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INCREASING THE TECHNICAL AND ECONOMIC EFFICIENCY OF HYDRAULIC NETWORKS

The power costs for moving the working medium through pipelines are determined as follows:

$$N = \rho g Q \Delta H, \qquad (1)$$

where Q is the volumetric flow rate of the energy carrier, m^3/s;

ΔN– pressure loss during movement of the medium, m:

$$\Delta H = \left(\lambda \frac{L}{d_1} + \sum \xi_м \right) \frac{Q^2}{2gS^2}; \qquad (2)$$

ρ– density of the transported medium, kg/m^3

g – acceleration due to gravity, m/s^2

λ– coefficient of hydraulic friction;

L, d_1, S – length, diameter and cross-sectional area of the pipeline (m, m, m^2).

In the self-similar region, characteristic of the main modes of movement of energy carriers in thermal power plants, the coefficient of hydraulic friction can be considered constant.

The cost of electricity spent on moving energy carriers:

$$C_E = C_{E1} \cdot N \cdot \tau, \text{ UAH}, \qquad (3)$$

where C_{E1} is the cost price of a unit of electricity, UAH/kW·h

τ – pump operating time, h

As the pipeline diameter increases, power consumption, and therefore energy for driving the pumps, decreases.

On the other hand, as the diameter increases, the metal content of the pipeline increases, and, consequently, its cost:

$$C_{тр} = C_{м1} \cdot \rho_м V_g, \text{ UAH}, \qquad (4)$$

where $C_{м1}$ is the cost of a unit of metal mass, UAH/kg;

ρ_m– metal density.

Thus, the task of optimizing hydraulic networks can be reduced to minimizing the total cost, which consists of the cost of pipelines and the cost of energy spent on moving energy carriers:

$$C_{\min} = \min\{C_E + C_{тр}\}. \qquad (5)$$

The minimum of the cost function is determined by the following values of the derivatives:

$$\frac{\partial C}{\partial d} = 0; \quad \frac{\partial^2 C}{\partial d^2} > 0, \qquad (6)$$

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