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Design and Development of Water Flow Sensor

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Abstract: *Effective water management begins with timing and regulating irrigation water application in a way that will satisfy the need of the product or aquifer and is available to consumer at rates tolerated according to the soil characteristics. So are many water flow measurement techniques as well as different types allwater flow meters used to measure the volume of water flow in pipelines but the sealis too costly. This paper describes design and development of low cost automatic water flow devices saving water as well as energy. hall Effect water flow sensor is used as a sensing unit with a turbine rotor inside it whose speedof rotation changes with the different rate of flow of water. The hall effect sensor outputs the corresponding pulse train for frequently input to the microcontroller*.

Keywords: *Hall Effect Sensor,Flow Rate of Water, Magnet, Transducer*

I. Introduction

Effective water management begins with accurate water flow measurement. Development of a digital water flow meter is an essential problem in water management that has been surprisingly little investigated. Flow measurement technology has grown speedily in recent decades. Physical phenomena discovered in last decades have been the starting point for many variable flow an indicator to know whetherthere are leakages along the pipelines. Flow can be measured with contact type or non-contact type of sensor, accurate flow measurement is an essential step both in the terms of qualitative and economic points of view. The measurement of water flow is required for water management purposes in the area of water resources planning, pollution prevention and flood controls (Thandaveswara, 2014). Shapes, size, price ranges and accuracy are factors that affect choice of flow meters as some have comparative advantages over others. Previously, technique known as ultrasonic flow measurement a non-invasive type of measurement is widely used to calculate flow, because of its capability toavoid noise interferences in its output (Ria et. al., 2013). Now a day due to its non-linear characteristics its use is been restricted.Various types of flow meters that are available in the market are shown in Figure1.

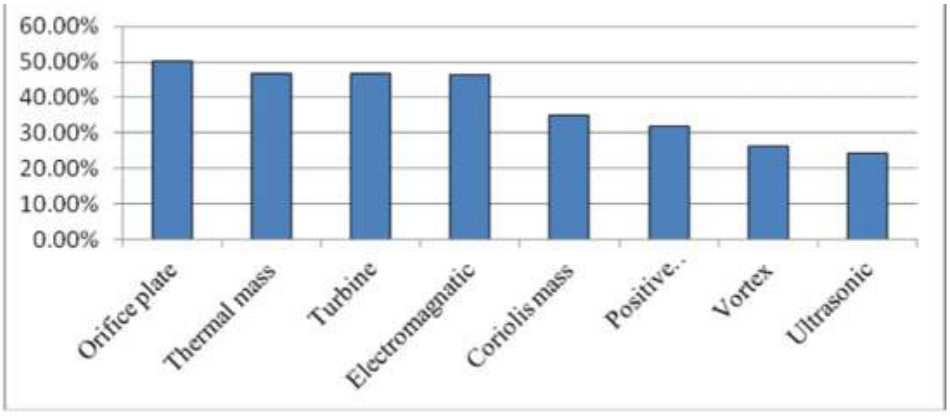

Figure 1. Industrial flow meter usage [1]

Measuring devices. In recent year's technical development in other fields such as optics, acoustics and electromagnetism have resulted not only in improved sensitive designs but also in new flow measuring concepts Wang and Ronald (2014). = Recently, flow meters have proven to be an excellent device for measuring flow in any water application domain. In irrigation fields flow meters are required for measuring the water needed to supplement the insufficient rainfall. Flow meters also serves as.

Some of the sensor which calculates the flow rate based on the speed of water, ultrasonic sensors which works on two different principles that is transit time measurement principle and other is based on Doppler Effect but these are having high cost of maintenance. The aim of this paper is to develop a prototype of a low cost turbine type water flow meter whichmeasures to water flow rate/totalization of water passed through the pipelines. This typeof flow meter not only conserves the water by only providing the required amount of water to the fields but also saves the energy by having the pump automatically off. Pump gets off after the amount of time set by the user.

II. Selection Of Sensor

Flow sensors, the devices that detect and measure water flowing through pipes, are becomingnecessary components of efficient water management systems and mainly acts as a sensory organ for the brain in the flow measurement oncontroller, giving it information to make operating decisions. Flow meter basically works with the output of the flow sensor. In this system in order to calculate the flow the rotor surrounded by a magnet along with the Hall Effect sensor is used. As the water flows through the rotor, it's blades rotates. As the turbine rotates magnetic field is produced and accordingly an Ac pulse is generated which is thenconverted into the digital output with the help of Hall Effect sensor placed just after theturbine. The number of pulses generated per liter can be counted by the softwareprogramming. Thus pulses produce an output frequency which is directly proportional tothe volumetric flow rate/total flow ratethrough the meter. Also measuring flow rate through rotating rotor provides high accuracy, excellent repeatability, simple structure and low pressureloss. Table 1 lists the specifications of water flow sensor.

Working voltage	5V-24V
Maximum current	15 mA（DC 5V）
Weight	43 g
External diameters	20mm
Flow rate range	1～30 L/min
Operating temperature	0℃～80℃
Liquid temperature	<120℃
Operating humidity	35%～90%RH
Operating pressure	under 1.2Mpa
Store temperature	-25℃～+80℃

Table 1. Specification of Water Flow Sensor

III. Methodology

1.1 What is Hall-Effect Sensor?

A Hall Effect sensor is a transducer that varies its output voltage in response to a magnetic field. Hall Effect sensors are used for proximity switching, positioning, speed detection, and current sensing applications. In its simplest form, the sensor operates as an analog transducer, directly returning a voltage. With a known magnetic field, its distance from the Hall plate can be determined. Using groups of sensors, the relative position of the magnet can be deduced. Electricity carried through a conductor will produce a magnetic field that varies with current, and a Hall sensor can be used to measure the current without interrupting the circuit. Typically, the sensor is integrated with a wound core or permanent magnet that surrounds the conductor to be measured.Frequently, a Hall sensor is combined with circuitry that allows the device to act in a digital (on/off) mode, and may be called a switch in this configuration. Commonly seen in industrial applications such as the pictured pneumaticcylinder, they are also used in consumer equipment; for example, some computer printers use them to detect missing paper and open covers. When high reliability is required, they are used in keyboards.

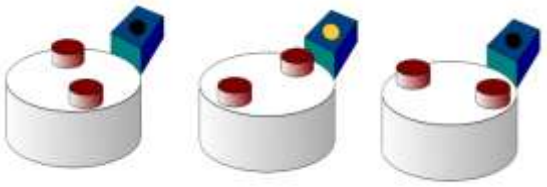

Figure 2. Pulse Generator Hall Sensor

Hall sensors are commonly used to time the speed of wheels and shafts, such as for internal combustion engine ignition timing, tachometers and anti-lock braking systems. They are used in brushless DC electric motors to detect the position of the permanent magnet. In the pictured wheel with two equally spaced magnets, the voltage from the sensor will peak twice for each revolution. This arrangement is commonly used to regulate the speed of disk drives.

3.2 Flow Measure by using Hall-Effect Sensor

Hall-Effect Sensor can be used to create a flow meter or calculating amount of liquid passing. Measure liquid/water flow for your solar, computer cooling or gardening project using this handy basic flow sensor. This sensorsits in line with your water line, and uses a pinwheel sensor tomeasure how much liquid has moved through it. The pinwheel has a little magnet attached, and there's a Hall Effect magnetic sensor on the other side of the plastic tube that can measure how many spins the pinwheel has made through the plastic wall.

Fig 3: Hall Effect Sensor.

3.2 Transfer Function of Hall Effect Sensor

The transfer function for a digital output Hall Effect sensor incorporates hysteresis as shown in Figure 4.

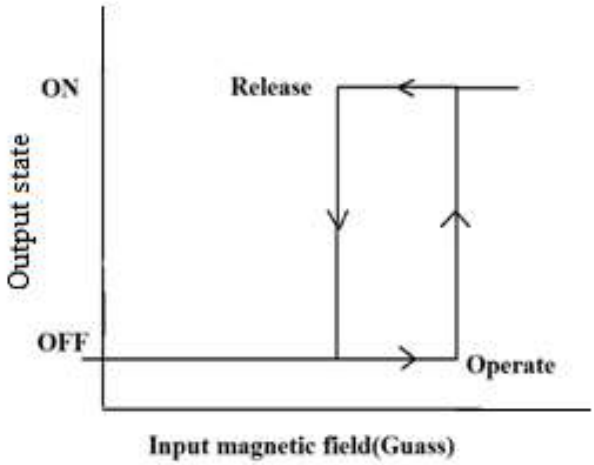

Figure 4. Transfer Function of Hall Effect Sensor

The principal input/output characteristics are the operate point, release point and the difference between the two. As the magnetic field is increased, the output of sensor remains the same untilthe operate point is reached. Once the operate point is reached, the state of the sensor will change. There will be no effect of further increased magnetic field input. Now if magnetic field comes below the operate point, the output will remain the same until the release point is reached. Now at this point the sensor returns to its original OFF sate. This hysteresis eliminates the false triggering that can be caused by minor variations in input.

IV. Result and Performance Analysis

The design and the type of circuitry involved in the Water Flow Monitor Module has been approached keeping in mind the ease of installation and a minimalistic hindrance. A micro-controller module that can communicate wirelessly with the computer can also be used instead of a USB connection.

Frequency (Hz) = 7.5 * Flow Rate (L/min)
= 7.5 * 30 (L/min)
= 225 Hz99

The sensor will output 450 Pulses for a Liter of water that will pass through it, hence if 1 Liter of water will flow through the sensor in a minute, we would be getting 450 pulses a minute. Therefore, for 1 second there will be approximately 3.75 pulses per second per Liter of water flow. Hence the calibration factor is set to 3.75. The sensor is connected to the Digital Pin 2 which uses an ―Interrupt 0‖ and this is configured to trigger on a ―Falling Edge‖. Since the calibration factor over here is considered for every second, there are cases in which the loop will not execute in a second. Hence we calculate the number of milliseconds that have passed since the last execution and scale the output according to that. We also apply the calibration factor to scale the output based on the number of pulses that the sensor outputs at that second.

V. Conclusion

In summary, a technique to measure flow rate of water in domestic water supply pipelines is introduced. Though the use of Hall Effect sensor has been in studied in many areas but here we have seen the benefit of using Hall Effect sensor in measuring the flow rate of water within the pipelines. Application of hall sensor in this field proves to be a good system that can detect the leakage in the pipelines if we observe the flow rate of water regularly, saves water as excess water would not be delivered to the crops which may also damage it and at last but most important that is in the terms of cost the system proves to be a low cost with many of the benefits as compared to the other products available in the market. So development of low cost water flow meter can replace the other high cost water flow measuring meters available in the market. This system eliminates the manual mistakes in flow rate measurement. Also it is more accurate in comparison to other types of meters. This system is more attractive, as it provides automatic operation with great accuracy and the most too cheap method to measure flow rate of water in agriculture.

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