Design and Fabrication of Electromagnetic Flow Meter

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Abstract

Measuring the flow of liquids is a critical need in many industrial plants. Many flowing fluids present difficult handling problems in metering. If these liquids are conducting to certain extent, their flow rates can be metered by what is known as induction flowmeter or simply magnetic flow meter. The liquids in this category are corrosive acids, acids slurries, paper pulp, detergents, beer etc. The measurement of flow in such a case involves the speed of flowing fluid which is measured in terms of the potential difference induced when the liquid moves in tubing/pipe with a transverse magnetic field impressed. When a liquid with conductivity at least about 10^5 S/cm flows through an insulating tube of diameter d placed in a magnetic field of flux density B, then to pair of electrodes mounted perpendicular both to the magnetic field and flow, a voltage E is induced which is dependent on flux density, the tube diameter or the conductor length and the liquid flow velocity

Keywords: Electromagnetism, Flow measurement, Flowmeter

I. INTRODUCTION

Flow measurement is the quantification of bulk fluid movement. Flow can be measured in a variety of ways. Positive-displacement flow meters accumulate a fixed volume of fluid and then count the number of times the volume is filled to measure flow. Other flow measurement methods rely on forces produced by the flowing stream as it overcomes a known constriction, to indirectly calculate flow. Flow may be measured by measuring the velocity of fluid over a known area.

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II. LITERATURE SURVEY

Yukio Sai, Yousuke Kubota [1] proposed that an electromagnetic flowmeter generates a magnetic field perpendicular to a ring earth electrode contacting fluid at an end portion of a measuring tube and a point electrode attached to a lower portion of the measuring tube so as to measure a flow rate without depending on a fluid level. The electromagnetic flowmeter comprises magnetic field generation means for generating the magnetic field in the measuring tube to be perpendicular to an axial direction of the measuring tube such that electromotive force generated in fluid is not influenced by the fluid level, flow rate output means for calculating a flow rate of fluid flowing in the measuring tube based on a potential developed in the fluid by said magnetic field generated by the magnetic field generation means so as to output the calculated flow rate, and display means for displaying the flow rate.

Mannhaz E Riester H [2] proposed that an electromagnetic flowmeter with excitation signal as a square wave. Toyofumi Tomita [3] proposed that square wave excitation current is supplied to an excitation coil. A magnetic field generated in this coil is impressed on an electrically conductive fluid. The voltage induced in the electrically conductive fluid is drawn out as a flow rate signal by means of a pair of electrodes. The issue of the flow rate signal is delayed by the sample hold circuit to an extent corresponding to half the period of the flow rate signal.

Toshio Sekiguchi [4] proposed that a signal generator for an electromagnetic flowmeter provided with a flow tube having an insulated liner through which a fluid to be metered flows to intercept an electromagnetic field established therein to induce a signal depending on flow rate in a pair of electrodes mounted at diametrically-opposed positions on the tube.

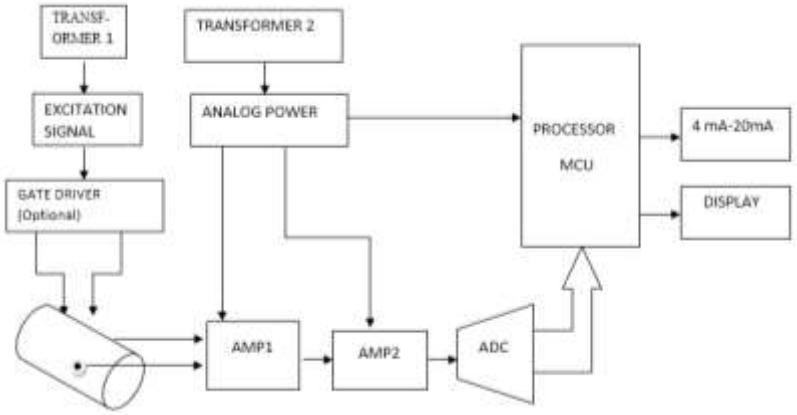
Jimmie W. Hamby, Hubert S. Pearson [5] proposed that an improved flowmeter system is described, together with circuitry, hardware, and techniques for its utilization for determining the rate of flow of fluids in conduits at a situs substantially remote from the information gathering and analysis situs.

III. BLOCK DIAGRAM AND EXPLANATION

A. Process Description

The electromagnetic flowmeter uses Faraday's Law of electromagnetic induction to measure the process flow.
When an electrically conductive fluid flows in the pipe, an electrode voltage E is induced between a pair of electrodes placed at right angles to the direction of magnetic field.
The electrode voltage E is directly proportional to the average fluid velocity V.
electromagnetic flowmeters are primarily embedded system which are divided mainly into 5 functional blocks:

1) Coil excitation
2) Signal conditioning unit
3) Processing unit
4) User interface



– TRANSFORMER 1: Transformer 1 is used to provide the voltage in the range of 5-30V as per requirement by stepping down the 230V AC. This voltage is used for the excitation of coils of electromagnetic flow meter.
– EXCITATION SIGNAL: Mainly electromagnetic flowmeters are classified by their excitation signal type. There are various types of signal excitation for electromagnetic flowmeter:

AC signal
DC signal
Pulsating DC signal

– TRANSFORMER 2: Transformer 2 provides the voltage which is required to run the amplifier and display circuit.
– AMP1: Amplifier 1 is used in first stage of signal conditioning, having high input impedance which helps to amplify the low power signals coming from electrodes.
– AMP2: Amplifier 2 having low power, high precision output. Also this amplifier having accurate gain adjustments

IV. MATHEMATICAL MODELLING

In electromagnetic flowmeter we use faradays law of electromagnetic induction which is as follows,
e= BLV
Where, e= induced voltage
B= Magnetic Field
L= Distance between two electrodes
V= velocity
In our electromagnet, we have wounded copper wire on iron core and the value of magnetic field produced is as follows,
B= μ N I
Where, μ= Permeability=4*Π(i.e. pie)* 10^{-7}
N= Number of turns
I = current flowing through coil* (*can be vary as per requirement)

V. ADVANTAGE

Electromagnetic flowmeter has advantage of simple structure, no moving parts, and no obstruction of fluid flow throttle parts, so when the fluid passage does not cause any additional pressure loss, and it does not cause such wear, blockage, in particular for measuring the slurry with solid particles, sewage and other liquid-solid two-phase body, and a variety of viscous slurry.
Because of its structure, no moving parts, so the corrosion can be attached insulation lining and selection of corrosion-resistant electrode material, play a very good corrosion resistance, so that can be used for a variety of corrosive media measurement.

VI. RESULTS

As per the mathematical modelling which is based on the construction of electromagnetic flowmeter i.e. Number of turns, current flowing through coil, Distance between two electrodes, velocity then we get the voltage in the range of millivolts which is induced across the electrodes which are inserted in the device. This voltage further will be amplified and used to run display circuit and the actual flow can be seen on display.

VII. CONCLUSION

The most important aspects of any flowmeter is to measure the accurate flow. The methods has to be used relies varied objective like higher sensitivity and resolution.

To maintain the flow measuring system and to make it more reliable. It is important to accurate measurement of flow parameter to have a good control on system. So as to take this control we have designed our system which can match the industrial standard of a Flowmeter.

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REFERENCES

[1] Yukio Sai, Yousuke Kubota," Construction of Electromagnetic flowmeter" US5880376 A Mar 9, 1999
[2] Mannhaz E Rieste," Electromagnetic flowmeter with square-wave excitation" US3783687A, Jan8,1974
[3] Toyofumi Tomita," Basics of Electromagnetic flow meter" US4644799 A, Feb24,1987
[4] Toshio Sekiguchi," Signal generator for electromagnetic flowmeters" US4373400 A, Feb15,1983
[5] Jimmie W. Hamby, Hubert S. Pearson." Electromagnetic borehole flowmeter system" US 5388455 A, Feb 14, 1995
[6] Principles of Industrial Instrumentation,2nd Edition by D Patranabis published by TataMcGraw-Hill.
[7] Introduction to Measurements and Instrumentation, 4th Edition by Arun.K.Ghosh published by PHI Learning Private Limited Delhi.