Study on Design of Electromagnetic Flow meter

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Abstract

Electromagnetic flow meter by measuring the varying of magnetic flux, which is related to the velocity of conductive flow, can measure the rate of fluids very carefully and precisely. Electromagnetic flow meter operation is based on famous Faraday's second Law. In these equipments, the constant magneto-static field is produced by electromagnet(winding around the tube) outside of pipe and inducting voltage that is due to conductive liquid flow is measured by electrodes located on two end side of the pipe wall. The fundamental concept to design the electromagnetic flow meter, exciting winding and simulations will be shown by figures ,simulation graph re presentation for better understanding and improvement.

Keywords: *Electromagnetic Flow Meter, Induction Voltage, Finite Difference .*

Introduction

ELECTROMAGNETIC flow meters rely on the Faraday principle, that works with Emf which generated by changing on magnetic flux density. The magnetic field produces by exciting wire in two kinds of DC and A Cexcitation systems. Therefore, induced voltage between electrodes calculated by simple equation $E = B \cdot d \cdot \upsilon \ m$, that illustrate the operation of an electromagnetic flow meter that based on the Faraday's law. In above equation, B is magnetic flux density, d is length of conductive which is equal to diameter of the pipe and m υ is mean flow velocity[1]-[3], [6] , [5]

By selecting constant magnetic field, the magnetic potential is directly proportional to transposed velocity of flow[1]-[5], [10]. For measuring of difficult fluid velocity such as slurry, melting material and special liquid by electrical conductivity is useful. In [1],[5], [6] a primary design is presented by the form of a two-dimensional weight function, that shows profile the velocity-to-voltage signal ratio of flowin cross-section pipe.
The operation of electromagnetic flow meter by circular cross-section is presented in [3], [8]-[9], in comparison with rectangular cross-section or open channel on which the induced voltage is independent from the distribution of fluid velocity [6]-[7], [11].

In this paper we are going to study about design and modelling of electromagnetic flow meter with homogeneous magnetic field and effective velocity of fluids on induced voltage. Also representation of operation of EM flow meter, effects of fluid conductivity coefficient and effective of the fluid level in pipe on induced voltage.

2.GENERAL OPERATION PRINCIPLE OF EM FLOW METER

The operation of electromagnetic flow meter based on Faraday's law that is known from theoretical analysis which is seen for static magnetic field. The produced voltage signal is consistent of the volume rate of fluid flow in transposed velocity profile. The dependence of induced electrical voltage, in measurement region to fluid velocity υ"*sm* "and magnetic density of flux *B*"*T*" [4]-[7]is shown in Fig. 1.

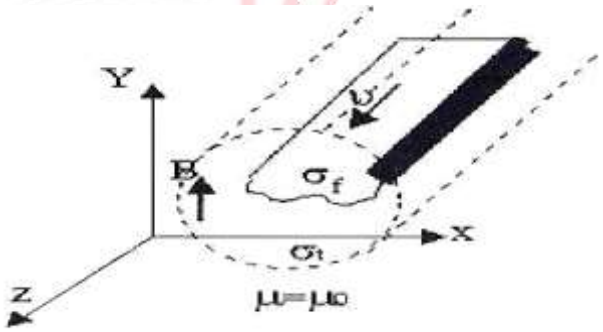


Fig.1 Basic model of EM

EM flow meter that is consist of pipe with circular cross-section for passing a fluid, producer of magnetic field in the direction of fluid and a couple of electrodes on the cross side of pipe wall. [5] Fig.2

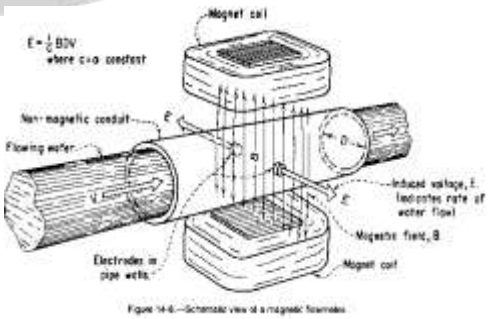


Fig.2 Schematic view of EM

The magnetic field is produced by exciting wires with alternative current from one side to another of the pipe. Also, the material of the pipe must be made of

 DOI : 10.18231/2454-9150.2018.1393

non-magneticones because of the self- influence. Magnetic field interaction that is caused to generate an electrical field *E*, inside fluid by positive (negative)ionsmovements of fluid that is based on Lorentz law.Therefore,this electrical field can present by gradient of electricalpotential.

3. METHOD

In this paper we are going to study Electromagnetic flowmeter by simulation graphs and figures.

Structure of E.M. flow meter

Entirely, electromagnetic flow meters are made up two sections, signal detecting unit and signal processingunit.Signal detecting is included of non-conductive tube for fluidflow, electrodes and electromagnet parts.

The electrodes are considered as copular shape like.Themagnetic field is usually produced by a pair of identicalcircular coils that spaced one radius apart and a laminatedyoke. Also, they wound the current flows through both coilsin the same direction.

The electromagnet can supply with two kinds of excitation,AC and DC. After all, most of measurement are done on lowconductivefluids, we can use of sinusoidal exciting system byAC power supply. This kind of power supply can becontrolled by frequency convertor of the power supply thatcan decrease the peaks of the noise caused by AC voltagewhich is arisen into error signals in the detecting section ofthis kind of flow meter by AC excitement.

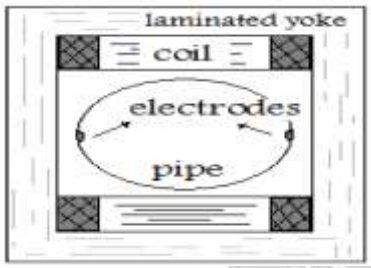


Fig.3

The second part of the electromagnetic flow meter, we havesignal processing that shown on Fig. 4. In this section,detecting signals in comparison with small unwanted voltagesare filtering then amplifying.[4]-[6]

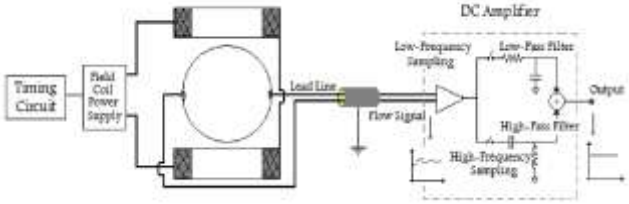


Fig.4

4. SIMULATED ANALYTICAL GRAPHS

The distribution of produced magnetic field and so distribution of electric field between two electrodes has beenshown in Fig. 5 and 6, respectively.Also, in the Fig. you can obviously seen the effects ofproduced magnetic field lines on electrodes by highconductivity coefficient, as a result the nearly homogenousmagnetic field inside the tube can clearly seen. [5]

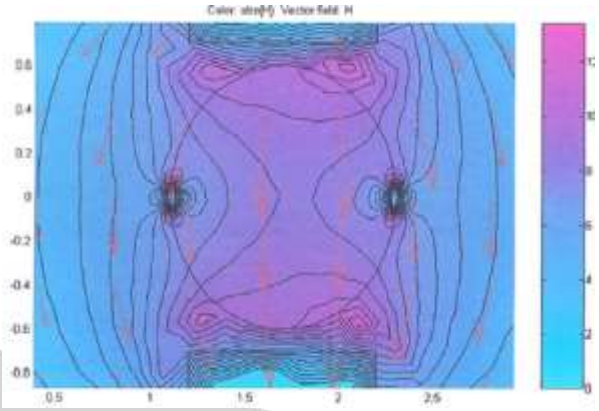


Fig. 5 Distribution of magnetic field inside tube

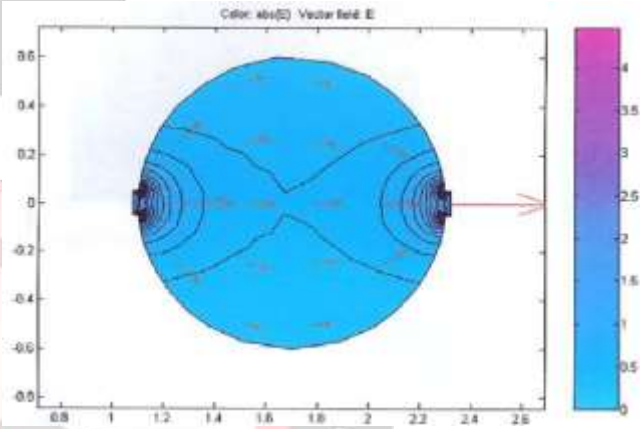
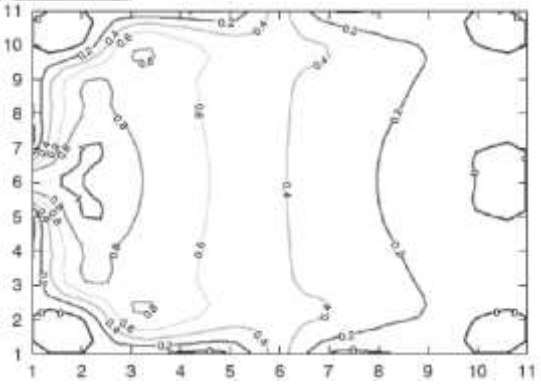


Fig.6 Electrical distribution around electrodes

The results for voltage variations betweentwo electrodes for difference state of fluid level are shown inFig. 7 and Fig. 8.

The distribution of electric potential between electrodes incross-section measurement region can be seen in two dimensional and three-dimensional states that are illustrated fully filled pipe and 60% filled pipe condition. [5]



Y-axis

Fig. 7

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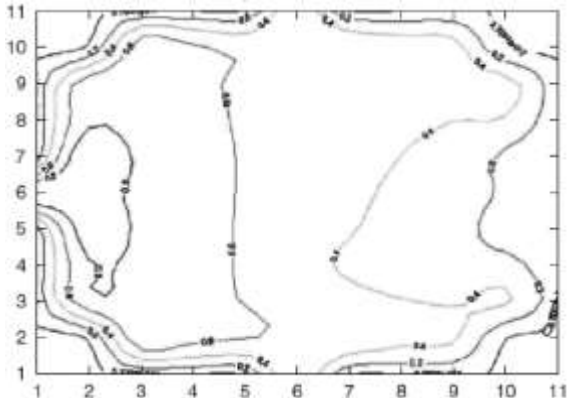

Fig. 8

The distribution of electrostatic potential for fully filled pipe condition is symmetrical. In contrast, the state of inhomogeneous on fluid flow for 60% filled pipe condition isshown obviously where is because of thefluid-to-airconductivity coefficient ratio effect. [6]

The induced voltage between two electrodes by changingon conductivity coefficient of fluid flow for two differentvelocity of fluid inside the tube is shown in Fig. 10 and Fig.11.[5]

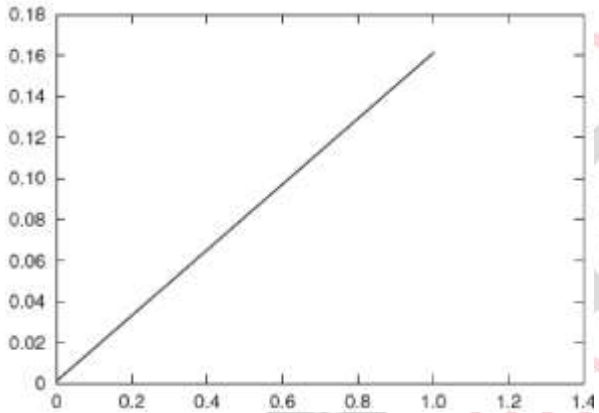

Fig.10 Induced voltage for constant velocity υ=1 m/s

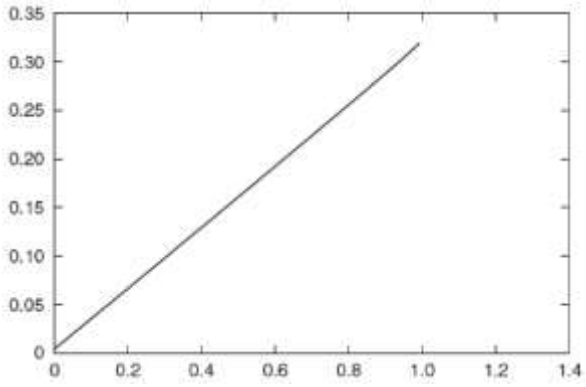

Fig.11 Induced voltage for constant velocity υ = 2 *m/s*

5. SUMMARY AND CONCLUSION

We present the analysis and design of circular E.M.flowmete. This analysis is based on induced voltage asrely on theFaraday's law.According to simulation results, we can calculate thedistribution of magnetic flux density on the flow cross-sectionof tube that isalmost uniform. Comparatively, in our design,the outcomes of induced voltage variation betweenelectrodesin fully filled tube state by 60% filled pipe condition weresurveyed.

We describe theeffect of increasing fluid flow velocity and fluid conductivitycoefficient on electromagnetic flow meter, perfectly.This method of measurement for fluid flow have very wideapplication arena, which can entirely use for any type of fluidlike acids, polymer inchemical industry, and especially fortheir infusion.

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