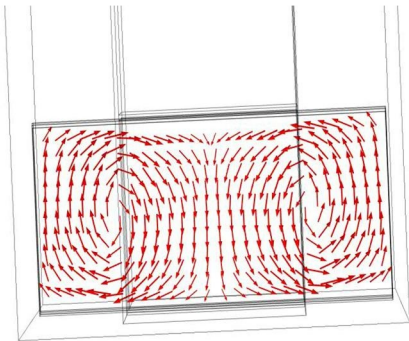


Figure 2: Current Eddies formed in Flow medium