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INFLUENCE OF EXTERNAL CONDITIONS ON THE RESOURCE GAS CHANGE IN GAS TRANSMISSION SYSTEMS

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The algorithm of the gas reserve in the gas transmission systems is represented in the article. Estimation of the influences of environmental conditions is approached to assess the accuracy of specific example margin pipeline «Torzhok-Minsk-Ivantsevichy CS "Smolensk" – CS "Krupki"».

Introduction. The gas transmission system (GTS) is an important transport link integrated into the main pipeline network of the Russian Federation and the European Union (EU). It runs through the territory of the Republic of Belarus connecting gas flow from suppliers to consumers. Supervisory control of GTS registers a number of tasks; one of them is measurement of the transported gas amount and development of this problem - gas reserve management in the GTS. Practice shows that the operation of gas reserves calculation in the gas transportation system by balance method (i.e. based on accounting units of input and output data of the system even at relatively small intervals of time (calendar month)) leads to significant errors due to accumulation of measurement errors. In this regard, the PGU developed a software package that allows calculating and determining margin gas telemetry data on the basis of determination modes of GTS. As a result, this method solves the problem of errors accumulation during measurement.

Main part. The mathematical model of the GTS is a set of interconnected objects in accordance with the technological scheme; (linear portions (LP), compressor plant (CP), gasdistribution stations (GDS), gas reduction point, valves and regulators etc.). Active elements are allocated GTS, e.g. allowed to control quantities of pressure change and (or) temperature between their input and output (CP, gas reduction point etc.). During calculating the gas reserve regime, active elements of the hydraulic system of GTS is considered to be specified and taken into account when simulating known measurements of the input and output pressures and (or) gas temperatures at their locations in the circuit. This allows excluding from the calculation models of these objects.

Measuring the amount of transmitted gas in the GTS is an important dispatch task. The creation of a software package (SP) for the calculation of reserve gas in the gas transport system, which was implemented in the Belarusian section of the main gas-pipelines (GP), made it possible to improve the efficiency of management and the accuracy of data on the system of trunk gas pipelines that run through Belarus. The solution of this problem is a consequence of more general problems solution: determination the regime of transport gas by the gas transportation system under a number of criteria and parameters defined for each section GP based on the computational algorithm. At the same time it is necessary to take into account the dependence of some parameters to each other, the nature of these links and the overall structure of the GTS, which determines the physical configuration of the network due to the specificity of the subject area.

At the same time, be aware of the relationship of some parameters from each other, the nature of these links and the overall structure of the GTS, determine the physical network configuration, due to the specifics of the subject area.

GTS configuration is not continuous. If repair work is necessary, a stream of transported gas along branch can be transferred to a reserve one. Therefore, it's necessary to support various structural links between the nodes of the GTS. During calculating the mode of transport of gas, the actual structure of the gas transportation system should be used at a given time, that is, the actual state of the cranes should be taken into account. The following issues should be considered:

- gas reserve in operating linear sections (LU);
- unchanged gas reserve in the disconnected LP, gas temperature is taken equal to the ground temperature, and pressure is calculated from the condition of the unchanged reserve from the moment of disconnection;
- Change in gas reserves in LU, operating as a cylinder, i.e. connected on the one hand to the operating LU, while pressure is taken from the operating LU, and temperature is assumed equal to the ground temperature;
- change in the gas reserve, both during bleeding and when filling out the disconnected LU [2].

The application of the developed algorithms for search of the unknown parameters of GTS in the SP allowed producing simulations of stationary and non-isothermal gas flow throughout the GTS network, taking into account the structure of the gas transmission network and all the other criteria which are enough to

describe the transport of gas. Based on the simulation model, the SP determines all the unknown parameters of GTS that are necessary for the further calculation of gas reserve. Designed SP also provides the desired accuracy of the calculations results, the minimum value which does not exceed the precision used in the system of temperature sensors and pressure sensor that are specified by their nameplate data. It is also possible to change the number of displayed data existing objects, such as pressure, diameter, temperature, length, costs, stocks and names.

Based on the example of the pipeline Torzhok-Minsk-Ivantsevichy CS "Smolensk" – CS "Krupki" pipeline, an account of the amount of gas transported in the gas transportation system for external factors was carried out:

- The soil temperature;
- The soil moisture;
- The density of the soil;
- Wind speed;
- Thickness of snow;
- The thermal conductivity of snow.

Calculations were carried out for 3 soil types: sand, loam, and mixed type of soil.

As a result of the calculations, the factors that have the greatest effect on the change in the amount of gas in the gas transportation system have been identified. These main factors are the ground temperature. Dependences of the gas reserve on these factors are shown in Table 1 and Table 2.

Table 1. – Changing the amount of gas depending on the soil temperature

The soil temperature, °C	Sand	Loam	Mixed
0	21,15746	21,18741	21,21141165
2	21,04038	21,08009	21,11872447
4	20,93769	20,96316	20,98549885
6	20,84183	20,85047	20,89129941
8	20,6968	20,69607	20,82144254
10	20,60534	20,6207	20,64250751
12	20,46669	20,47323	20,5002083
14	20,30571	20,36103	20,35386013
16	20,18639	20,20605	20,19707245
18	19,99467	20,04438	19,96359833

The change in the amount of gas depends on soil temperature. At low temperatures the amount of gas is much higher than at high temperatures. From the calculations the temperature is changed by 18 degrees, the differences is excit:

Sand ≈ 1,687 million m^3 (5.8%)

Loam ≈ 1,756 million m^3 (5.7%)

Mixed ≈ 1,818 million m^3 (6.25%)

Table 2. – Changing the amount of gas depending on the soil moisture

The soil moisture, %	Sand	Loam	Mixed
0	20,85959	20,93735	20,9328135
4	20,8993	20,96774	20,95339981
8	20,93276	20,9713	20,97569352
12	20,97862	20,9856	20,97730335
16	21,00701	20,99662	20,98545006
20	21,03526	21,01657	21,0036948
24	21,06233	21,03048	21,01660271
28	21,07589	21,09053	21,03927692
32	21,09526	21,09955	21,04243804
36	21,10477	21,11614	21,06511225

Analyzing the change in the amount of gas depending on the soil moisture, the results show that at the higher humidity there is gas in the pipeline, but with absolutely low humidity (e.g. 0%), we see that we have a smaller amount of gas. The difference is:

Sand ≈ 247 816 million m3 (1%)

Loam ≈ 186 594 million m3 (0.74%)

Mixed ≈ 155 422 million m3 (0.64%)

Other factors such as soil density, the wind speed, the thickness of the snow cover, and snow thermal conductivity do not greatly affect the amount of gas in the pipeline (a difference of a maximum of 0.08%) [1].

Conclusions. These calculations provide that the controllers should take into account such factors as temperature and humidity of the soil during the measurement of the gas amount in GTS. The final decision on the choice between the use of a mixed soil model and the behavior of accurate calculations based on a detailed study of data on the structure and condition of soils along the route of the gas-wire should be determined as a result of economic calculations of the feasibility of working on studying the composition of soils and developing a monitoring system for their state.

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