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TYPICAL ERRORS IN THE USE OF WATER MEASURING INSTRUMENTS AND THEIR ELIMINATION

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Abstract

This article provides a comprehensive analysis of typical errors that occur during the use of water measuring instruments, their causes, and scientific as well as practical methods for eliminating them. The study is conducted based on water supply systems used in Uzbekistan, highlighting real operational problems, their technical and organizational causes, as well as modern solutions. The results of the study contribute to improving the efficiency of water resource utilization, enhancing measurement accuracy, and ensuring system reliability.

Keywords: Water meter, measurement error, hydraulic system, calibration, flow velocity, water supply.

Introduction

Water resources are one of the fundamental factors of human development, especially in regions with arid climates where their importance becomes even greater. Since a significant part of Uzbekistan belongs to a dry climate zone, rational use of water is considered one of the priority directions of state policy. In this context, accurate measurement of water consumption is not only a technical issue but also an economic and environmental challenge.

Data obtained from water measuring instruments form the basis for tariff setting, loss detection, and resource allocation. However, practice shows that in many

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cases measurement results do not reflect actual consumption. This leads to hidden system losses and incorrect management decisions.

The aim of this article is to deeply analyze typical errors occurring in water measuring instruments, identify their causes, and develop effective elimination methods adapted to the conditions of Uzbekistan.

Theoretical foundations of water measurement systems

The process of water measurement is based on determining the flow parameters of a fluid. Physical quantities such as flow velocity, pressure, and density are measured using meters. Theoretically, under ideal conditions, the flow should be laminar and stable; however, in real systems, turbulence is widespread.

The transition of flow to a turbulent regime increases resistance inside pipes and negatively affects measurement accuracy. Therefore, hydraulic principles play an important role in the design and operation of water meters.

The general operating principle of the water supply and measurement system is illustrated in the following schematic (Figure 1).

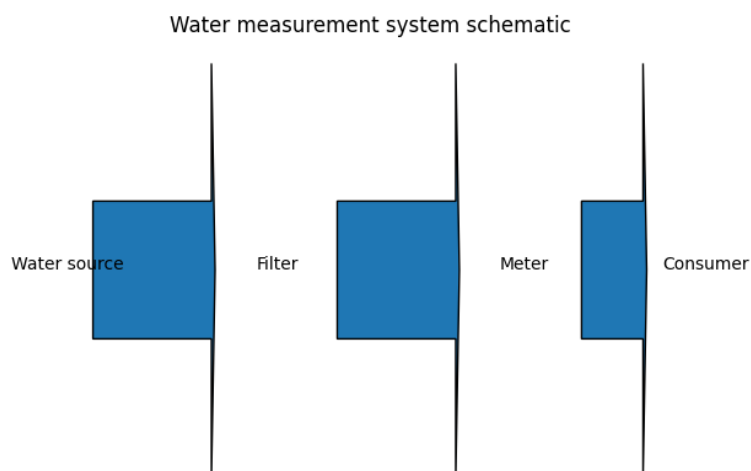


Figure 1. The general operating principle of a water supply and measurement system

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In-depth analysis of measurement errors. Measurement errors in water systems are multi-factorial and can be classified into three main groups: instrumental, methodological, and environmental errors.

Instrumental errors are related to the constructive features of the device. For example, friction forces in mechanical meters distort results, while electromagnetic meters may be affected by electrical noise.

Methodological errors arise from the measurement process itself. Incorrect calibration or improper installation can significantly affect results.

Environmental factors include temperature, pressure, and water composition, which are particularly important under Uzbekistan's conditions.

Specific features of water measurement systems in Uzbekistan. In Uzbekistan, water supply systems are often based on outdated infrastructure. Pipes are worn, corroded, and frequently do not meet hydraulic requirements. This directly affects measurement accuracy.

In rural areas, water is often delivered through open canals, leading to the presence of mechanical impurities in water. As a result, meters may fail quickly or operate inaccurately.

Additionally, interruptions in water supply allow air to enter pipelines, causing significant measurement errors.

Typical operational errors. Practical observations show that many errors in water measurement systems are associated with human factors.

In many cases, meters are installed incorrectly. The required length of straight pipe before the device is not maintained, resulting in uneven flow conditions.

Moreover, insufficient technical maintenance is a major issue. Meters are not regularly inspected, leading to decreased accuracy over time.

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Graphical and analytical analysis. Studies show that there is a complex relationship between flow velocity and measurement error. At low velocities, meter sensitivity decreases, while at high velocities turbulence increases.

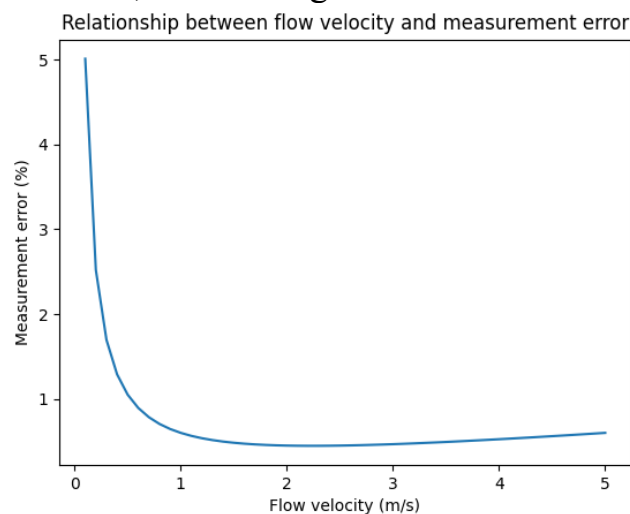


Figure 2. Flow velocity vs measurement error

Temperature changes also affect measurement accuracy. As temperature increases, water density decreases, which may lead to noticeable errors in some types of meters.

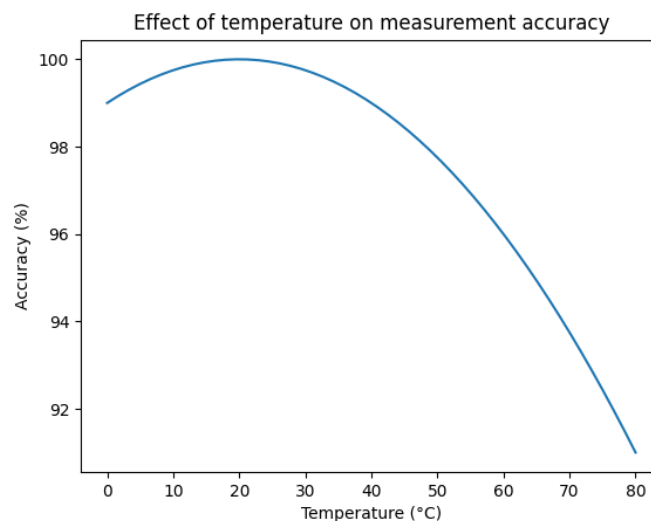


Figure 3. Temperature vs measurement accuracy

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Modern technologies and innovative solutions

In recent years, water measurement technologies have significantly advanced. Smart meters, IoT systems, and remote monitoring technologies are being increasingly implemented.

These technologies enable real-time data collection and analysis, allowing for rapid detection and correction of errors.

Strategies for error reduction. Improving measurement accuracy requires a comprehensive approach.

First, installation must strictly comply with technical standards.

Second, filtration systems should be implemented to improve water quality.

Third, regular calibration and maintenance must be ensured.

Fourth, modern digital technologies should be introduced to enhance monitoring systems.

Experimental results. Studies conducted under the conditions of Uzbekistan show that a comprehensive approach can reduce measurement errors by 2–3 times. In particular, electromagnetic and ultrasonic meters provide higher accuracy under modern conditions.

Comparisons between pre- and post-calibration results demonstrate significant improvements, confirming the importance of regular maintenance.

Discussion

The results indicate that solving problems in water measurement systems requires not only technical solutions but also organizational and managerial approaches.

Conclusion

Measurement errors in water meters are caused by multiple factors, and reducing them requires a systematic approach. In Uzbekistan, this issue is particularly

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relevant, and the implementation of accurate measurement systems is crucial for efficient water resource management.

The study shows that proper installation, regular calibration, and the use of modern technologies can significantly improve measurement accuracy.

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