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Description and principle of operation of the measuring system level installation with an immediate change in liquid level from 0 to 20 m at the base of the laser measuring system Xl-80

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Abstract: The article describes operation and design principle of leveling installation based on the laser measuring system XL-80 with a direct change in the liquid level unit in the range from 0 to 20 meters. A method for determining the starting point using a microwave Micropilot S FMR532 is described.

Keywords: level measurement, level gauge, level gauge, liquid level, laser interferometer.

According to the order of the Russian Federation Government of April 19, 2017 №737-R "On approval of the strategy of ensuring the unity of measurements of the Russian Federation until 2025" one of the objectives of the strategy is to create conditions conducive to the construction of the Russian Federation innovative economy. The main directions and priorities of development of the system of ensuring the unity of measurements include:

- development of the reference base of the Russian Federation;
- improving the level of metrological support of priority areas of science, technology and technology;

The world is actively working to update the reference base according to the needs of industry, science and technology, health, environment, defense and security. The introduction and development of new high-tech innovative technologies impose increased requirements for accuracy and ranges of measurements [1].

FGUP «VNIIR» developed and manufactured a level transmitter unit based on the principle of direct change in the liquid level in 1989, by analogy with the model level transmitter unit [2]. In 2017, the plant was modernized in the part of the measuring system.

The design of the level transmitter unit (Fig.1) represents two communicating vessels in the form of metal pipes with a diameter of 610 mm and height of 21 meters in one of which the measuring system is located. Filling and emptying of vessels with liquid is carried out by means of a hydraulic system installed at the base of the vessels, consisting of pipelines, shut-off and control valves, a pump and a tank with liquid. The hydraulic system is controlled by an automation system.

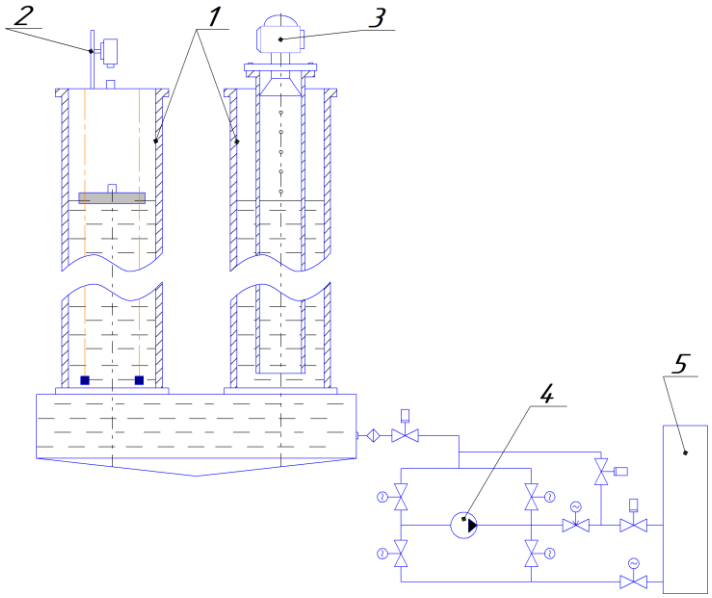

Figure 1 Scheme of level transmitter installation:

1-measuring pipes, 2-measuring system, 3-verifiable level transmitter, 4-pump, 5-liquid tank.

Measuring system of level transmitter installation (Fig.2) implemented on the basis of laser measuring system XL-80 (hereinafter – the system XL-80) and consists of a laser unit, compensation unit XC-80, a set of optical elements for the measurement of linear motion and polymer float.

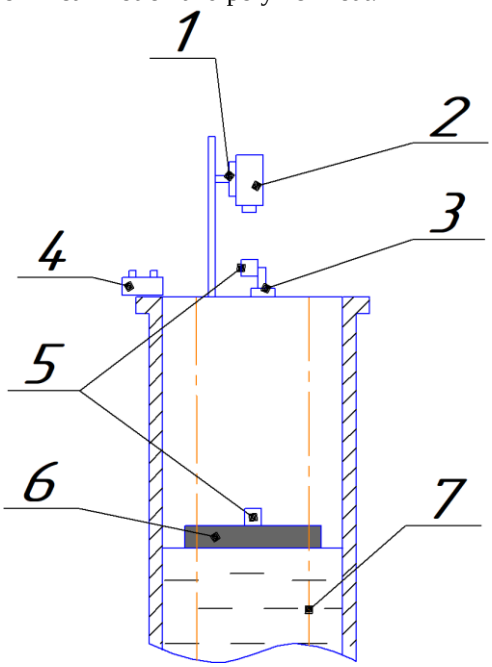

Figure 2 Level measuring system

1-table for mounting the laser unit, 2-laser unit, 3-trigger, 4-compensation unit, 5 - set of optical elements, 6-polymer float, 7-guide float.

The principle of operation of the XL-80 system is based on the interference method of displacement measurements using a frequency-stabilized helium-neon laser with circular polarization of radiation. The laser beam is divided into two orthogonal linearly polarized components, which, after passing through the optical elements that form the interference, enter the polarization analyzers and photodetectors.

The movement of the float of the measuring system occurs along the guides, which are two nylon threads fixed in the upper part of the pipe of the level transmitter installation. At the ends of the guides are fixed loads weighing 10 kg each, which allows to achieve the verticality of the guides. The laser unit of the measuring system has a table for mounting (Fig.3), to adjust the laser unit in two planes. The beam divider included in the complex of optical elements is mounted on a stand for mounting geodetic tools (Treger), which allows you to adjust the divider in the horizontal plane. The set of the above solutions allows measurements in the entire range of the level transmitter system without loss of the XL-80 beam.

Figure 3 Table for mounting the laser unit

Compensation unit XC-80 is designed to measure atmospheric pressure, temperature and relative humidity. Readings from the sensors of the compensation unit XC-80 are used to adjust the nominal value of the wavelength of the laser radiation in order to obtain its actual value, thereby eliminating measurement errors associated with fluctuations in environmental parameters.

Since the XL-80 system is designed to measure linear displacements and the reference point can be selected in any value of the measurement range, and the liquid level is the vertical distance between the free surface of the liquid located in the tank and the plane taken as the reference point [3], and the level gauges are designed to determine this distance (length), there is a need to determine the constant (zero) reference point on the level meter.

To implement a constant (zero) reference point on the level transmitter unit is used contactless level transmitter microwave Micropilot s FMR532 (Fig.4) mounted on the measuring pipe of the level transmitter unit. According to the readings of the level transmitter, the level transmitter is filled with a liquid in the range from 0 to 20 m. the Upper level value determined by the level transmitter is equal to the initial reference point of the XL-80 system and is the zero reference point of the level transmitter.

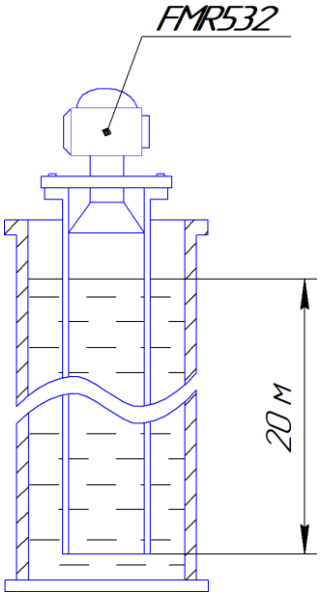

Figure 4. Determination of the initial reference point using a non-contact level transmitter

The convergence of the initial reference point measurements at 20 meters using the microwave Micropilot S FMR532 level transmitter was verified by changing the liquid level in the level transmitter installation relative to the initial reference point by forward and reverse motion, and by controlling the changes using the XL-80 system. According to the results of the test, the convergence of the liquid level measurements in the level transmitter unit, using the microwave level transmitter Micropilot S FMR532, at the level of 20 m does not exceed ±0.06 mm.

References

Based on the analysis used in the Russian Federation level transmitter units, certified as the standard unit of length in the field of liquid level measurements [4], the use of a system based on the interference method of displacement measurements, as a measuring system level transmitter unit is an innovative solution that allows for the most accurate reproduction of the liquid level among the existing level transmitter units, as well as implements the main directions and priorities of development of the system to ensure the unity of measurements, in accordance with the order of the Government of the Russian Federation of April 19, 2017 №737-R "On approval of the strategy of ensuring the unity of measurements of the Russian Federation until 2025".

Examples follow:

[1]. Order of the Government of the Russian Federation of April 19, 2017 N 737-R "About the approval of Strategy of ensuring unity of measurements in the Russian Federation till 2025".
[2]. state standard 8.321-78 State system for ensuring the uniformity of measurements. Industrial application level gauges and float-type level gauges Methods and means of calibration.
[3]. state standard 8.570-2000. State system for ensuring the uniformity of measurements. Steel vertical cylindric tanks. Calibration methods.
[4]. Bikkulov V.Sh., Kondakov A.V. Overview of standards of liquid level units // Automation, telemechanization and communication in oil industry, 2017, №6, 4-6

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