

ANALYSIS OF SCIENTIFIC RESEARCH ON THE CALCULATION OF LONG-DISTANCE WATER PIPELINE SYSTEMS**Parpiev Sayfiddin Fazliddinovich**

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Abstract. In a scientific article, the work carried out in the drinking water supply system in our country, in particular, the provision of clean drinking water to the inhabitants of the Bogishamol massif of the city of Andijan, and the scientific work carried out by foreign scientists in this regard were studied.

Keywords: main water supply, clean drinking water, pipe roughness, friction coefficient, pipe diameter, Hazen-Williams equation, Altshul formula, Shifrinson formula, pressure water treatment, service life.

Currently, approximately 2 billion people worldwide lack access to clean drinking water, while over 2.3 billion are forced to consume water that does not meet sanitary standards.

According to experts, global water demand is projected to increase by another 50 percent by 2050. These statistics underscore the urgent need for the conservation and rational utilization of water, nature's most precious resource.

Furthermore, in accordance with the Decree of the President of the Republic of Uzbekistan No. UP-6024 dated July 10, 2020, the Concept for the Development of the Water Sector of the Republic of Uzbekistan for 2020–2030 was established. Additionally, Presidential Decree No. UP-6200 dated April 6, 2021, ensures that every citizen of the country has full access to water resources. Crucially, the Presidential Resolution No. PP-257, dated May 24, 2022, 'On Additional Measures to Increase the Level of Provision of Drinking Water Supply and Wastewater Services to the Population' was enacted to further enhance these initiatives.

Effective January 1, 2023:

- The replacement of water meters with expired calibration periods for residential consumers shall be financed by "Uzsuvtaminot" JSC and its regional water supply enterprises;
- The import and installation of water meters and their auxiliary components that do not meet technical regulations shall be strictly prohibited within the territory of the Republic;
- Upon the commissioning of fully operational drinking water supply facilities (wherein measuring equipment is installed and drinking water is delivered directly to households), consumers may, at their discretion, execute direct contracts and seal measuring equipment either through Public Service Centers or directly with "Uzsuvtaminot" JSC.

Effective January 1, 2023, legal entities and individual entrepreneurs are required to install modern smart water meters equipped with remote data transmission capabilities to regional water supply enterprises.

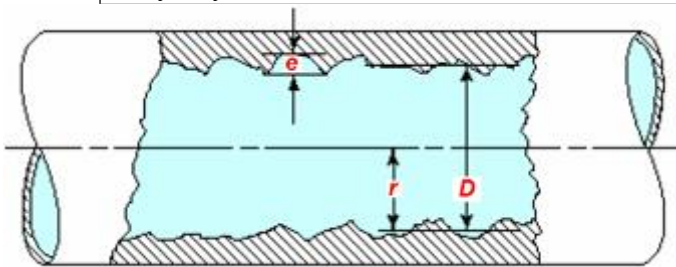
Effective January 1, 2024, legal entities and individual entrepreneurs failing to install modern water meters with remote data transmission features shall be billed for drinking water supply and wastewater services at rates applicable to unmetered consumers.

According to the Resolution, a dedicated metrology service along with its regional branches shall be established under "Uzsuvtaminot" JSC to manage the removal, calibration, and installation of cold and hot water meters.

The surging demand for clean drinking water necessitates the modernization of water facilities and the further optimization of hydraulic calculations for projected future drinking water pipelines. In this regard, numerous domestic and foreign scholars have conducted extensive scientific research.

It is well-established that the internal surface of a pipeline is not entirely smooth. The wall roughness of a pipeline restricts fluid flow; thus, parameter (ϵ) is introduced to characterize internal surface roughness, which is measured in units of length, typically millimeters (mm) due to its minute scale [1]. The hydraulic characteristics of water flow within pipelines are influenced not only by wall roughness but also by the pipe diameter.

Pipeline material	$\epsilon, (mm)$
Glass, copper	0,0015
Steel	0,045
Cast iron	0,26
Double-layer concrete pipes lined with a steel pipe	0,6
Polyethylene	0,0015



Schematic of pipe roughness

The primary performance indicators of a water pipeline system are friction head loss and pipe wall roughness. In the hydraulic calculation of water pipelines, either the Hazen-Williams or the Darcy-Weisbach equation is utilized to determine the head loss [2].

$$h = \lambda \frac{L}{D_h} \frac{W^2}{2g}$$

Here D_h – Calculated pipe velocity; W – Flow velocity; L – Pipeline length; λ – Darcy friction factor

It is well known that A.D. Altshul's coefficient approximation method is widely utilized [3].

$$\lambda = 0,11 \frac{e}{D_h} + \frac{68}{Re}^{0,25}$$

When $Re(e/D_h) > 500$, A.D. Altshul's equation for rough pipes aligns with the Shifrinson equation, whereas for smooth pipes, when $Re(e/D_h) < 10$, it coincides with the Blasius equation[4].

Professor F.A. Shevelyov established the relationship between the hydraulic friction coefficient and the operational lifespan of the pipeline based on A.D. Altshul's equation[5].

Building upon the research of F.A. Shevelyov, scientists M.Y. Panov, A.S. Levadnov, V.I. Sherbakov, and V.G. Stogney determined the dependency of the hydraulic friction coefficient on the operational lifespan of the pipeline[3].

$$\lambda_T = \lambda_0 + \frac{0,8\epsilon \cdot 1 - \exp(-0,1T)}{1 - \exp(-4D)}$$

Here $\lambda_0 = \frac{0,01559}{D^{0,226}} + \frac{0,684}{W}^{0,226}$; D – calculated pipe diameter; T – operational

lifespan, years; W – average water velocity in the pipe, m/s; λ_0 – friction coefficient of a new

steel pipe; ε – corrosive activity of water, characterized by the mass of corrosion products per unit area (mg/sm²).

In particular, Nguyen Huy Cuong, in his scientific work titled Improving and Optimizing the Design of Water Supply Systems in Large Cities Accounting for Pipeline Aging, proposed an updated hydraulic calculation method for the Thu Duc district of Ho Chi Minh City, which incorporates the friction coefficient of aged pipelines [6].

The experimental research was conducted over a single quarter within the Thu Duc district, which spans an area of 7.6 km². By 2050, the population of this area is projected to reach 110,000, with an expected daily water consumption norm of 250 L/s. This implies a twofold reduction compared to the current level.

Furthermore, he proposed a method to reduce the complexity of hydraulic calculations for water systems in large cities characterized by extensive closed-loop networks. This method facilitates cost reduction and improves management during pipeline operation.

Additionally, the study determined the dependency of the roughness coefficient of steel, cast iron, and concrete pipes on their operational lifespan.

$$C = C_0 \frac{19 e^{1 - \exp(-\partial T)}}{1 - \exp(-4D)}^2 - F_0 \text{ cast iron pipes}$$

$$C = C_0 \frac{114 e^{1 - \exp(-\partial T)}}{1 - \exp(-4D)}^2 - \text{or steel pipes}$$

$$C = C_0 \frac{15 e^{1 - \exp(-\partial T)}}{1 - \exp(-4D)}^2 - F r \text{ concrete pipes}$$

Where: ∂ – is the annual increase in absolute roughness, mm/year; C_0 – is the roughness coefficient of a new pipe.

Aleksey Petrovich Avsyukevich conducted scientific research on improving the efficiency of pressurized water supply systems with multiple consumers. He optimized existing mathematical models and proposed a new model for the design, reconstruction, and operation of pressurized water supply systems that operate under extreme conditions and account for priority consumers.

He developed a comprehensive set of general measures to enhance the functionality of pressurized water supply systems with numerous consumers, considering both the technical constraints imposed on system components and multi-functional operating regimes, while also proposing new constructive solutions.

Furthermore, another Russian scholar, Mikhail Borisovich Zakharovich, in his research on increasing the operational reliability of water supply systems and pipelines, developed the scientific foundation for a methodology to comprehensively analyze the condition of water treatment supply and pipeline systems.

A scientific basis was established to evaluate the technical condition of systems and equipment during prolonged operation within highly corrosive environments.

He also analyzed the relationship between the water supplied to the distribution network and specific groups of consumer accounts.

To perform the hydraulic calculation of a drinking water system, it is first necessary to determine the distances between facilities built based on the city master plan, the average water flow rate, and the water discharge at each node.

Water pipeline systems can be classified into branched (dead-end) and looped (ring-type) networks. Looped networks are considered significantly more reliable than branched ones, as they consist of closed loops and circuits.

The calculation of a looped water network involves determining pipe diameters, the characteristics of pumps at secondary lifting stations and booster pumping stations, as well as the dimensions of reservoirs and water towers.

Since water is supplied to Andijan city from the Khanabad reservoir, it reaches most of the city's consumers via gravity-driven pipelines. However, since the Bogishamol district is situated on a hilly terrain, water is pumped to this area using booster pumps. Considering that this system forms a closed network, scientific research is currently being conducted to mitigate head losses by reducing the hydraulic friction coefficient.

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