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Design and Implementation of Water Level Management Using PLC and SCADA Visualization

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ABSTRACT: In this paper we proposed to develop an experimental setup of PLC and SCADA based water level control. The system automatically controls water level with the help of PLC. Three level sensors (float switches) are used to provide level data to the PLC. The PLC is connected to float switches which are placed in tank to generate control signals and turns ON and OFF the pump. Thus the level in the tank is constantly monitored and brought to a constant level. The automation is further enhanced by constant monitoring using SCADA screen which is connected to the PLC. The proposed model can effectively supervise level control in multiple tanks.

KEYWORDS: Automation, SCADA, PLC, HMI, Tank-level Control.

I. INTRODUCTION

The Controlling of water level tank is crucial mechanism in our day to day activity. In many industries it is common to observe that large amount of water is wasted from the tank. The project "Water level management using PLC and SCADA visualization" is designed to monitor the level of water in the tank. The system has an automatic pumping system attached to it. The pump starts automatically when water in tank goes to lower level to fill the tank and turns OFF.

When sufficient level of water is reached. Water is commonly used for agriculture, industry and domestic consumption. Therefore, efficient use and water monitoring are potential constraint for home or office water management system. The problem such as poor water allocation, inefficient use, lack of adequate and integrated water management can be solved by using this system. The common method of water level control for home appliance is simply to start the feed pump at a low level and allow it to run until a higher water level is reached in the water tank. But humans are required to start and stop the motor also there is chances of overflow of water and dry run of motor. Proper monitoring is needed to ensure water sustainability so PLC based automated water level sensing and controlling can be used. We are controlling the water level automatically by using PLC, sensor and motor. The float switches senses the presence of water and give indication to the PLC. The PLC produce control signal to drive the motor. If there is no water content the PLC give signal to start the motor and if there is sufficient water in the tank the PLC give signal to stop the motor. It also prevent dry run of the pump in case the level in the tank goes below the suction level. In this project Siemens PLC is used which lie in the cheapest category or entry level of PLC. The reason of it been cheap is that it has limited number of input and output ports. In this project automation of water tank is achieved by using float switch as level sensor in order to set a low level and high level inside the tank.

II. LITERATURE REVIEW

In the past, humans were the main methods for controlling a system as Manual controller [1]. When the operator operates the process to a desired condition, then it carries out the corrective action is said to be manual control [1]. The operator adjusts the output to operate the plant. During startup, this mode is normally used. More recently electricity

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has been used for control and early electrical control was based on Conventional control system [1]. Conventional control system comprises electromagnetic relay, timer, and switch etc. It can be used to control a specific process operation. But in the process if any changed is required then whole control system has to be changed and also rewiring is need. The development of low cost computer has brought the most recent revolution. Relays are used to operate automated machines, and these were interconnected using wires inside the control panel. In some cases a control panel covered an entire wall. Some relays need to be replaced as lifetime of relay contacts was limited. If any replacement was required, machine needs to be stopped and hence production also. Also, sometimes it could happen that there was not enough room for necessary changes. As far as maintenance, electricians had to be very skill full in finding errors. In short, conventional control panels proved to be very inflexible. As explained above in manual or conventional control there are some drawbacks due to this case we forced to make automatic control system using PLC.

III. GENERAL OBJECTIVE

The purpose of the project is to maintain liquid to a required level to any control system. To reduce manual operation and get better accuracy PLC is used in this work.

A. Specific objective

- To monitor and maintain the liquid level in the tank
- To developed an Automatic water monitoring system
- To incorporates an interactive medium between the end user and the machine
- To develop controller using PLC as programming
- To prevent an accident by over filling an open tank
- To monitor overfilling of tank
- To avoid over pressure condition in closed tank
- To avoid wastage of Water
- To prevent over labor of the pumping Machine
- Since the demand of electric city is very high, Automatic water level control saves energy
- There are two scopes in this project. For the first scope which is hardware development are two main sections and those section are;
- To select input sensor
- To design PLC block diagram

For the second scope which is the software development, there are two main sections and that section are:

1. To develop a software using ladder logic diagram
2. To simulate the control system using software.

IV. SYSTEM COMPONENT DESCRIPTION

A. Float Switch

A float switch is One of the reliable, well proven technologies for liquid level sensing. The float switch comprises a magnet contained within a float, as well as a magnetic reed switch contained within a fixed housing. The movement of a float due to changing liquid level, will cause the reed switch to operate (i.e. close or open) at a particular level. This tried and trusted technology is based on a relatively simple design that offers long term reliability without the need for the user to calibrate the switch. Many industrial processes needs devices that are able to sense the liquid level stored within various thanks or containers. The signals from these devices may be used to provide indication of the status.

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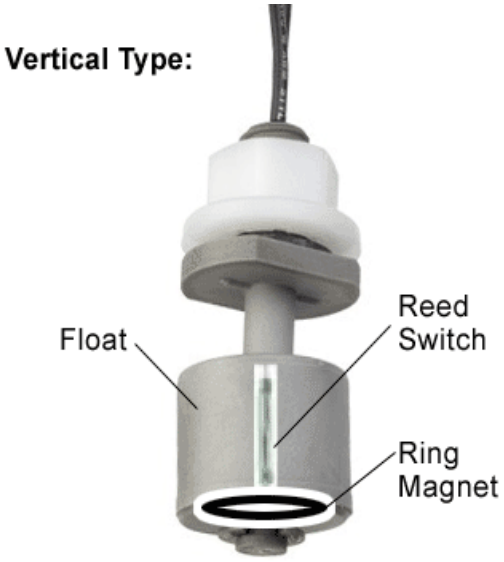

Fig4.1: Float Switch

B. SMPS

It is an electronic power supply which is having switching regulator that converts electrical power efficiently .An SMPS transfer power from a DC or AC source, to DC loads, such as personal computer, by converting voltage and current characteristics . SMPS can be used in mobile phone charger, personal computer, etc. The efficiency of SMPS greater than that of linear regulators because the switching transistor dissipates little power when acting as a switch. But the disadvantages is the greater complexity, the low-pass filter must block generation of high amplitude, high frequency energy to avoid electromagnetic interference, a ripple voltage at the switching frequency & the harmonic frequencies[3].

Fig4.2 : Switched-Mode Power Supply (SMPS)

C. Contactors

A contactor is an electrically controlled switch used for switching an electrical power circuit, similar to relay except with higher current rating kilovolts.

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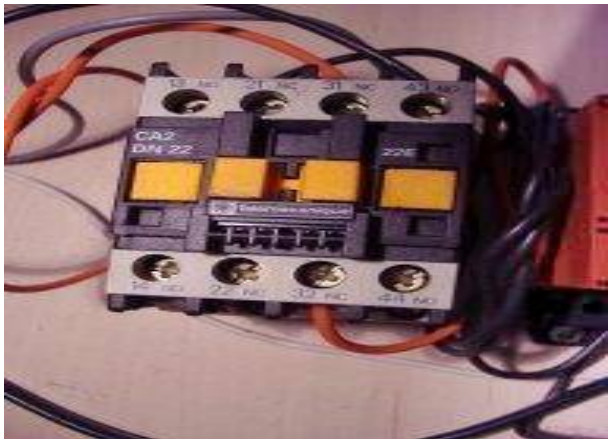

Fig 4.3 : Contactors

A contactor is controlled by a circuit which has a much lower level than a switched circuit. Contactor range from those having a breaking current of several amperes to thousands of ampere sand 24V DC to many

D. Human Machine Interface

Through Human Machine Interface the user interacts with the system. By means of a GUI the current status of the system is communicated to the user. From the interface the user can also turn ON or OFF various functions.

E. Programmable Logic Controller

This serves as the main control unit of the system. The ladder logic is prewritten on a non- volatile memory. The ladder logic was implemented in Siemens SIMATIC manager. On basis of this logic the PLC takes its decisions. In our project Siemens S7-1200 was used. The S7-1200 enables space-saving and modular configurations. The slots are freely addressable as there are no slot rules. So a single S7-1200 in an industry can automate and monitor a large number of tanks. They are scalable in terms of their performance and are equipped with integrated IOs, integrated PROFINET interface for programming, HMI connection, distributed IOs and distributed drive architectures.

Fig4.5 : PLC S7-1200

The S7-1200 can be optimally adapted to yours individual requirement by means of pluggable signal modules and communication modules.

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F. Relay and Motor

A relay is an electrically operated switch. 8 pin relay is used in this project to protect the motor. A small aquarium motor is used in the system is to pump the water from the lower tank to the upper tank. The DC output of the PLC is converted into a signal compatible to effectively control the motor being used with the help of relay.

V. DESIGN AND IMPLEMENTATION

The overhead Tank is to be filled by a Pump. The pump will automatically start when the water level of Over Head Tank reaches below Low Level and stop when the level reaches High Level. Dry run is checked by the Low Level sensor of the Underground Tank [2]. In that case Pump will not run.The implementation is divided into three parts:-

1. Sensor Positioning
2. HMI Designing
3. Ladder Programming

A. Sensor Positioning: Three float switches were used to sense presence of water at required levels. The sensors are LT_LL – Low Level Sensor lower tank (I 0.2), UT_LL – Low Level Sensor Upper tank (I 0.0), UT_HL – High Level Sensor Overhead tank (I 0.1) are placed.

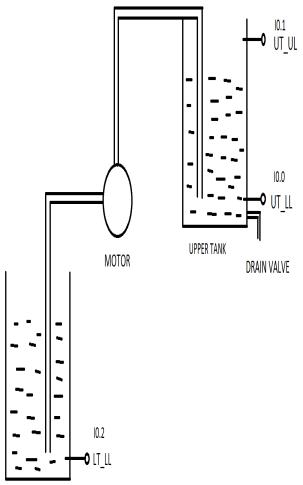

Fig 5.1 : Sensor Positioning

B. HMI Designing: The Human Machine Interface was created in WinCC Explorer [3]-[4]. We used tags for the communication of the PLC Ladder logic operation in the Simatic manager with the HMI. The created HMI is shown in Fig below. The whole project is shown along with the sensor positions.

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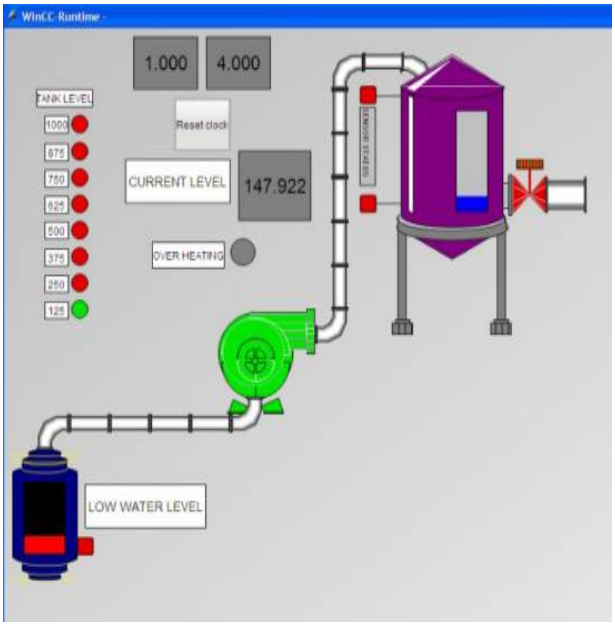

Fig 5.2 : HMI Designing

C. Ladder Programming: The Ladder programming for the Siemens S7-1200 was done in Siemens Simatic manager [2].

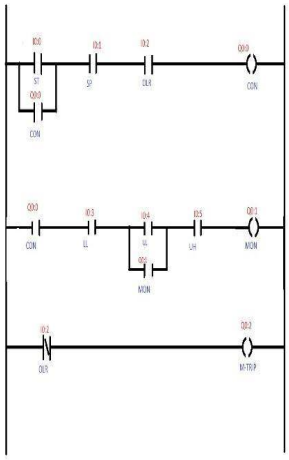

Fig 5.3 : Ladder Programming

VI. FUTURE SCOPE

A digital type sensor such as proximity sensor can be used. One more sensor above the higher level can be place for continuously detecting the overflow of liquid and able to shut down the overall process if higher level sensor fails. Also, better pump and valve can be installed which performs very rapidly for the rising and dropping of water level in a lower tank and give much fast update of water level in the tank. By adding theft detection system theft of water which occurs at water distribution system can also be solved.

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VII. CONCLUSION

In this paper, the aim for automating the water level control process has been achieved succesfully. No human supervision was necessary. The PLC S7-1200 also offers many Input Output ports. Hence this single system can control many tanks making it efficient and cost effective.

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