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The Program Complex of Hydraulic Calculation of Parameters of Functioning of a Multi-Ring Gas Supply Network

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ABSTRACT: In this paper we solve the problem posed, research on formation of complex models, algorithms, software module, information-structural analysis, evaluation functioning a multi-ring gas supply network and estimating the physical and chemical parameters of gas, which allows experts to make sound decisions on the regulation processes of flux as the desired product.

KEYWORDS: complex, automation, evaluation, operation, decision-making, gas supply networks, accounting charges of gas, the pressure drop, hydraulic, distribution of the gas flow, physical and chemical parameters.

I.INTRODUCTION.

Fuel and energy systems in our Republic are a complex of technical systems management due to problems and tasks aimed at improving the efficiency of energy use.

These challenges were and remain one of the main priorities in the economic development in any country.
The use of gas in the national economy allows automate production processes in industry and agriculture, to improve the sanitary conditions at work and at home, healthier air in the cities.

Theoretical research and practical implementation these problems are to increase the efficiency applied and developed concepts, algorithms, tools and techniques of modern information and communication technologies that determine the quality decision-making in the most reasonable time. In our Republic created all necessary conditions for the informatization society, as well as for the development and improvement of its legal and regulatory framework [1,2,3].

II. LITERATURE SURVEY

GafurovSh.S. and others, the task of forming an algorithm and a calculation program for assessing the technical and economic characteristics of the functioning of gas supply systems has been solved. Here is a mathematical model of hydraulic calculation for the radiant structure of a gas-supply network consisting of a number of sections. This work can be applied to branched or dead-end gas supply systems without taking into account hydraulic fracturing, or to collectors connected to urban systems.

Kassin N.V. and others. "Mathematical modeling of branched hydraulic systems", mathematical models and methods for estimating the flow distribution of the target product are described and justified, which reduce to a system of equations consisting of (n-1) linear equations.

Strekalov A.V. "The method of numerical solution of the flow distribution problem in network hydraulic systems" is devoted to the problems of adapting the numerical solution of systems of nonlinear algebraic equations for solving flow distribution problems in arbitrary hydraulic systems of arbitrary complexity. The task of flow distribution is to find unknown volume or mass flow, as well as pressures in all elements of the hydraulic system.

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Loginova K.V. "Modeling of complex hydraulic networks with adjustable parameters" explored the issues of creating a complex of mathematical models, algorithms for solving the problem of multicriterial estimation and making managerial decisions aimed at providing an automated end-to-end cycle of developing a new generation of software and hardware automation tools and creating multi-level information management systems on their basis real time, providing optimization of operational modes of operation of technological vices, and also manage their performance.

III. SITUATIONAL ASSESSMENT MODEL INDICATORS FOR THE MULTI-RING GAS SUPPLY NETWORK.

Qualitative functioning of gas supply networks in general, and multi-ring gas supply network in particular, is directly related to the problems and tasks of optimizing gas supply systems, covering a wide range interrelated issues of optimal system design, operation control in the course for their operation, as well as a number of other tasks.

These problems are a certain complexity, since the gas supply networks are essentially subsystems of large scale power systems, are constantly evolving and are characterized by multi-factor dependence of technical and economic indicators. This requires the development and implementation of modern tools, methods and systems, information - communication technologies.

The city's gas supply system is a complex set of facilities, technical devices and pipelines that ensures the supply and distribution of gas between industrial, municipal and household consumers in accordance with their demand.
The technological scheme of the gas distribution station includes an automatic protection system that guarantees the value of gas pressure in urban networks, not exceeding the permissible level.

Gas distribution stations are connected by branches with a ring of high pressure category (up to 1.2MPa), which is located on the periphery of the city. From this ring, through several network hydraulic fracturing, the gas enters the ring networks of high (up to 0.6 MPa) or medium pressure.

Gas supply system of the city is influenced by many factors, the main of which are: the size of the city, the features of its layout and development, population density, number and nature of industrial consumers and power plants, etc.).
Modern gas supply networks (Fig. 1) are a complex structure, consisting from the following main elements: the gas networks of low, medium and high pressure, gas distribution stations, regulating stations and installations.

Usually, if knowing the length of the settlement network sites and design flow of gas, pick up the diameter of the pipeline and determine the pressure loss, then check not exceeding the standard value of the resultant pressure drop. Failing which the held some adjustment diameters, more design considerations than to optimize the system. The distribution of the estimated pressure drop between sections of the gas network is one of the most important optimization problems.

A fluctuation in gas to consumption by hour in the day comes from the downward flow of gas at night on the domestic needs of the population, and also depends on the mode of industrial enterprises. Therefore, to ensure continuity, supply to consumers of gas supply system is calculated on the maximum hourly flow rate.

Gas flows from the main gas pipelines in the city, settlement and industrial gas supply system through the gas distribution stations. Distribution station is the final portion of the main gas pipeline and is a kind of boundary between the city and the main gas pipelines.

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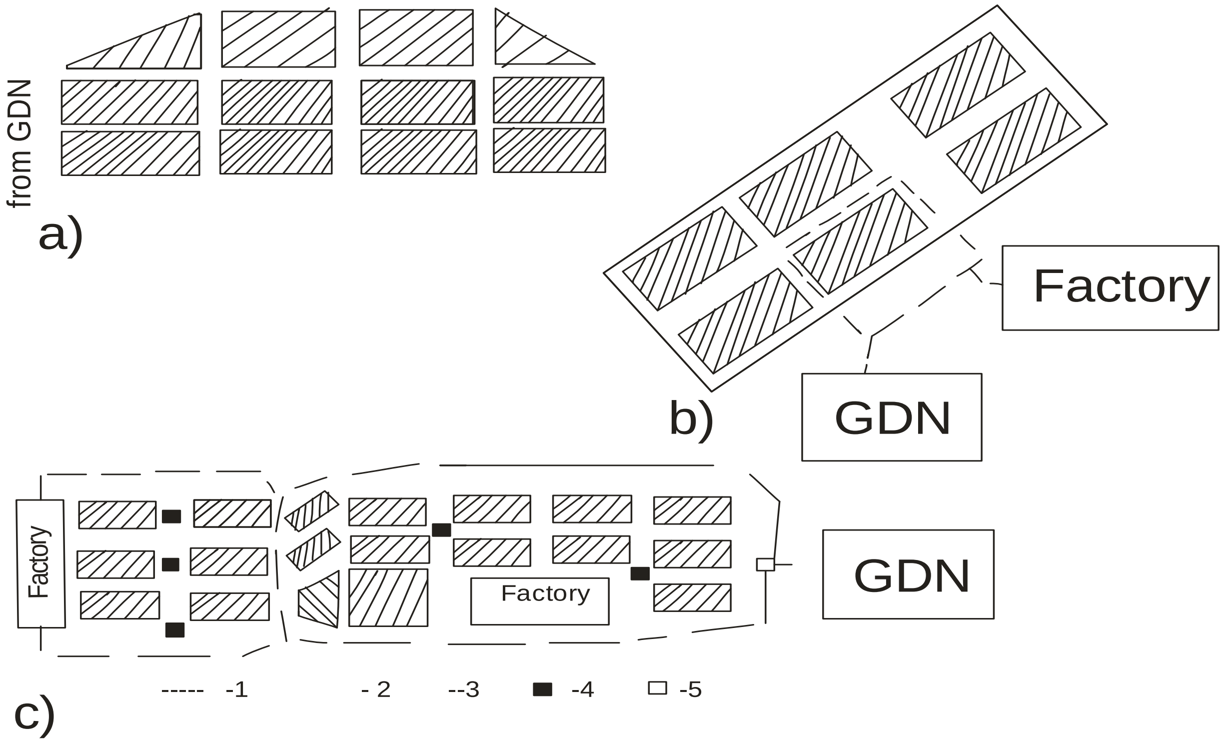

Figure 1.Systems of gas supply networks: a - single-stage; b - two-stage; c - three-stage. Pressure gas pipelines: low – 1; medium – 2; high – 3. Power supply: low – 4; 5 - medium pressure. Where GDN - gas distributing network.

IV. MODULE AND ALGORITHM OF THE PROBLEM OF CALCULATING CONTINGENCIES.

The main source of data for the calculation hydraulic medium pressure gas pipelines are: network diagram, the estimated costs of all consumers of gas and the pressure drop in the network, that are, the difference in pressure at the gas outlet of the gas distribution network and the most distant from its point of consumption for the scheme. For the calculations we perform the following steps:

a) we produce hydraulic calculation of medium-pressure gas pipelines throughout the region turbulent motions of the gas:

$$\frac{P_n^2 - P_k^2}{L} = 1{,}4 \times 10^{-5} \times \left(\frac{K_e}{d} + 1922 \times \frac{v \times d}{Q}\right)^{0.25} \times \left(\frac{Q^2 \times \rho}{d^5}\right) \quad (1)$$

where P_n , P_k – absolute gas pressure at the beginning and end of the pipeline, MPa; L – length of the calculated area, km; K_e – equivalent absolute roughness of the inner wall surface of the pipe, sm; d – internal diameter of the pipeline, sm;v – kinematic viscosity coefficient, m^2/s; ρ – density of gas in kg /m^3;Q –consumption of the gas, nm^3/h.

b) Make a preliminary calculation of the diameter of the ring by the approximate relationships:

$$Q_{es}=0{,}59\times\sum K_c\times Q_i , \quad (2)$$

whereQ_{es} – the estimated flow rate, nm^3/h; Q_i - estimated cost of gas consumers, nm^3/h; K_c– coverage ratios of gas to consumers.

Calculated the estimated length is:

$$R = \frac{P_n^2 - P_k^2}{l_k} , \quad (3)$$

where l_k – the estimated length of the ring, m.

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c) To perform two variants of hydraulic calculation of emergency modes are turned off at the head sections of the left and right of the point of supply. In this case, a ring network becomes deadlocked at which gas flows moving from the head to the point of extreme points.

Determined by summing the estimated cost of each part of the network of gas from this operation from the end of the impasse in the direction of the head item. The diameters of the sections are adjusted so that the gas pressure at the last user did not drop below the minimum values. For all branches calculated diameter pipelines for the full use of the pressure drop at a limited selection of gas. Calculation is carried out in the following order:

- calculates the distribution of gas flows during normal operation of the network and identifies the gas pressure in all grid points;
- checked the diameters of branches to focused consumers with an estimated hydraulic regime. If necessary, the diameters of the taps increase to the required dimensions.

Pressure loss due to local resistance, according to [5] taken at a rate of 10% of the linear losses. Next, the calculation is performed for emergency operation when you turn off the head sections. When the emergency mode is assumed that extreme off section, and the movement of gas occurs around the ring in one direction during one mode - clockwise at the other - and counter - clockwise at reduced loads.

V. MODULE AND ALGORITHM OF THE PROBLEM OF CHOOSING THE DIAMETER PORTIONS GAS SUPPLY NETWORKS.

The purpose of the calculation is the identification and selection of the diameters of the gas supply network sites based on the minimum capital requirements, while ensuring security of supply given.

The main input data of the program are: Q_i - consumption of the gas at each part of the network, m^3/h; l_i - length of sections, m; λ_i, λ_f, λ_j - Lagrange multipliers for rings and directions specified arbitrarily; m - number of rings of the network; n - number of sections of the network; v – kinematic viscosity coefficient, m^2/s;d – internal diameter of the pipeline, sm; γ - number of directions in which it should meet the conditions do not increase the pressure loss allowable value; ΔP - pressure drop in the pipeline; C_i - the importance of linking to each ring; Z_i - amendment of each ring; a - correction factor.

The calculation program performs the following steps:

a) the values are calculated Z_i for each segment gas distribution network according to the formula:

$$Z_i = \frac{1}{11{,}02|\lambda_j + \lambda_i + \lambda_f|}; \qquad (4)$$

b) the condition is checked using a differential pressure in the gas supply networks in the directions (from power supply to distant points in the network):

$$\sum C_i Z_i^{0,826} = \Delta P_0; \qquad (5)$$

c) if the condition (5) is not executed then it is corrects for all Z_i areas included in this course:

$$Z_i^{'} = Z_i a^{1,2106}, \qquad (6)$$

where

$$a = \frac{\Delta P_0}{\sum C_i Z_i^{0,826}}; \qquad (7)$$

d) condition is checked for each link of the rings:

$$\sum C_i Z_i^{0,826} = 0; \qquad (8)$$

e) if the condition (8) is not executed then we are entered amendments on Z_i for all of the rings:

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$$Z_i^{'} = Z_i - \Delta Z_I + \Delta Z_{II}, \qquad (9)$$

where ΔZ_I - the correction of the ring; ΔZ_{II} - amendment of the neighboring rings, which borders this site.

The amendment ΔZ to the ring is given by:

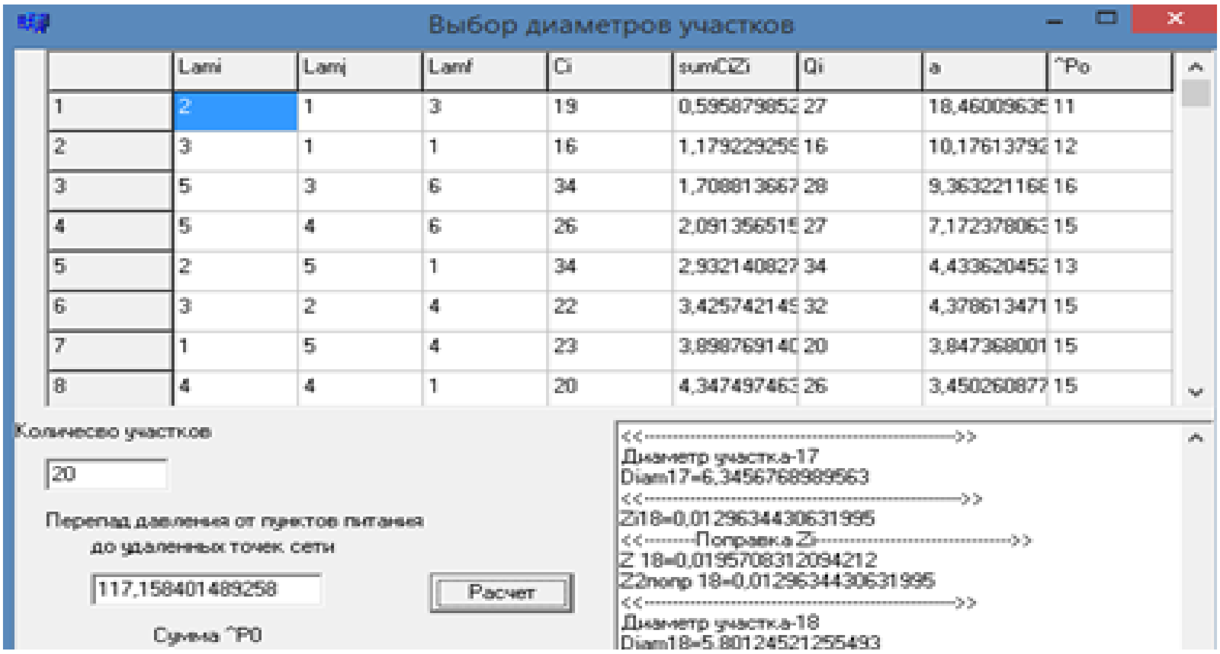
$$\Delta Z = \frac{\sum C_i Z_i^{0.826}}{0.826 \sum | C_i Z_i^{0,826-1} |}; \qquad (10)$$

e) in the case of the condition linking the network and condition (5) in the directions are calculated diameters of all areas, then:

$$d_i = Q_i^{0,304} \frac{1}{Z_i^{0,174}}. \qquad (11)$$

Further, for calculating the pressure drop necessary to determine settings such as the Reynolds number is dependent on the nature of the gas flow, and the hydraulic resistance coefficient λ[4,5].The program code is presented on Figure 2.

Figure 2.Computer code.



VI. INFORMATION MODEL OF IDENTIFICATION AND PHYSICOCHEMICAL PARAMETERS OF GAS.

In the course of gas transportation and its receipt to gas distribution stations and distribution points, it is cleared of mechanical impurities, condensate and moisture, its volume content is measured, the pressure is reduced and is odorized before being fed to the consumer.

The main component of natural gases is methane (up to 98%) [1].
The composition of gases always includes water vapor and quite often such components as nitrogen, hydrogen, sulphide, carbon dioxide and helium.

In the composition of natural gases and condensate (gas), along with hydrogen sulphide, there are other sulfur compounds, which are divided into two groups - active and inactive [3].

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Methane under standard conditions (at atmospheric pressure and 20 ° C) behaves like a real gas. Ethane is located on the boundary of gas-vapor phase states.

Propane and butanes under normal conditions are gases, because their critical parameters are very high.
Hydrocarbon content the sulfur, content the sulfur compounds mechanical impurities and oxygen (Table 1.).

The value of this indicator is not more than 1%. In addition, oxygen contributes to increased corrosion in the system. The industry standard does not establish the specific content of individual hydrocarbons in the commodity gas.

Table 1. Composition of natural gas

Name	% content of chemical substances
Methane CH_4	95,1
Ethane C_2H_4	2,3
Propane C_3H_8	0,7
Butane C_4H_{10}	0,4
Hydrogen sulfide	0,2
Carbon dioxide	0,2
Oxygen	0,5
Pentane	0,6

The results of automation and calculations on the forms of the gas supply network, identification technical and technological indicators are given in the program interface.

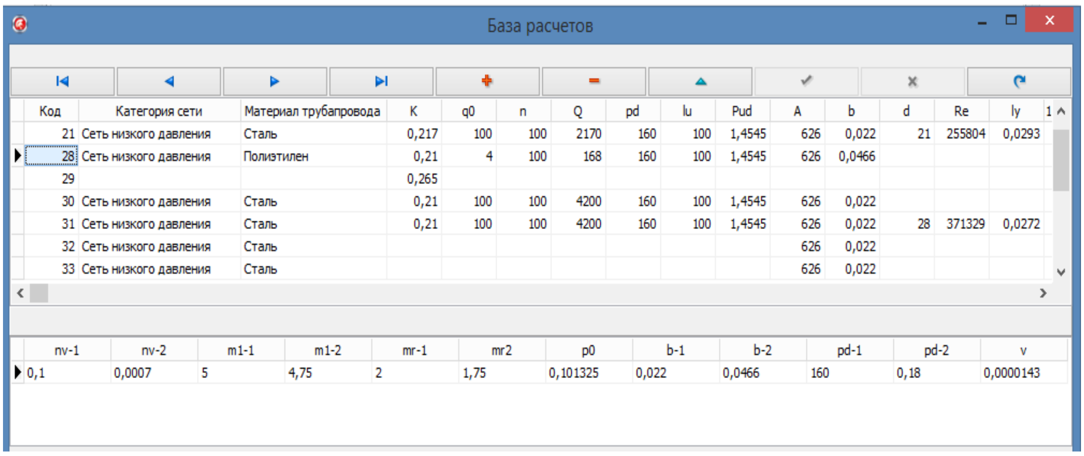

Figure 3.Computer code.

VII. CONCLUSION

As a result of the performed work on the analysis and assessment of the physicochemical parameters of the gas of the gas supply network:
- formed by hydraulic calculation algorithm of symmetric and asymmetric schemes gas supply systems;
- formed the program of automation functioning a multi-ring gas-supplying network is developed at occurrence of supernumerary situations;
- developed the program for calculating the coefficient of hydraulic resistance for the stub yard gas distribution network of low pressure;
- the results of computational experiments showed good agreement with the actual production dataorganization "Samarkandshaharhaz".

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