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Methods for determining losses of internal consequences of water supply systems

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Abstract: The correctness of hydraulic calculations in the design of water supply systems and ensuring sufficient pressure and uninterrupted water supply in the most remote areas is one of the main challenges facing engineers today. This article provides recommendations for determining the pressure loss in pipes, taking into account the coefficient of hydraulic resistance due to the type of pipe wall tension.

Keywords: turbulent motion, hydraulic resistance, fluid, velocity, equivalent, laminar thickness.

Research method. The research method is the analysis of pipes that serve to regulate the hydraulic profiles of pipelines currently used in existing water supply systems in order to obtain a positive solution.

Research results and analysis. pipe walls will have some degree of roughness. This coarse-grained pipe is characterized by varying dimensions or very little gravity on the wall surface, depending on how the material is made and how smooth it is. In order to characterize the roughness, the average height of vibrations of the pipe surface is taken to be equal to the absolute one and is marked with a Δ (Fig. 1). If the absolute gravity is less than δ of the thickness of the laminar boundary layer, it is called a hydraulic smooth pipe. (Figure 1 a)

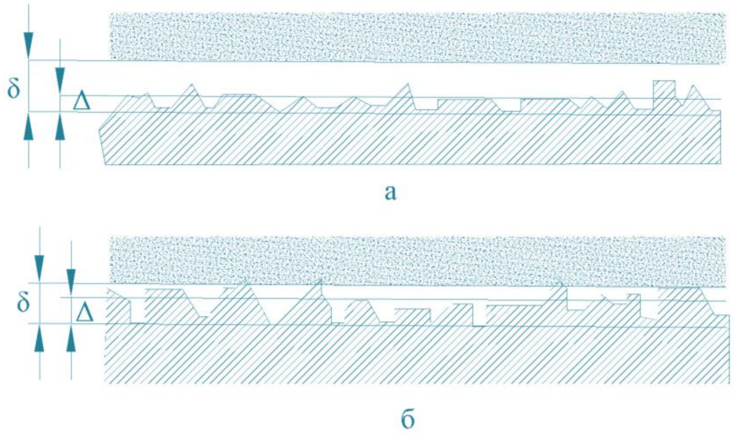

Figure 1. Hydraulic smooth and roughness of pipes.

If Δ laminar thickness is greater than δ, these pipes are called hydraulic roughness pipes (Fig. 1 b).

Determining the roughness of a pipe is a difficult task, and its calculation makes it difficult to calculate the hydraulic resistance. For this reason, the concept of roughness Δ it is introduced to facilitate computational work. These values are determined by hydraulic tests of pipes, and the values of the absolute density when calculating hydraulic losses are as follows:

1. New metal and ceramic pipes with flat joints Δ = 0.01-0.15 mm;
2. Well water pipes and concrete pipes in good condition Δ = 0.2-0.3 mm;
3. Pipes with less dirty water pipes in good condition Δ = 0.3-0.5 mm;
4. Pipe and pipe from less rusty water supply Δ = 0.5-2.0 mm;
5. New cast iron pipes Δ = 0.3-0.5 mm;
6. Commonly used cast iron pipes Δ = 1.0-3.0 mm;

To account for this, the concept of relative gravity, which follows similarity laws and more accurately describes the effect of impermeability on flow hydraulics, is calculated as the ratio of the absolute chord to the pipe diameter:

$$\varepsilon = \frac{\Delta}{D} \qquad (1.1)$$

Using relative stiffness makes it easier to calculate pipe resistance. The Darcy-Weisbach expression is mainly used for laminar and turbulent motion in determining the pressure lost in pipes.

$$h_l = \lambda \frac{l}{d} \frac{v^2}{2g} \qquad (1.2)$$

In this expression, the value of the resistance λ depends on how the liquid flows in the pipe. While laminar motion only depends on the Reynolds number, in turbulent motion it depends on the Reynolds number and the internal stiffness of the pipe wall. This pipe is called a hydraulic smooth pipe if the average deformation rate at the outlet is less than Δ <Δ and the hydraulic resistance does not affect the value (Fig. 1).

If Δ> δ affects the flow acting on the core of the turbulent core, then such a pipe is called a rough pipe. In such pipes, the coefficient of resistance λ depends on the roughness. There are many empirical expressions for λ. For hydraulic smooth pipes, the Blazuz expression can be used:

$$\lambda = \frac{0{,}3164}{\sqrt[4]{\mathrm{Re}}} \qquad (1.3)$$

In addition to the Reynolds number when λ is found for a turbulent fluid in a turbulent pipe, the ratio of the strain rate to the radius or diameter of the pipe depends on Δ/r_0 , Δ/d. The reason for this ratio is that it has little effect on the fluid acting on a larger pipe with a value of (Δ)) but in pipes with small diameters it can have a large effect. The influence of the Reynolds number and relative deformation on the drag coefficient can be seen on the graph of I. Nikuradze (Fig. 2).

In his experiments, I. Nikuradze glued fine sand particles of the same size to the inner walls of the pipe. Such a pipe is called an evenly distributed pipe..

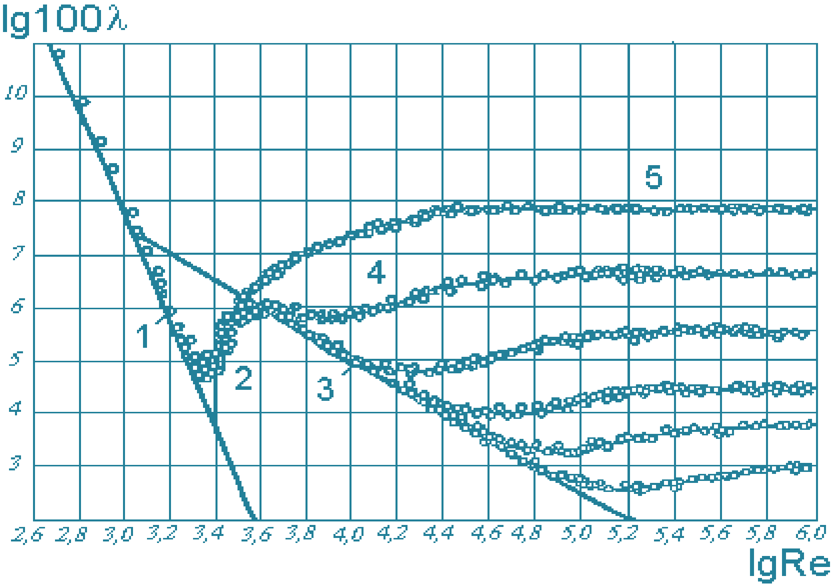

Figure 2. Nikuradze's schedule

He studied the movement of fluid in various sputum tubes. Reynolds number Re=500÷106 and relative stiffness $\frac{\Delta}{r_0} = \frac{1}{15} \div \frac{1}{500}$in the range of variation:

In a lump pipe of various thicknesses, the laminar (Re <2300 or log Re <3.36) is located on a straight line built on the points found for the liquid, that is, the drag coefficient λ depends only on the Re number in the laminar motion.

The critical Re number is practically independent of different pipe values for a pipe, since the separation from a straight line obtained in experiments is approximately equal to the Re number. For small Reynolds numbers andΔ/r_0 , Δ/d in the region of turbulent motion (Re> 3000 or lg Re> 3.48), the experimental points are located above the second straight line shown in the figure (3000<Re<30000; $\Delta/r_0 = 1/250$. Therefore, for these cases λ depends only on the Reynolds number. The drag coefficient for large Reynolds numbers (Re> 30000) и Δ / r_0 depends on the relative Reynolds number, independent of the Reynolds number, parallel to the absorption (Reynolds) axis, which is separated from the second straight line constructed from the experiment.

Thus, the hydraulic resistance found for a turbulent fluid can be divided into three regions:

1. Smooth hydraulic pipe

$$\lambda = f(R_e) \tag{1.4}$$

Definition of λ in square area

$$\lambda = f\left(R_e \frac{\Delta}{r_0}\right) \tag{1.5}$$

Square (car) area, that is

$$\lambda = f\left(\frac{\Delta}{r_0}\right)$$

(1.6)

According to the above, Nikuradze II's experiments were carried out on artificial uniformly distributed rough pipes. In life, in the pipes used, the roughness is unevenly distributed. Therefore, the concept of equivalent laying is introduced when describing the roughness of pipes in industry. Equivalent granularity is expressed as the absolute force of gravity, which is evenly distributed so that the amount of time lost in calculations is equal to the time lost in the actual pipe. The equivalent granularity value is calculated based on the hydraulic test of the pipe and the corresponding expressions.

One of the most common expressions for finding the resistance coefficient λ for a tube with natural roughness is the Altshul A.D formula

$$\lambda = 0{,}11\left(\frac{\Delta_e}{d} + \frac{68}{Re}\right)^{0.25} \tag{1.7}$$

For small Reynolds values ($Re < 10\frac{d}{\kappa_э}$), expression (1.7) transforms into another Blasius expression (1.3), mentioned above. If the Reynolds numbers are very large ($Re > 500\frac{d}{\kappa_э}$), then expression (1.7) will be transformed into the Shifrinson expression, that is, the fluid flow in rough pipes will be determined:

$$\lambda = 0{,}11\left(\frac{\Delta_e}{d}\right)^{0.25} \tag{1.8}$$

Expression (1.7) is easy to calculate from a scientific point of view.

For all turbulent flows, Colpbrook and White propose the following equation. Determination of the liquid resistance coefficient in steel and cast iron pipes in the case of an increase in V <1.2 m / s is determined by the following formula.

$$\lambda = \left(\frac{1{,}5 \cdot 10^{-6}}{d} + \frac{1}{\mathrm{Re}} \right)^{0{,}3} \tag{1.9}$$

Therefore, it is recommended to use the liquid in heating systems, ventilation and other areas in order to find the drag coefficient in turbulent motion.

Conclusion. The coefficients of hydraulic resistance in pipelines used in water supply systems are one of the key components of providing the population with drinking water under pressure sufficient for hydraulic calculations to be performed. For hydraulic calculations, it is advisable to use the above formulas, which are used when accounting for liquid.

In addition, it is necessary to take into account the local pressure, geometric and network fittings that will be lost in the network. When designing hydraulic systems, taking into account the specific formulas and characteristics of the materials used, the design of the water supply system provides long-term service to the population.

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