UDK 622.692.4+622.691.24
N.Prytula[1,2], O.Hryniv[2], O.Khimko[3]
[1] Ya. S. Pidstryhach Institute for Applied Problems of Mechanics and Mathematics, NAS Ukraine,
[2] Ltd. „ Matematychnyy tsentr",
[3] National University "Lviv Polytechnic "

CALCULATION OF DYNAMIC VOLUME CHANGES IN GAS ACCUMULATED GAS TRANSPORTATION SYSTEM

The problem of finding of the volume of the accumulated gas in gas transmission systems is considered. The list of factors which influence the size and accuracy of its calculation is given. Problem solutions are offered. Results of numerical experiments are given.
Keywords: the gas transmission system, a volume of the accumulated gas, an optimum mode, a compressor station, an underground gas storage.

Introduction

Volume of accumulated gas in the gas transportation system of Ukraine and its individual parts selected as the dynamics of change over time - one of the most important characteristics of the integrated system and the characteristics of the regime. These options, if they are received with guaranteed accuracy to assess: gas dynamic operational situation in the GTS, GTS quality operation, the effect of changing modes of technological facilities for gas flows in distribution gas pipelines, the main influence factors on the flux in the system, the level of possible gas leakage in the system.

In addition to the above mentioned parameters enable to: assess the level of depressurization system in emergency situations and, to some extent, this situation localize; compare actual and optimal allocation of amounts accumulated gas in the system and estimate the level of optimum operating conditions; create a management system that will direct traffic system in the direction of steepest achieve optimal mode with minimal fuel - energy resources.

Calculation of accumulated gas volumes and dynamics of change require:

- examine existing methods on the real data on the impact on the accuracy of the calculation averaging the basic parameters underlying the methods;
- investigate the influence of non-stationary gas flows, incompleteness, inaccuracy and frequency measurement data on the accuracy of calculation results;
- examine the impact of the adequacy of models of gas flows, including those adopted in the existing methods, the real gas-dynamic processes on the accuracy of the calculation;
- to analyze the capabilities of metrological support, location and measurement instruments to assess the possible impact on the accuracy of the calculation indicated;
- examine the impact of hydraulic condition of the objects on the accuracy of the calculation of the volume of accumulated gas.

On the basis of the above work on calculating the volume of accumulated gas and the dynamics of change, it is necessary to use adaptive non-stationary model of gas flows reasonable accuracy, the methods of calculating gas dynamic parameters that are included in the model gas flows and used to calculate the volume of accumulated gas, with an accuracy comparable with the accuracy of the measured data, and information provision possible systematic and random deviations calculated from the measured data, which is not possible to prove or localize mathematical methods.

Calculation of the volume of accumulated gas and its regulation in the subsystems and the system as a whole can be achieved by conducting:

- calculation of the gas in the ground (called virtual weighted metering), where there are no measuring instruments;
- calculation of the rate of change of the volume of gas accumulated between different subsystems;
- calculation of balance and imbalance in the rate of gas inflow data in selected subsystems GTS;

- calculation of peak performance storage facilities for possible assessment rate of elimination of imbalances in the system;
- updating technological schemes and states of objects to ensure timeliness and accuracy of the calculation;
- predicting the occurrence of critical amounts of accumulated gas and critical dynamics of existing imbalances and the formation of an acceptable liquidation.

Table 1

Evaluation of the absence or minimal gas transportation (extreme ratings)

№	Diameter pipelines (mm)	Length (km)	Geometric volume (share in total volume) (m^3, %)	Total volume of gas at maximum pressure (Kg /sm^2 , m^3)	The volume of gas with a minimum pressure (kg/sm^2 , m^3)
	1400	5 455.00	8 393 063.00 **(44.75%)**	73.00	45.00
	1200	3 874.00	4 379 169.60 **(23.30%)**	53.00	35.00
	1000	4 427.00	3 475 195.00 **(18.49%)**	53.00	35.00
	820	1 799.00	996 458.90 **(5.30%)**	45.00	35.00
	720	358.00	145 685.95 **(0.78%)**	43.00	15.00
	≤ 530 (avg.300)	19 837.00	1 401 484.05 **(7.45%)**	25.00	10.00
		35 750.00	**18 791 056.5**	**1 215 242 634.00**	**766 873 280.00**

Table 2

The calculated volumes for different modes of operation of gas transportation system

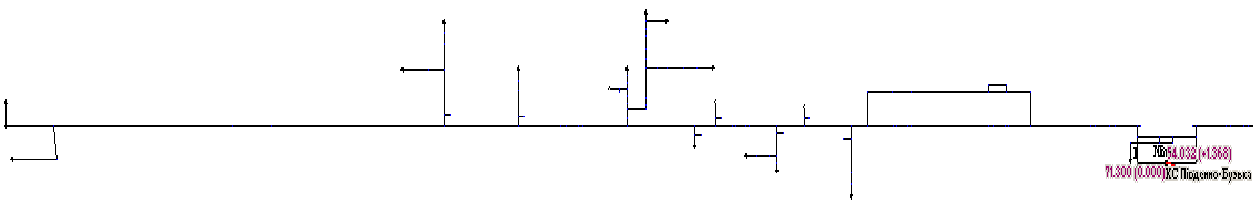
№	Terms	The volume of gas (m^3)	Comparison of maximum capacity (%)
1	The minimum amount accumulated gas (with minimum gas transportation and lack of gas supply to the system)	766 873 280.00	63.10
2	The maximum amount of gas accumulated (with minimum gas transportation)	1 215 242 634.00	100.00
3	The maximum amount of gas accumulated (by volume close to the maximum gas transportation)	1 042 212 658.00	86.00
4	The minimum amount in real terms	884 000 000.00	73.00
5	The maximum amount in real terms	1 050 000 000.00	86.00

Support maximum volume of accumulated gas underground storage facilities provided (UGS). One of the most important characteristics is its UGS load peak - The maximum amount of gas at a given sampling time. Load peak underground storage facilities Ukraine during the season of gas varies within 80 - 320 million. M3 - the technological schemes in the real world load peak achieved 265.9 million. M3). The maximum amount of gas accumulated in the GTS equal volume is shown for 4 days in early season sampling and 12 dobam in peak mode of the storage facilities at the end of the season sampling. The maximum value of the volume fluctuations accumulated gas in the GTS does not exceed 20%. You can always go to the maximum amount of gas accumulated by 1-2.5 days of storage facilities in peak mode.

Redistribution of accumulated gas volumes in the system provides significant savings in fuel gas.

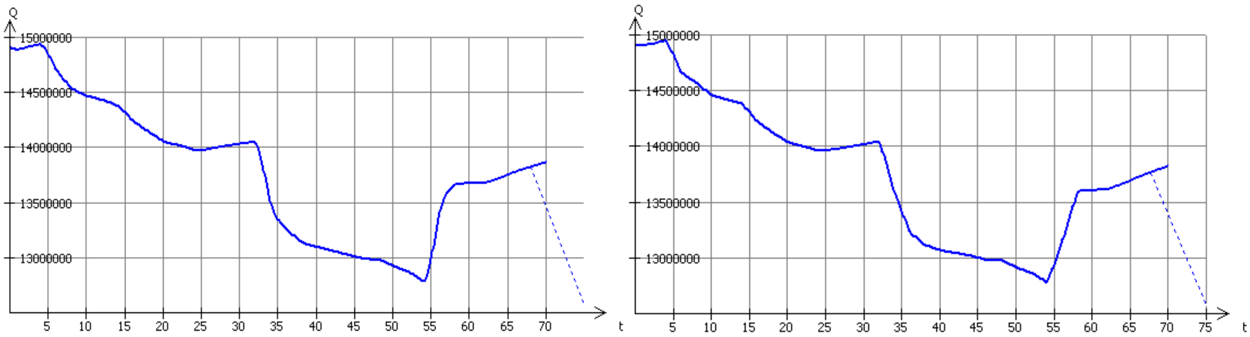
Numerical experiments

An area between GTS KS Pivdenno-Buz′ka – Anan′yiv.



Pict. 1. Scheme of the region GTS " KS Pivdenno-Buz'ka – Anan'yiv " with bleed

Putting for KS Pivdenno-Buz′ka boundary conditions for pressure release, and all other objects-selection boundary conditions for gas flow, before filling in data from database for a period of 3 days, we obtain the following results of modeling gas-dynamic processes of the subsystem (modeling was carried out within 70 hours of step-by time variable c) (pict. 2, left). Now for the same system we use the boundary conditions for Ananev on gas pressure and obtain the following results (pict. 2, right). The example figures on the horizontal axis delayed the time in hours and the vertical axis - the volume of gas in m^3.



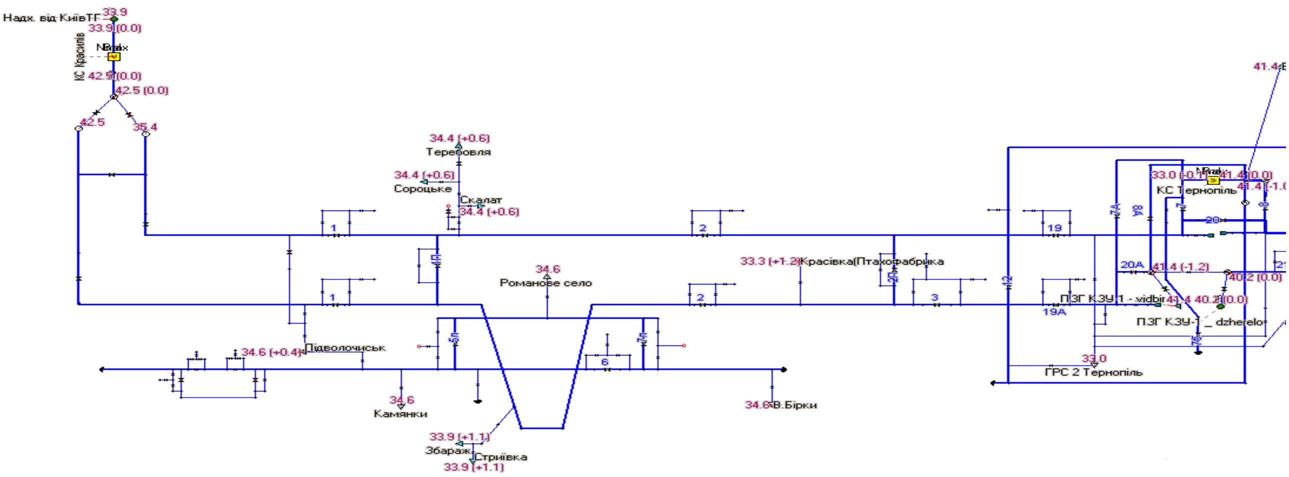
Pict. 2. Charts volume change of accumulated gas in the system (calculated) for different types of boundary conditions.

The value of accumulated gas volumes deviate by no more than 0.15% at time intervals of transient with a maximum speed in all other cases, 0.05%.

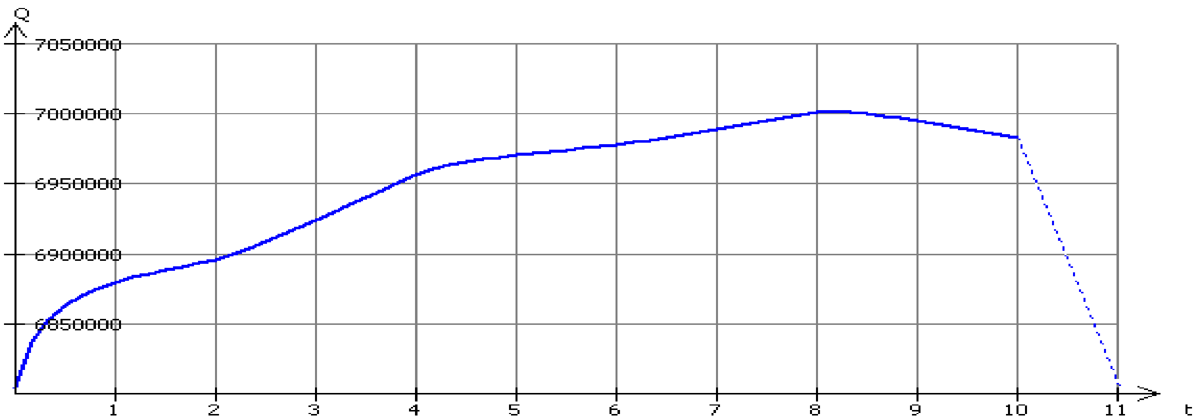
Were calculated unsteady regimes units "Ukrtransgas" (for example, unit UMG "Lvivtransgas").

We consider the diagram (pict. 3.). Boundary conditions for both KS gas pressure. Simulation was carried out for 10 hours, step-by time variable (Δt) was set equal to 600 s (10 min).

Наведемо результати моделювання (рис.4):



Pict. 3. Flowsheet pipeline KS Krasyliv - KS Ternopil'



Pict. 4. Schedule change in the volume of gas accumulated in the system (calculated)

The numerical experiments showed that under regimes GTS close to stationary, the methods of calculating the volume of accumulated gas weakly dependent within the accuracy of measurement of the number of relevant variables break apart sections of pipe.

Conclusions

Calculation of the volume of accumulated gas with high accuracy is a systemic problem. The accuracy of the calculation is affected by many factors, some of which can be considered random, other - systematychnymy. Numerical experiments confirmed that transient models allow gas flows with an accuracy close to that of measurement, calculate the volume of gas accumulated in the system. Given the stationary gas flow measurement error and accuracy adaptation does not contribute to the accumulation of errors in the calculation of the volume of accumulated gas in the pipeline.

1. Сарданашвили С. А. Расчетные методы и алгоритмы/ Сарданашвили С. А. – Москва: Изд-во “Нефть и газ”, 2005. – 577 с. 2. Селезнев В. Е. Методы и технологии численного моделирования газопроводных систем/ Селезнев В. Е., Алешин В. В., Клишин Г. С. – Москва : Едиториал УРСС, 2002. – 448 с. 3. Бобровский С. А. Трубопроводный транспорт газа/ Бобровский С. А. Щербаков С. Г., Яковлев Е. И. – Москва: Наука, 1976. – 475 с. 4. Ю.Сінчук, Н. Притула, М. Притула. Моделювання нестаціонарних режимів газових мереж// Вісник Національного університету “Львівська політехніка”. Комп’ютерні науки та інформаційні технології. – Львів, – 2010. – №663. – С. 128–132.