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Energy Efficient Liquid Level Controller Using Plc

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Abstract: With the help of higher sensitive semiconductor strain gauge, the Energy efficient liquid level controller have been designed and implemented by PLC Programming software.The strain gauge attached tobottommost of tank .As the water grows up and down, the strain gauge output changed. This output sensed by the Wheatstone bridge detector. The digital signal generated bysignal conditioning system and comparator wasfurther sensed by PLC Input module. As thestatus of liquid level in the tank changed and compared by PLCprogrammingsoftware, thecontroller output will also be changed. The benefits of system, elaborated in this researchare to understand the need of energy efficient controller.

Keywords: PLC,strain gauge,stress, semiconductor.

1. INTRODUCTION

In this system, strain gauges sensethe pressure of liquid of a tank at the bottom position. The strain gauge output depends on the liquid pressure.If strain gauge output crossed the certain threshold value then solenoid control valve will be open/closed [1]-[4]. Thesystem is used high gauge factor based semiconductor strain gauge and full gauge Wheatstone bridge configuration which provides higher sensitive [4]-[6].

The relationship between strain and pressure evaluated by the following relationship

$$\text{Modulus of Elasticity(E)} = \text{Stress (S) / Strain (e)}$$

$$\text{Strain(e)} = \text{(Change in length – Original length) /Original length}$$

$$\text{Stress (S)} = \text{Force (F) / Area (A)}$$

$$\text{Gauge Factor} = \text{(Strain in resistance) / (Strain in length)}$$

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Liquid Pressure at the bottom of tank =liquid density*liquid height*g

2. STRAIN GAUGE SENSORS

When exterior forces are applied to a standing object, stress and strain are the outcome. Stress is distinct as the object's interior resisting forces, and strain is defined as the displacement and deformation that arise [6]-[9].

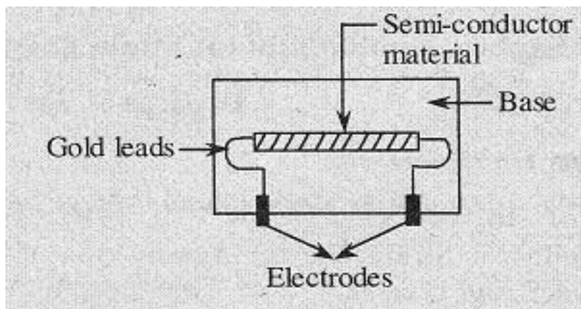

Fig 1.1: Semiconductor strain gauge.

The Fig.1.1 represents the semiconductor strain gauges which are joined via gold leads. The major advantage of using a semiconductor gauge is its greater sensitivity as compared to other types of strain gauge.The Fig. 1.2 represents the full Wheatstone bridge configuration with fourstrain gauges designed in Multi-SimSoftware.

The output of Wheatstone bridge is connected to signal conditioning system. The analog signal obtained by the signal conditioning system is converted into digital logic via comparator (PC). A comparator is device that produce logic 1 or 0 accordingly the threshold value.The strain gauge output appears across the null detector.

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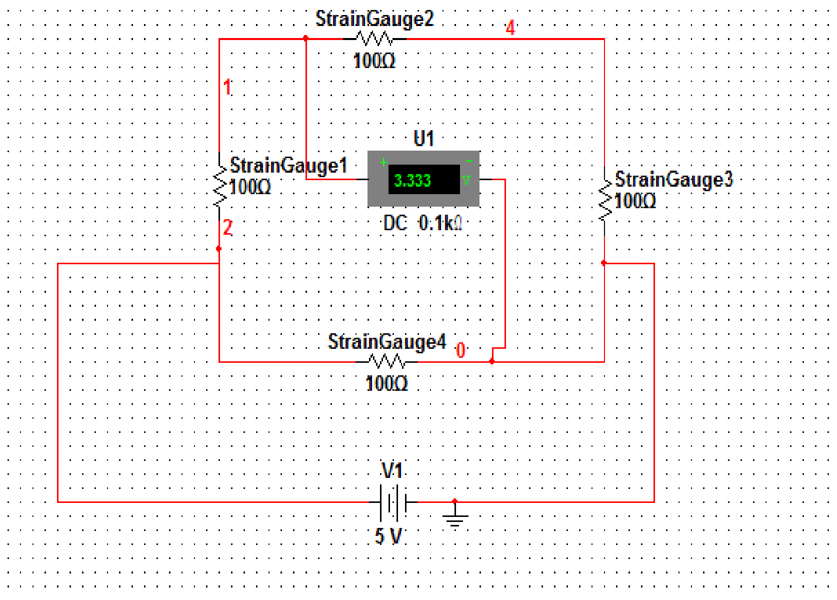

Fig 1.2: Simulation of FullBridgeWheatstone Bridge on multisim software.

3. HARDWARE MODULE

Block diagram of liquid level controller is shown in Fig. 1.3.When the strain gauge outputs crossed the certain threshold voltage then the comparator logic goes high.As soon as the comparator logic goes high, the input of normally closed (NC) switch becomehigh. It causes the

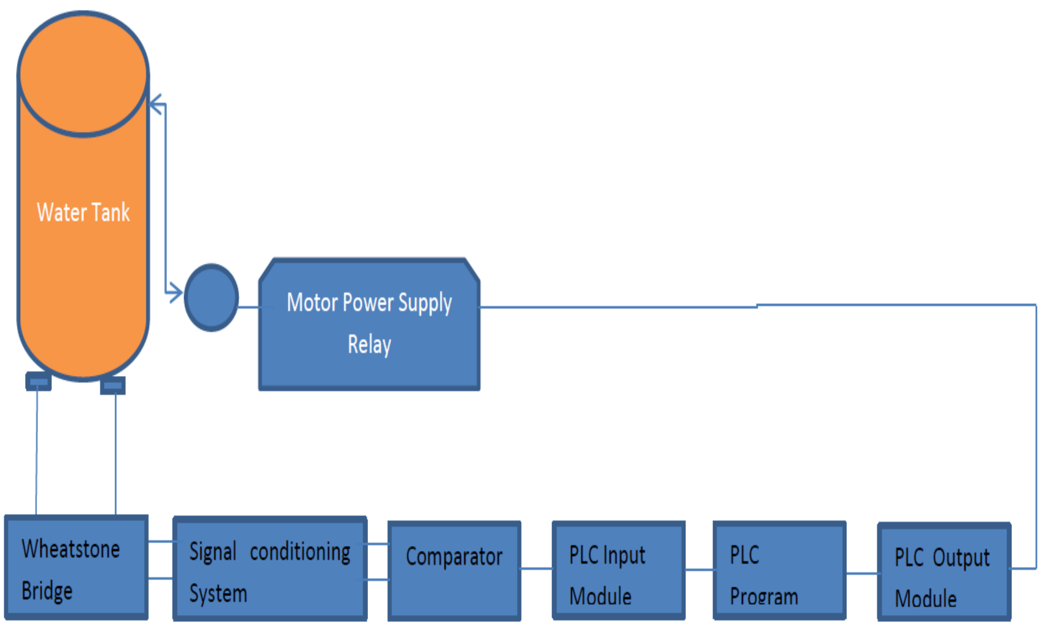

Fig 1.3 Block diagram of liquid level controller

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rung conditioning of PLC programming goes to fail. At this time,PLC output goes to false and breaks the power supply of electrical motor.The Fig. 1.4 represent the hardware of micrologix PLC in which have 6 input module and 4 ouput module.

Fig 1.4 Hardware of Micrologix 1000PLC

The Fig. 1.5 represent hardware model of efficient liquid level controller. The system connected to micrologix PLC.

Fig 1.5Hardware module of liquid level controller

4. SOFTWARE MODULE

The PLC programmed are execute several times without any interrupt.The program string completed in two-rung.The holding bit provides output signal to motor output relay.

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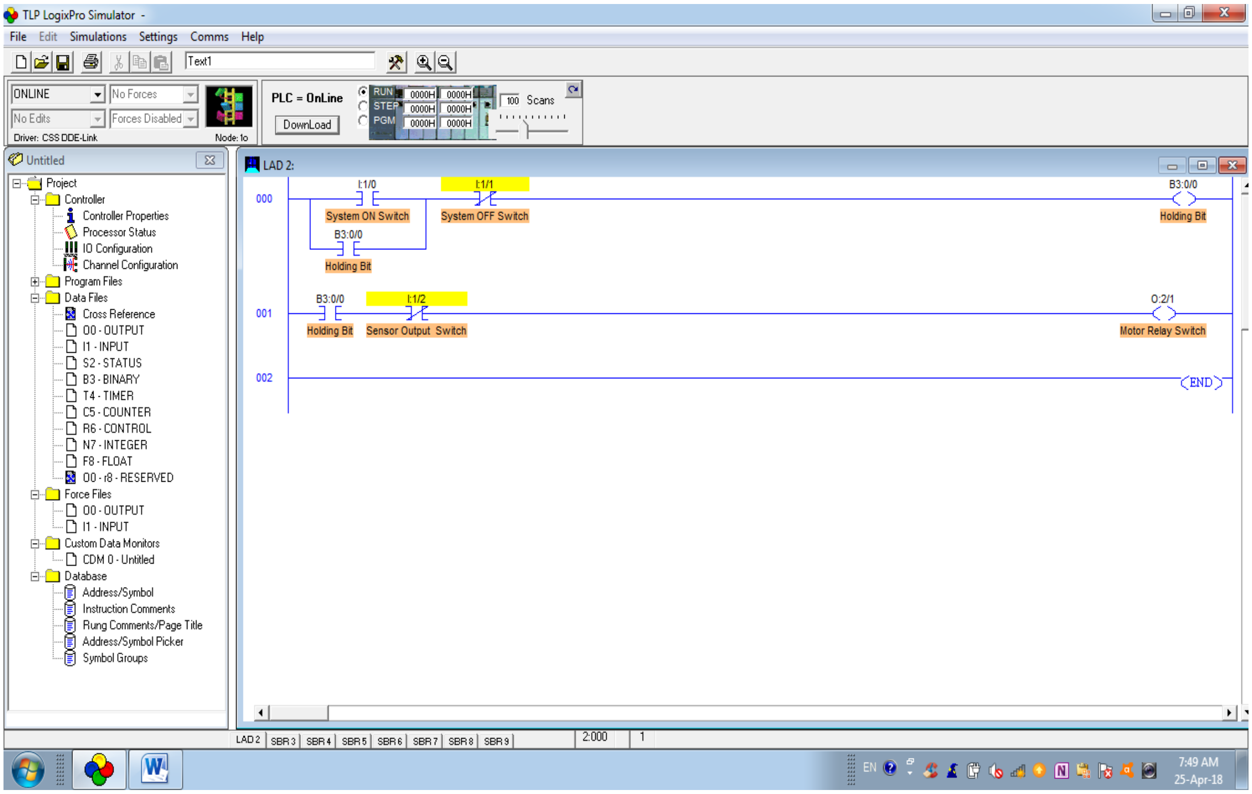

Fig 1.5: PLC Programmed on the Logix Pro Software

The Fig 1.6 represents the programming of energy efficient liquid level controller.The Rung 1 represents the holding bit. In the rung 2 the NC input shows the comparator output.

5. RESULT AND DISCUSSION

Table 1 shows the reading of the null detector and status of solenoid control valve. The null detector reading depends on change in resistance of strain gauges.

TABLE1
Experimental result of the system

S.No	Wheatstone bridge output	Threshold Value	Solenoid Control Valve Status
1	00.00 mv	500 mv	Open
2	80.52mv	500 mv	Open
3	188.94mv	500 mv	Open
4	195.88 mv	500 mv	Open

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5	**225.88mv**	**500 mv**	**Open**
6	**388.89 mv**	**500 mv**	**Open**
7	**415.66mv**	**500 mv**	**Open**
8	**476.88mv**	**500 mv**	**Open**
9	**498.49 mv**	**500 mv**	**Open**
10	**500.01 mv**	**500 mv**	**Closed**
11	**500.02 mv**	**500.mv**	**Closed**

The comparator logic is high when the bottom liquid pressure crossed the threshold value which is 500 mV.

TABLE 2
Experimental result of the system

S.No	**Liquid Pressure at bottom P=p*g*h**		**Change in resistance**	**Time**
1	**490bar**	**h=0.5m**	**50mΩ**	**11.00 AM**
2	**980**	**h=0.10m**	**65mΩ**	**11.10 AM**
3	**1372**	**h = 0.14**	**86mΩ**	**11.20AM**
4	**1666**	**h =0.17**	**96mΩ**	**11.30AM**
5	**1862**	**h =0.19**	**105mΩ**	**11.40AM**
6	**2450**	**h=0.25**	**119mΩ**	**11.50AM**
7	**3920**	**h =0.40**	**147mΩ**	**12.00 PM**
8	**5390**	**h =0.55**	**155mΩ**	**12.10PM**
9	**6468**	**h=0.66**	**165mΩ**	**12.20PM**
10	**8330**	**h=0.85**	**187mΩ**	**12.30 PM**

Table 2 represents the liquid pressure at the bottom position of tank. As soon as liquid pressure is changed the gauge resistance is changed.

6. BENEFITS OF SYSTEM

This systemare used PLC which are provides longer life to the system and no maintains cost.
System consumesvery less power supply and protect overflow of liquid from the outlet oftank.

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this topic.

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