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**Research Article** 

# DESIGNING OF THE AUTOMATED CONTROL SYSTEM OF LIQUID LEVEL IN THE TANK SIZES SPECIFIED

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#### ABSTRACT

The article describes the components of the automated liquid level system in the vessel of known volume and their interaction.

# **K**EYWORDS

Automated system, software, microcontroller, liquid level sensor.

# Introduction

Modern rapidly developing measuring technology is increasingly being introduced into the operational processes of control and

technological regulation. At the same time, measurement methods are constantly being improved, the accuracy of measuring instruments

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is increasing, on the basis of which various systems for monitoring. accounting managing technological processes are created. In many industries, this involves liquid level measurement. This area of measurements is constantly developing, new measurement methods are being developed [1-4]. The creation of automated systems, especially based on highprecision level gauges with a continuous measurement process, makes it possible to more accurately estimate production costs, optimize production process control, prevent losses, and improve the quality of information support of the first technological process. Thus, the industry is constantly increasing demand for high-precision low-cost liquid level meters, combined into a process control system. The tasks of automating various technological processes do not lose their relevance in modern industries. The developed system is designed to control the level of milk in a container a known size Blagoveshchensky Dairy Plant, where improvised means are still used to measure it [5-8].

The project involves the installation of a special sensor (level gauge) in the tank and its connection to a programmable microcontroller, which will ensure the transfer of the obtained measurements to a logometer (digital cascade indicator) and to a computer. To implement the project, it is necessary develop special software (SW) of two types. Firstly, a program for the microcontroller, which will make it possible to read the electrical signal from the level gauge and conversion into a pulse-width modulation (PWM) signal for transmission to a ratiometer and to

Personal Computer. And, secondly, an application that allows not only to track the current liquid level remotely, but also store and process measured data. In his list functions include: displaying

information about past measurements at the request of the user, conducting analysis of stored information (for example, the total volume of milk for a certain period of time, the maximum and minimum levels for the entire period of observation), the formation of a message about reaching a critical value, etc.

Rationale for the choice of technical means. Measuring the level of petroleum products is a rather difficult task that requires careful selection of sensors due to the aggressiveness, viscosity and explosiveness of the controlled environment.

For more than a hundred years, oil has been the most important mineral in the history of mankind (the world's first pump for the extraction of "black gold" was developed in 1916 by our compatriot, inventor Armais Arutyunov). Oil is the basis of various fuels, lubricants, solvents, petrochemical raw materials, etc. Dark and light oil products have their own individual physical and chemical properties, which determine the way to control the level of oil products at all stages of storage, transportation and processing.

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Features of the environment make the process quite complicated and require the following factors to be taken into account:

- Significant temperature and pressure drops in the tank:
- Toxicity aggressiveness of or the environment:
- Probability of corrosion of equipment parts;
- Sticking of product particles;
- Change in the density of the measured oil products:
- Requirements for explosion-proof execution of sensors.

All these conditions significantly complicate the task of measuring the level of oil products in a tank, especially when high accuracy is required. But there is a solution: the control of the level of liquid petroleum products in tanks is successfull y implemented using level gauges, both contact and non-contact. Non-contact measurement of the oil level can be provided by ultrasonic level gauges EchoTREK, EasyTREK, ULM-53, and radar level gauges Sitrans LR250, Sitrans probe LR, PiloTREK.

In the list of contact points, it is worth paying attention to the MicroTREK microwave level transmitter for accurate measurements in difficult conditions, the economical NivoTrack magnetostrictive level transmitter, the DLM-35 capacitive level transmitter, the LMK 331 hydrostatic level transmitters (for aggressive liquids) and LMP 331 (for viscous media).

Thus, the ACS includes the following technical components: level liquids. sensor microcontroller, ratiometer, personal computer; software components:

Microcontroller software, software required for operator's work.

The development of the system required choose reliable components with low cost.

Liquid level measuring instruments implemented by various methods based on various physical principles. To the most common contact methods of level measurement, allowing to convert it value into an electrical quantity and transfer its value to automated process control systems, include: wave, float, capacitive, hydrostatic and buoy. Of the listed types, the float level sensor is one of the most inexpensive and at the same time reliable devices. Its advantages include resistance to foam and bubbles in the liquid, as well as the ability to work with viscous liquids. Such a sensor should have some freedom to descend and ascend relative to the attachment point. Distance, on which such a float floats is called the regulation level. If the sensor installation top of the tank is not possible, then the float level sensor is mounted in the wall of the tank.

Among the float sensors, the "Dump liquid level indicator sensor" was chosen - a rheostatic type, electromechanical, the resistive element of which is made using thick-film technology. Sensor characteristics: operating temperature range from minus 40°C to plus 60°C, as well as vibration

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loads in three axes at an acceleration of 50 m/s and a frequency of (50-100) Hz, shock loads at an acceleration of 100 m/s<sup>2</sup> and a frequency of 80-



Fig. 1. Microcontroller Arduino UNO.

As a microcontroller, the choice was made in favor of the Arduino UNO R3. Arduino - hardware a computing platform whose main components are a simple I/O board and a development environment in the Processing / Wiring language. Arduino. It can be used to create

stand-alone interactive objects, and connect to software running on a computer. This board has

6 analog inputs and 6 outputs capable of outputting a PWM signal. These signals are available on the board via pads or pins. connectors. Several types of external expansion boards are also available, called "shields", which attach to the Arduino board via pin headers. Characteristics of the microcontroller: processor - ATmega328p, supply voltage - 5 volts, flash memory - 32 Kbytes, EEPROM - 1 KB, SRAM - 2 KB, number of binary inputs / outputs - 14, supported USB interface - 8U2. The appearance of the microcontroller is shown in fig. 2. As a

120 beats per minute. Average device life - 12 years. The appearance is shown in fig. 1.



Fig 2. Digital cascade indicator.

logometer, a digital cascade indicator of the TsKI 01 SB type was chosen, designed to control the position of the voltage regulator of power transformers with regulation under load and operating in combination with a motor drive of the voltage regulator. It is used for mains and special transformers designed for power supply systems and for supplying processes, providing a remote indication of the voltage regulator of the transformer. The indicated ratiometer designed for indoor operation with installation on an electric panel and is shown in fig.3.

#### How the system works

Inside the liquid level sensor there is a permanent magnet at the end of the lever, which

switches reed switches (contacts). At the other end of the lever is a float. When the water level

rises, the float is pushed up, moves the lever, moving the magnet from one position into

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another. Further, when the magnet approaches, the reed switches close, each closed reed switch corresponds to its own water level. The signal received from the sensor is sent to the microcontroller, in which the program is running. When changing the value of the sensor signal in the range from 45 to 540, the level pulse width modulation output by the microcontroller varies proportionally from 0 up to 200 and is measured in liters. This value is displayed on the ratiometer, PC monitor and is constantly updated.

There is a wide range of means for monitoring and measuring the level, using various physical methods: capacitive, electrocontact, hydrostatic pressure, float, ultrasonic, radio wave. These methods and tools allow you to control the level of various media: liquid (pure, contaminated), pulps, oil products, free-flowing solids of various dispersion. At when choosing a level gauge, it is necessary to take into account such physical and chemical properties controlled environment such as temperature, abrasive properties, viscosity, electrical conductivity, chemical aggressiveness,

etc. In addition, one should take into account attention to operating conditions in or around the tank: pressure, vacuum, heating, cooling, method of filling or emptying (pneumatic or mechanical), the presence of a stirrer, flammability, explosion hazard and others.

Modern production automation systems require statistical and information data to estimate costs, prevent losses, optimize production process control, improve efficiency use of raw materials. This ever-increasing demand for information leads to the need to use in control systems not simple signaling devices, but means providing continuous measurement.

Today, level measurement in many industries carried out by different operating principles by level gauges, of which float, buoy, hydrostatic, electric, ultrasonic and radioisotope. measuring instruments are also used.

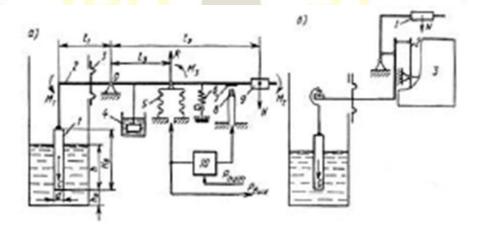


Fig.3. Diagrams of pneumatic displacers.

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The layout of the displacer pneumatic level gauge is shown in fig. 4. The level gauge works as follows. When the liquid level in the apparatus is equal to the initial h0 (in a particular case, h0 can be equal to 0), the measuring arm 2 is in equilibrium, since the moment M1 created by the weight of the displacer G is balanced by the moment M2 created by the counterweight N. When the liquid level becomes greater than h0, part of the buoy is immersed in the liquid. Therefore, the weight of the displacer decreases, and consequently, the moment M1 created by the displacer on the lever 2 also decreases. Since M2 becomes larger than M1, the lever 2 rotates

around the point 0 clockwise and covers the nozzle 8 with the damper 7. Therefore, the pressure in the nozzle line increases. This pressure is supplied to the pneumatic booster 10, the output of which is the output of the level gauge.

On fig. 4 shows a diagram of level measurement with a manometer. Applicable for for these purposes, pressure gauge 1 can be of any type with appropriate limits measurements determined by the dependence  $p = \rho gh$ . Hydrostatic measurement pressure with a pressure gauge can also be carried out according to the scheme shown in fig. 4.

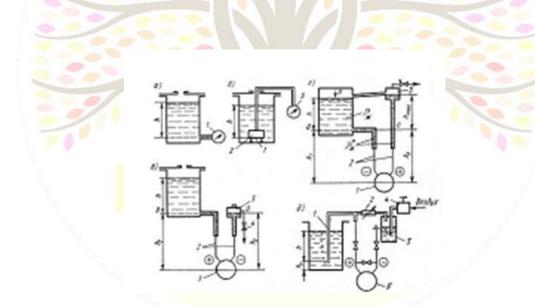


Fig.4. Level measurement schemes with hydrostatic level gauges

According to this scheme, the value of the measured level is judged by the pressure of the air filling the manometric system.

In the lower part of the manometric system there is a bell 2, the hole of which is blocked by a thin elastic membrane 1, and in the upper part there is a pressure gauge 3. The use of an elastic membrane excludes the dissolution of air in the

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liquid, however, it introduces an error in determining the level due to the elasticity of the membrane. The advantage of this scheme for hydrostatic pressure measuring independence of the pressure gauge readings from its location relative to the liquid level in the tank.

When measuring the level according to the considered schemes, measurement errors occur, which are determined by the accuracy class of pressure gauges and changes in the density of the liquid.

The same signal is simultaneously sent to the negative feedback bellows 5. Under the action of pressure PBout, a force R arises, the moment M3 of which coincides in direction with the moment M1, i.e. the action of the force R is aimed at restoring the balance of lever 2. The movement of the measuring system of the transducer occurs until the sum of the moments of all forces acting on lever 2 becomes equal to 0. The output signal of pneumatic displacers varies in the range of 0.02-0.1 MPa when the level changes from zero to the maximum value. The initial value of the output signal (0.02 MPa) is set by spring 6 (see Fig. 6, a). To prevent self-oscillations of the measuring system of the level gauge, a damper 4 is used. The sealing of the technological apparatus when a sensitive element is installed in it is achieved by a sealing membrane 3. If necessary, the displacer can be installed in a remote chamber located outside the technological apparatus. The minimum upper measurement limit for

pneumatic level gauges is 0.02 m, the maximum is 16 m.

#### Conclusion

In the course of the work, a project was completed for an automated system for monitoring the level of liquid in tanks of a given size, selected means of technical implementation, created software for the microcontroller in C#. A program for storing and analyzing measured data is currently being developed.

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