DESIGN AND DEVELOPMENT OF AN AUTOMATED WATER LEVEL CONTROL SYSTEM

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Abstract. This study details the design and implementation of an automated water level controller using the MC14066 integrated circuit, which acts as a threshold detector to facilitate on/off pump control. The controller was tested in real-world conditions to regulate water levels within a tank, specifically interfacing with a single-phase 0.5 HP AC pump. It effectively maintained predetermined minimum and maximum water levels of 10 and 50 liters, respectively. This automated system proved to be highly efficient in preventing overflows and underfills, thus significantly reducing the potential for water and energy wastage. The implementation highlights the controller's applicability and effectiveness in maintaining critical water levels, offering significant benefits for residential, agricultural, and industrial settings.

Keywords: electronic circuitry, water level, integrated circuit, control, regulator.

SUV SATHINI ROSTLASHNING AVTOMATLASHTIRILGAN TIZIMNI LOYIHALASH VA ISHLAB CHIQISH

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Annotatsiya. Ushbu tadqiqotda MC14066 integrallangan sxemasidan foydalangan holda avtomatlashtirilgan suv sathini nazorat qilish qurilmasining dizayni va ishlab chiqilishi batafsil bayon etilgan. Ushbu qurilma nasosni yoqish/o‘chirish uchun chegaraviy aniqlovchi sifatida ishlaydi. Qurilma haqiqiy sharoitlarda sinovdan o‘tkazilib, 0,5 ot kuchiga ega bo‘lgan bir fazali AC nasos bilan interfeys orqali tank ichidagi suv sathini tartibga solishda foydalanilgan. Qurilma 10 va 50 litr bo‘lgan oldindan belgilangan minimal va maksimal suv sathlarini samarali tarzda saqlab turdi. Ushbu avtomatlashtirilgan tizim toshib ketish va kamayishning oldini olishda juda samarali ekanligini isbotladi va shu bilan suv va energiya sarfini sezilarli darajada kamaytirdi. Qurilmaning joriy etilishi nazorat qilish qurilmasining suv sathini muhim darajada saqlashdagi

qo‘llanilishini va samaradorligini ko‘rsatib, uy-joy, qishloq xo‘jaligi va sanoat sohalari uchun katta foyda keltiradi.

Kalit so‘zlar: elektron sxemalar, suv sathi, integrallangan sxema, nazorat, regulyator.

Introduction

The necessity for effective water management in various sectors such as industry, agriculture, and residential settings often involves the use of overhead tanks fed by electric pumps. Traditionally, these tanks are monitored manually to determine when they are full, typically indicated by overflow.

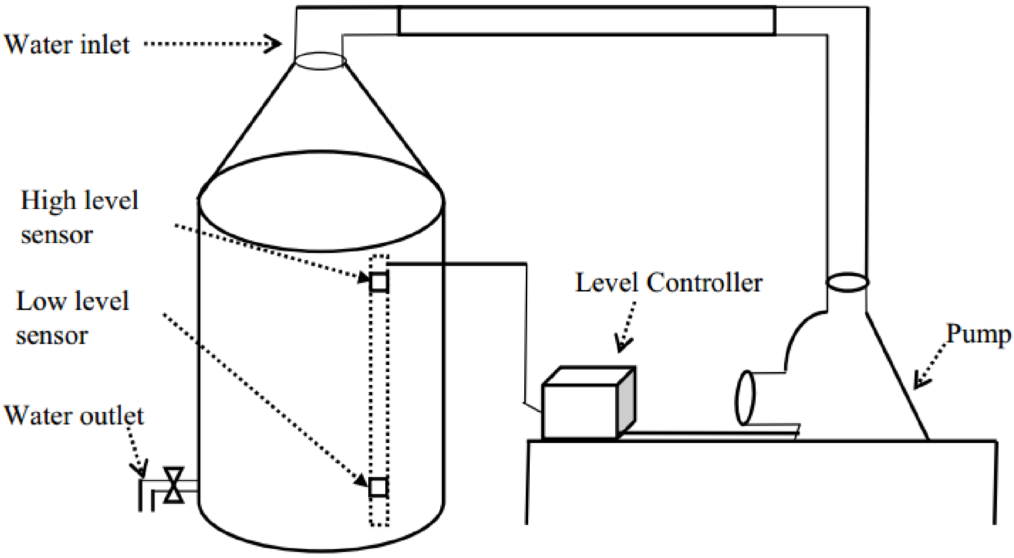

Figure 1: Schematic of the tank and regulator.

This method can lead to significant losses, especially if the liquid being managed is expensive or environmentally harmful. The introduction of an automatic feedback control mechanism could revolutionize this process by enabling pumps to operate only as needed, thereby enhancing efficiency and reducing waste. While pumps with variable speed motors offer more efficiency than simple on/off systems, they are often prohibitively expensive for small to medium enterprises.

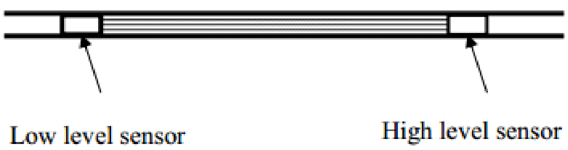

Figure 2: Schematic of the Sensor Assembly.

Moreover, most high-quality water level sensors are imported and costly, making them inaccessible for widespread use in households. This paper focuses on a cost-effective, simple but efficient automatic water level control system designed to address these issues, using readily available electronic components.

Traditional methods for determining water levels in tanks involve either tapping the tank's side until the sound changes or manually dipping a measuring stick into the tank. Both methods are flawed; the former is unreliable, and the latter is cumbersome and time-consuming. In contrast, more sophisticated approaches use electronic circuitry to sense water levels, utilizing integrated circuits (ICs) that allow for precise control and regulation. This technology has evolved significantly since the development of the transistor at Bell Laboratories in 1947, which marked the beginning of replacing vacuum tubes for switching electronic signals. It wasn't until 1959, however, that Texas Instruments developed the integrated circuit, revolutionizing electronic design and functionality. Particularly relevant to this study is the MC14066 integrated circuit, designed for specific control tasks like water level regulation.

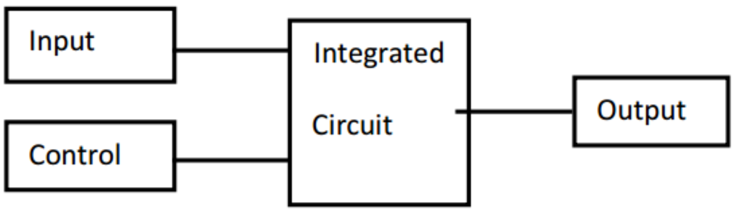

Figure 3: Functional block diagram of MC14066.

Despite advances, as of now, in Uzbekistan, sophisticated water level sensing and control systems are not commonly manufactured locally and are typically imported.

The proposed system is a closed-loop control device that utilizes liquid levels to manage the power supply to a pump, functioning as a discrete on/off actuator through an electronic circuit. This system employs two electronic sensors strategically positioned to detect low and high water levels. The sensors' output signals are converted into on/off commands that control the pump's power supply, as illustrated in the schematic diagram in Figure 1. One of the primary advantages of this system is its versatility—it is not constrained by the size or material of the liquid tank. Any existing tank can be retrofitted into a controlled environment by installing a regulator sensor and integrating the necessary circuitry. The sensor used, depicted in Figure 2, operates based on the electrical conductivity of water, which varies with the concentration of dissolved salts. This sensor comprises a metallic conductor housed within a plastic tube, rising in synchronization with the water level in the tank. This design allows for precise and adaptable water level management suitable for various applications.

The liquid tank, pivotal to the system, is constructed from G14 galvanized iron sheet, molded and welded into a cylindrical shape where the diameter is twice the height for optimal stability and capacity. It features essential inlet and outlet pipes to facilitate water flow.

A single-phase electric pump, specifically the MKP-60 model from Oceanic Water Pump company, is used, operating at 0.5 horsepower, equivalent to 0.37 kW. This pump efficiently manages the water intake and discharge.

Central to the water level control is the MC14066 integrated circuit, which includes four independent switches that handle both digital and analog signals. This IC is crucial for transforming electrical input into actionable control signals that manage the pump's operation.

The setup involves a 12V DC input linked to the IC's input pin, which only transmits to the output when a control signal is present, determined by the water's contact with a strategically placed sensor wire. This control pin is grounded through a 100k resistor, and a secondary wire set at a predetermined water height creates an electrical path when in contact with water, thus generating a control signal.

When water reaches this sensor wire, it completes the electrical circuit, allowing the 12V DC to proceed and triggering the control signal. This results in the actuation of a TIP31 transistor through a relay, turning the pump on or off based on the water level.

This system efficiently automates the water level management by using electrical signals to control mechanical actions, reducing the need for manual intervention and enhancing the overall efficiency and lifespan of the pump.

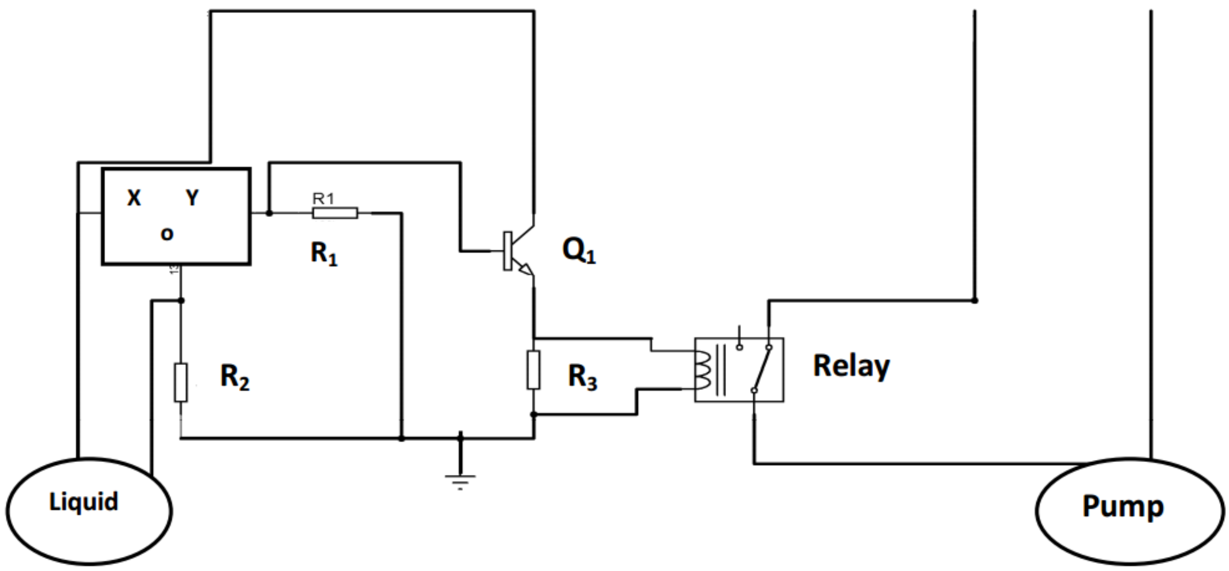

Figure 4: Circuit diagram of the water level controller.

To evaluate the performance of the newly developed water level control system, it was connected to a 0.37 KW (0.5 Hp) AC water pump, which is typical for this application but can be substituted with any similar AC pump. This setup was tasked with managing the water supply to an overhead tank. The system was calibrated to maintain the water level between a maximum of 50 liters and a minimum of 10 liters.

The operational test involved connecting the pump to a control device (regulator), with the water level sensor immersed in the tank and linked to the regulator through well-insulated output cables. The system was initiated to start filling the tank. Upon reaching the predefined maximum water level of 50 liters, the regulator automatically deactivated the pump, halting the water inflow.

Further testing of the system's responsiveness to dropping water levels involved continuously drawing water from the tank. When the water level decreased to the set minimum of 10 liters, the regulator automatically reactivated the pump to replenish the tank. This process demonstrated the system's capability to effectively maintain the water level within the set limits, provided there was a continuous power supply. This test confirmed the functionality and reliability of the water level control system in real-world conditions.

Conclusion and Recommendations

An automatic water level regulator was developed and constructed at the Karshi Engineering Economics Institute, Karshi, using readily available materials. The core of the device's electronic circuitry features the MC14066 integrated circuit, complemented by other basic electronic components. The reservoir tank was crafted from durable galvanized iron sheet, while the sensor system was securely housed in plastic tubing and submerged in water to monitor levels accurately.

During the performance testing phase, the regulator demonstrated its capability to maintain water levels within a predefined range. This functionality not only showcases its potential to minimize energy and material wastage in various sectors, including process industries and small to medium-sized enterprises, but also highlights its applicability in agricultural settings, homes, and other areas where overhead tanks are commonly used to store water and various ionic solutions. The successful testing and implementation of this regulator suggest its broad utility in enhancing resource management and operational efficiency.

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