ISSN (Online) 2321 – 2004
ISSN (Print) 2321 – 5526

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH IN ELECTRICAL, ELECTRONICS, INSTRUMENTATION AND CONTROL ENGINEERING
Vol. 2, Issue 9, September 2014

Design and Implementation of Sensor for Noncontact Sensing of Liquid

Mr. Amol Ashok Kshirsagar[1], Mr. Shashikant Hippargi[2]

Assistant Professor, Department of Electronics & Tele-communication Engineering, Nagesh Karajagi Orchid College of Engineering & Technology, Solapur, Maharashtra, India [1]

Assistant Professor, Department of Electronics & Tele-communications Engineering, S.P.S.P.M'S N.B. Navale Sinhgad College of Engineering, Solapur, Maharashtra, India [2]

Abstract: With the availability of mechanical floats, floats with switches, conducting liquid probes and many other complex sensor, here is presented a novel sensor having non-contact sensing technique to sense liquid level. This sensor consists of a magnetic float guiding over a p.v.c pipe. Inside the p.v.c pipe are placed reed switches to monitor the low and high level of the tank. With the vide variations of tank dimensions this sensor can be conveniently designed and easily fabricated. The non-contact principle avoids use of high voltages, adds safety, increases the life of sensor and over comes the maintenance problem faced by the other sensors.

Keywords: non-contact; magnetic float; p.v.c pipe.

I. INTRODUCTION

In this paper a novel idea to design and implement a non-contact principle based sensor used to know the pre-determined level of liquid in commercially available tanks. It can be used widely for sensing level of liquid such as water. In India verities of tanks are encountered, making it impossible to provide a fixed design. The sensor overcomes this problem as it can designed as per requirement of tank by varying the length of the pipe as per the requirement. The traditional mechanical float commonly used to sense water level consists of a float ball, a rod and a on-off valve. As the water fills the float rises with water and closes the valve, thus discontinuing the flow of water. The problem of this gauge is that the valve starts leaking after prolong use. This is mainly due to aging effect and the wear and tear of the valve. The gauge needs to be replaced frequently if water pressure is high and exceeds the pressure that the valve can handle. Another sensor that is most frequently used is a float consisting of a steel ball and a limit switch. The float is lifted up by water and limit switch is operated by weight of steel ball when the required level is reached. This method is not at all precise and variation in sensing level is observed. Two such floats are required for a single tank. The tank dimensions affect the performance. The most commonly used method used is the level sensing by using conducting probe immersed in water. They use the conducting property of water. The problem faced is use of high voltages for conductivity, oxidation of metallic probes leading to failure of gauge and frequent change of probes. Thus, guaranteed operation is not achieved. This requires regular maintenance of probes. Here a specific design for most common 1000 liter water tank is designed and implemented. The sensor consists of a magnetic sensing float, guided by p.v.c pipe. The p.v.c pipe consists of a pair of reed switches placed at required distance to detect low and high level of the liquid. The arrangement is as shown in Fig. 1.

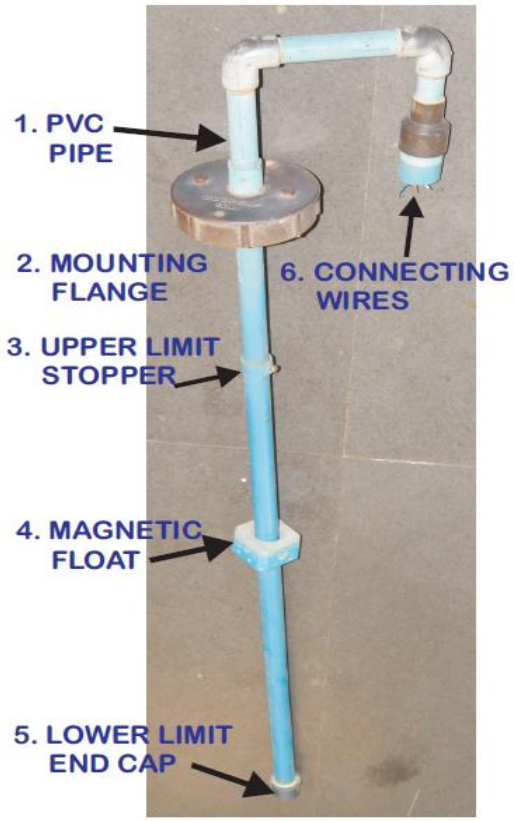

Fig. 1. Detail Diagram of Sensor

II. PROBLEM STATEMENT

A non-contact sensor to be able to overcome the drawbacks of conventional ways of liquid level measurement, to give

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trouble free operation for long duration, minimizing the maintenance required and non-contact sensing of liquid is desired to be designed and implemented.

III. PROPOSED WORK

This paper is organized as follows:

- The basic measurement principle.
- Construction of the sensor.
- Testing of the sensor.
- Installation and Mechanical arrangement.
- Operation of sensor.

IV. METHODOLOGY

A. Measurement Principle

As shown the Fig. 2. the measurement principle is simple. Whenever a reed switch is surrounded by magnetic field in a particular direction, the reed switch closes otherwise it is open [1]-[6]. The non-contact principle of liquid sensing is thus achieved.

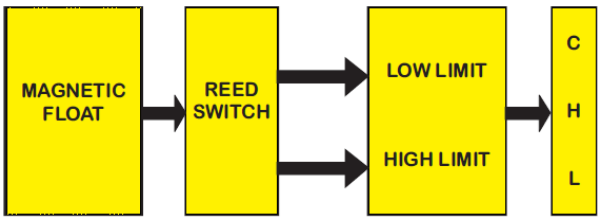

Fig. 2. Block Diagram showing Measurement Principle

B. Sensor Construction

The sensor construction is as shown in Fig. 1. is a p.v.c pipe of diameter 20mm and length 850mm is taken. The circuit of reed switch connection is shown in Fig. 3. is placed in p.v.c pipe. It is glued on top and bottom. The reed switch at the bottom of pipe is the low level limit and the second reed switch is placed at the desired upper level limit. The distance between the lower and upper limit is the desired distance in which the liquid level is to be controlled. The bottom of p.v.c pipe is sealed by end cap. The lower limit is set by end cap at bottom of p.v.c pipe. The float containing a magnetic ring is put on the pipe and the upper limit ring is set and screwed on pipe.

The distance between the upper and lower limit ring is 550mm. One can set the length of pipe and the control distance as per own convenience. The flange for mounting is fixed on the pipe. This mounting flange is of 110 mm diameter having two mounting holes. The top end of p.v.c pipe is connected by a coupler of 20mm to 40mm.The ends of the wire are connected to a three terminal screw connector. The connector is placed in the 40 mm pipe and can be closed by a 40 mm end cap. This completes the assembly of the sensor.

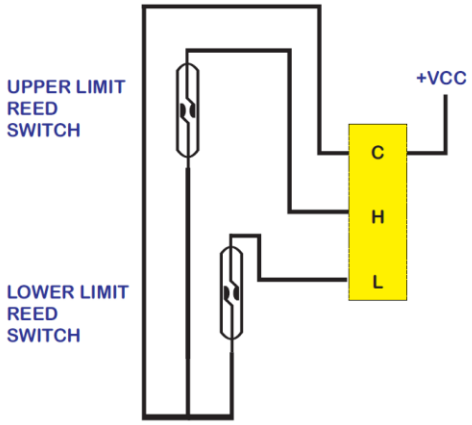

Fig. 3. Circuit Diagram of System Hardware

C. Sensor Testing

The sensor can be easily tested by a multi-meter on the continuity range. Hold one probe of the multi-meter at the common terminal (C) of connector and another probe at the lower limit (L) of the connector. Slowly bring the magnetic float by sliding on p.v.c pipe towards the bottom and stop when continuity sound from multi-meter is heard. This is the lower limit of the sensor. In similar way connect one terminal of multi-meter to the common terminal (C) and other probe of multi-meter to high limit (H). Slide the magnetic float upwards till one hears a continuity sound. Set this position by upper limit ring. This is the testing procedure of the sensor. Now the sensor is ready to control the liquid between low and high limit.

D. Sensor Installation

The sensor is mounted by a pair of nut-bolt on top of tank. For this the tank is cut at top to enter the float and pipe. The flange of the pipe covers this cut portion of tank. The sensor installation is complete and is ready to use. This arrangement is shown in Fig. 4.

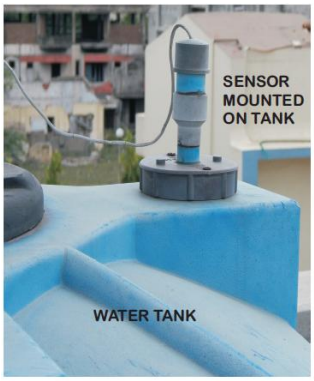

Fig. 4. Mechanical Set-up of the Sensor

E. Sensor Operation

The operation of gauge is quiet simple. When the tank is empty, the float is at the bottom limit and the lower limit reed switch is in closed position. If a multi-meter is connected between the (C) and (L) of the output connector

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then a continuity sound is heard. This condition represents a low level signal of the sensor. When the tank starts filling the magnetic float, floats on water and is guided by pipe, and when it reaches to the upper limit, the upper limit reed switch is in closed position. Now, if a multi-meter is connected between the (C) and (H) of the output connector then a continuity sound is heard. This condition represents a high level signal of the sensor. All the above functions are summarised in Table 1.

TABLE I
THE OPERATION OF SENSOR

Sr. No.	Float Position	+VCC At	Indication
1.	Upper limit stopper.	**H**	The liquid in tank is full.
2.	Lower limit end cap	**L**	The liquid in tank is empty.
3.	In between Upper & Lower limit	-	No operation (still) OR liquid is in between upper & lower limit.

F. System Arrangement

The overall system arrangement is as shown in Fig. 5. This set-up can be even done for other type of tanks. A suitable wiring is done as per requirement to the control unit.

Fig. 5. The Overall System Set-up

V. CONCLUSION

A non-contact sensor is thus designed and implemented. It is observed that the operation of sensor is reliable. The maintenance cost is almost zero except in case of physical damage. The sensor works perfectly with the change in liquid quality. Use of high voltages is avoided by this method thus making the unit to work on low voltages of 5v also. The only care that has to be taken is that the sensor should not be exposed to intense vibrations and hammering of sensor should be avoided. Dropping the sensor may cause the breakage of reed switches as they are made of glass. Handling of sensor should be done with care. High voltages should not be used for sensor operation.
This innovative sensor is sure to solve water management problems thus saving water, time, manpower and money.

ACKNOWLEDGMENT

Authors would like to thank the Department of Electronics and Tele-Communication Engineering and also those individuals who have motivated and helped in carrying this work successfully.

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BIOGRAPHY

Mr. Amol Ashok Kshirsagar is working as a Assistant Professor in Electronics & Tele-communication Department at N. K. Orchid College of Engineering and Technology, Solapur. He has a rich Industrial experience of six years and five years in teaching field. He has done B.E. (Electronics) and currently pursuing M.E. (E&TC). His special interest is in Micro-controllers, Instrumentation, prototyping new sensors.

Mr. S. S. Hippargi is working as a Assistant Professor in Electronics & Tele-communication Department at N. B. Navale Sinhgad College of Engineering, Solapur. He has a rich teaching experience of 14 years. He has done B.E. (E&TC), M.Tech. in Digital Communication and currently pursuing Ph.D. degree in Wireless Communication. His special interest is in the field of Wireless Communication and Image Processing.