STOCHASTIC MODELS AND METHODS OF OPERATIVE-DISPATCH CONTROL OVER THE GAS-TRANSPORT SYSTEM OF UKRAINE

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Abstract: *Stochastic models and methods of solving the problem of operative-dispatch control of the gas-transport system of Ukraine are considered. It is shown that the problem of operative-dispatch control of the gas-transport system is reduced to solving of two linked problem: operative planning and stabilization of gas-transport system conditions.*

Keywords: *Gas-transport system: operative planning, operative-dispatch control, stochastic model, stochastic method.*

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Introduction

Gas industry is one of the most important constituents of the Ukrainian fuel and energy complex, and it is hard to overestimate its influence on other branches of the national economy and national safety of Ukraine. The gas-transport system (GTS) is a basis of the Ukrainian gas industry.

The Ukrainian GTS is a unified technological complex and its two main functions are: transport and distribution of natural gas to Ukrainian consumers and transit of natural gas over Ukrainian territory to the countries of Central and Western Europe.

The main technological elements of the Ukrainian GTS include: six multiple-strand gas-main pipelines (GMP) 37,2 thousand kilometers length, 72 multiple-shop compressor stations (CST), 112 compressor shops (CSH), 786 gascompressor units (GCU), over 1420 gas-distributing stations (GDS) and 225 nonassociated gas fields.

Ukrainian gas-main pipelines (GMP) are connected with each other by system-defined connective gas pipelines, that ensure increasing of reliability indexes of the GTS and provide with the ability to manipulate with gas stream directions.

13 underground gas-holders (UGH) are used to guarantee technological stability of the Ukrainian GTS while volume of supplies and volume of natural gas usage fluctuate essentially. The main of those are located beside western borders of Ukraine, and their technical characteristics allow to smooth over considerable unevenness of gas extraction by importing countries and Ukrainian consumers. Moreover, Ukrainian UGH are used to store natural gas that has been preliminarily purchased by importing countries in Russia.

Spreading over great space and technical complexity of the Ukrainian GTS results in the fact that the processes of supply, transport and distribution of natural gas are performed by the three-level system of operative-dispatch control: amalgamated dispatching administration (ADA) DC “Ukrtransgas”, control points (CP) of gas-main pipelines administrations (GMA), control points of line production administrations of gas-main pipelines (LPAGMP).

At present time "The Ukrainian energy strategy until 2030" has been elaborated and approved by the Ukrainian Government. It determines the objects and the main lines of development of the gas industry in a long-term and near-term outlook.

It is being planned to supply a demand for natural gas on the Ukrainian home market at the cost of both increasing of volume of output from home fields (particularly, at the cost of forthcoming development of the Ukrainian part of shelves in Black Sea and Sea of Azov) and organization of hydrocarbon extraction and import of them. The import of natural gas policy should be guided by principles of diversification of supplies and routes of natural gas delivery with the object of ensuring the energy security of Ukraine. However, at present time the Russian Federation is the main source of export natural gas in Ukraine. This determines a strict technological and organizational interconnection between unified gas-supply system (UGSS) of Russian Federation and the Ukrainian GTS.

Signed contracts and technical agreement are the main documents to regulate operating modes of the Ukrainian GTS. This contracts include yearly, quarterly and monthly volumes of receiving and delivery of natural gas, and operation factors of gas flows (pressure, temperature, composition and humidity of natural gas), that should be guaranteed at inlets and outlets of the Ukrainian GTS. Monthly balances of supply, transport and distribution are created on basis of these documents, and they are detailed to 24 hours periods.

While realization of operational control over operating modes of the Ukrainian GTS the following factors are taken into consideration: actual operating mode of the technological equipment of the GTS, predictable volume of consumption of natural gas by home consumers (which is linked with the corresponding GDS's), and daily requests of importing countries for volumes of delivered natural gas, that come to the ADA DC "Ukrtransgas" from the control centre "Gasexport", LLC and the CPDD of JSC "Gasprom".

Signing of long-term contracts allows to forecast operating mode of the Ukrainian GTS for the nearest future and perform necessary technical maintenance, repair, reconstruction and modernization measures.

From a formal point of view, the Ukrainian GTS belongs to the class of object-orientated, multidimensional, manifold non-linear stochastic systems with distributed parameters, that are characterized by networked multilevel structure, availability of a DM in control circuit, availability of discrete and continuous command variables, high level of indeterminacy of objects, structure, parameters and conditions and influence of environment.

At present time there is no integrated solution of the problem of computer simulation and optimization of operating modes of the Ukrainian GTS both due to complexity of an adequate describing of reaction of the system to great number of deterministic and stochastic internal and external perturbations, and due to complexity of an adequate describing these perturbations themselves.

The results of system analysis of the Ukrainian GTS as a control object led to necessity of the Ukrainian GTS being considered as a stochastic object which is functioning in a stochastic environment [1].

1. Determination of the problem class of the problems of operative-dispatch control over the Ukrainian GTS.

In order to formalize the problem class of the operative-dispatch control of the Ukrainian GTS we consider it as an interconnected system of multiple-strand gas-main pipelines with multiple-shop compressor stations. From a technological point of you it is possible to represent the structure of the GTS as an ordered sequence of multiple-strand linear sections (LS) $LU = \{1, 2, 3, ..., lu\}$ and multiple-shop compressor stations (CS)

$CS = \{1, 2, 3, ..., cs\}$, From a formal point of view the structure of the GTS may be represented as a directed graph $G(V, E)$, where

$V = W \cup N = \{1,\ 2,\ \ldots,\ w,\ w+1,\ w+2,\ \ldots,\ n\}$ – indexing set of points of graph;

$W = \{1, 2, \ldots, w\}$ – indexing set of points of graph (inputs), that natural gas comes into the GTS through;

$N = \{w+1,\ w+2,\ \ldots,\ w+n\}$ – indexing set of points of graph (oupputs), that natural gas is taken out from the GTS from.

$E = L \cup M = \{1,\ 2,\ \ldots,\ l,\ l+1,\ l+2,\ \ldots,\ l+m\}$ – indexing set of arcs of graph of the GTS;

$L = \{1,\ 2,\ \ldots,\ l\}$ – indexing set of arcs of graph that correspond to active elements of the GTS, i.e. CS.

$M = \{l+1,\ l+2,\ \ldots,\ l+m\}$ – indexing set of arcs of graph that correspond to passive elements of the GTS, i.e. gas cleaning plants, gas cooling plants, pipeline sections, intercepting and controlling faucets etc.;

(Ω, B, P) – probability space with the defined flow of σ-algebras $\{B_t,\ t \in [0,\ T]\}$ on it, i.e. family of σ-algebras $B_t \subset B$, that from $t < t_1$ follows $B_t \subset B$ for;

Ω – space of elementary events;

B – σ-algebra of events from Ω;

P – probability measure on B;

$[0, T]$ – control interval.

Condition of the GTS in every instant of time $t \in [0, T]$ is characterized by a random vector

$$S(t,\omega) = \langle X(t,\omega), Y(t,\omega), U(t) \rangle, \tag{1}$$

where

$$X(t,\omega) = \langle X_1(t,\omega), X_2(t,\omega), ..., X_{\mathrm{i}}(t,\omega), ... X_w(t,\omega) \rangle \tag{2}$$

random column-vector of parameters of natural gas on outputs of the GTS, and its every i-th, $i \in W$ component is of the form of

$$X_i(t,\omega) = \langle P_i(t,\omega), q_i(t,\omega), T_i^0(t,\omega), N_i(t,\omega), S_i(t,\omega) \rangle, i \in W \tag{3}$$

where $P_i(t,\omega), q_i(t,\omega), T_i^0(t,\omega)$ – random values that characterize, correspondingly, pressure, consumption and temperature of natural gas on the *i*-th input of the GTS at the instant of time *t*;

$$N_i(t,\omega) = \langle N_{1i}(t,\omega), N_{2i}(t,\omega), ..., N_{ji}(t,\omega), ..., N_{ni}(t,\omega) \rangle \tag{4}$$

random vector, which characterizes hydrocarbon composition of natural gas, and $S_i(t,\omega)$ – humidity of natural gas on the *i*-th input of the GTS at the instant of time *t*;

$$Y(t,\omega) = \langle Y_1(t,\omega), Y_2(t,\omega), ..., Y_j(t,\omega), ..., Y_n(t,\omega) \rangle \tag{5}$$

random column-vector of parameters of natural gas on outputs of the GTS (inputs of the GDS), and its every j-th component is of the form analogous to vector $X_i(t,\omega)$:

$$Y_j(t,\omega)=\left\langle P_j(t,\omega),q_j(t,\omega),T_j^0(t,\omega),N_j(t,\omega),S_j(t,\omega)\right\rangle, j\in N\ , \tag{6}$$

where $P_j(t,\omega),q_j(t,\omega),T_j^0(t,\omega),N_j(t,\omega),S_j(t,\omega)$ – random values that characterize, correspondingly, pressure, consumption, temperature, hydrocarbon composition and humidity of natural gas on the *j*-th input of the GTS at the instant of time *t*;

$$U(t)=\left\langle d(t),b(t),\beta(t)\right\rangle \tag{7}$$

deterministic control vector, which determines work structure of LU – $d(t)$, work structure of KC – $b(t)$ and actual parameters of KC – $\beta(t)$ at the instant of time *t*. By-turn, each component of the control vector (7) is of the form of

$$d(t)=\left\langle d_1(t),d_2(t),...,d_i(t),...,d_{lu}(t)\right\rangle \tag{8}$$

vector of discrete, Boolean variables which determines work structure of all the lu linear sections of the gas-main pipelines of the GTS; each *i*-th component is of the form of

$$d_i(t)=\left\langle d_{1i}(t),d_{2i}(t),...,d_{ki}(t)\right\rangle,\quad i=1,2,...,\ lu \tag{9}$$

vector of discrete, Boolean variables that characterize the state (open/closed) of each of *k* intercepting faucets ob the *i*-th linear section of the gas-main pipelines of the GTS.

$$b(t)=\left\langle b_1(t),b_2(t),...,b_i(t),...,b_{kc}(t)\right\rangle \tag{10}$$

vector of discrete, Boolean variables that characterize state work structure of all the kc linear sections of compressor stations; each *j*-th component is of the form of

$$b_j(t)=\left\langle b_{1j}(t),b_{2j}(t),...,b_{rj}(t)\right\rangle,\quad j=1,2,...,\ kc \tag{11}$$

vector of discrete, Boolean variables that characterize the state (open/closed) of each of *r* intercepting faucets of the *j*-th CS, which determines the work structure of the *j*-th CS (layouts of engaging GCUs, LSs and GCPsin each of CS)

$$\beta(t)=\left\langle \beta_1(t),\beta_2(t),...,\beta_j(t),...,\beta_{kc}(t)\right\rangle \tag{12}$$

vector of continuous variables which determines actual controllable parameters for all the kc compressor stations, each its *j*-th component is of the form of

$$\beta_j(t)=\left\langle \beta_{1j}(t),\beta_{2j}(t),...,\beta_{sj}(t)\right\rangle \tag{13}$$

vector s of continuous controllable variables of the *j*-th CS (operating revolutions of CAP GCU drive, state of regulating(anti-surge) faucets, steering angles of distributor motors etc.)

According to designation of the GTS on a specified interval of control $[0,T]$ a deterministic column-vector is defined:

$$Z(t)=\left\langle Z_1(t),Z_2(t),...,Z_j(t),...,Z_n(t)\right\rangle \tag{14}$$

It is the vector of needed (predictable or stated in a contract) values of parameters of gas flows on all the outputs of the GTS (inputs of the GDS); each its *j*-th component is of the form of

$$Z_j(t) = \left\langle P_j(t), q_j(t), T_j^0(t), N_j(t), S_j(t) \right\rangle, j \in N, \tag{15}$$

where $P_j(t), q_j(t), T_j^0(t), N_j(t), S_j(t)$ are deterministic values, that characterize needed (predictable or stated in a contract) values of parameters of natural gas (pressure $P_j(t)$, consumption $q_j(t)$, temperature $T_j^0(t)$, hydrocarbon composition $N_j(t)$ and humidity $S_j(t)$) on the *j*-th output of the GTS (input of the *j*-th GDS)

Besides:

$$J_{1j}\left[X(t,\omega), Y(t,\omega), U(t)\right], j \in N \tag{16}$$

$$J_{2i}\left[X(t,\omega), Y(t,\omega), U(t)\right], i \in KC \tag{17}$$

are given random functions that are measured on the strength of all the variables and, if it is fixed, are measured in regard to σ-algebra B_t; they characterize, correspondingly, (16), i.e. quality of functioning of the GTS in regard to the *j*-th consumer (extent of execution of contract), and (17), i.e. efficiency of production of the *i*-th CS (unit costs in energy and value terms)

Using expressions (16)-(17), we can determine quality and efficiency indexes of functioning of the entire GTS.

$$J_1\left[X(t,\omega), Y(t,\omega), U(t)\right] = \varphi_1\left\{J_{11}\left[X(t,\omega), Y(t,\omega), U(t)\right], ..., J_{1n}\left[X(t,\omega), Y(t,\omega), U(t)\right]\right\} \tag{18}$$

where $J_1[X(t,\omega), Y(t,\omega), U(t)]$ is a measured random function, which characterize quality of functioning of the GTS at the instant of time *t* in regard to all the consumers; $\varphi_1\{\ \}$ is a deterministic contraction function.

Index of efficiency of functioning of all the CSs at the instant of time *t* is also determined via indexes of efficiency of each CS and can be given as

$$J_2\left[X(t,\omega), Y(t,\omega), U(t)\right] = \varphi_2\left\{J_{21}\left[X(t,\omega), Y(t,\omega), U(t)\right], ..., J_{2kc}\left[X(t,\omega), Y(t,\omega), U(t)\right]\right\}, \tag{19}$$

where $\varphi_1\{\ \}$ is a deterministic contraction function of local indexes of efficiency of each CS.

In this case overall quality and efficiency index of the functioning of the GTS can be given as

$$J\left[X(t,\omega), Y(t,\omega), U(t)\right] = \varphi\left\{J_1\left[X(t,\omega), Y(t,\omega), U(t)\right], J_2\left[X(t,\omega), Y(t,\omega), U(t)\right]\right\}, \tag{20}$$

where $\varphi\ \left\{J_1\left[X(t,\omega), Y(t,\omega), U(t)\right], J_2\left[X(t,\omega), Y(t,\omega), U(t)\right]\right\}$ is a deterministic contraction function of quality and efficiency indexes of the functioning of the GTS at the instant of time *t*.

We select contraction functions $\varphi\{\ \}, \varphi_1\{\ \}, \varphi_2\{\ \}$ the way so maximum of quality and efficiency of the functioning of the GTS is reached at the instant of time *t*, given the expression (20) reaches its minimum.

Since $J\left[X(t,\omega), Y(t,\omega), U(t)\right]$ is a random function, it is necessary to bring a functional of this function in order to state the exact problem. In lieu of this function mathematical expectation, probability or variance of a random function on a fixed interval can be used. It is reasonable to use mathematical expectation in order to minimize average losses. In this case the problem of operational control over transport modes and distribution of natural gas in the GTS on a time interval $[0,T]$ reduces to the problem of minimization of the functional of the form of

$$J(T) = \underset{\omega}{\mathrm{M}} \int_0^T J\,\left[X(t,\omega), Y(t,\omega), U(t)\right] dt \to \min_{U(t)\in\Omega}, \quad (21)$$

where $\underset{\omega}{\mathrm{M}}$ is a mathematical expectation symbol.

The region of feasibility is described by a system of equations which determines interrelation between $X(t,\omega)$, $Y(t,\omega)$ and $U(t)$, and also systems of inequalities that determine area of technologically acceptable transport modes and distribution of natural gas in the GTS.

Technological limits should be fulfilled for all the instant of times $t \in [0,T]$ and for all the realizations of random components of vectors $X(t,\omega)$, $Y(t,\omega)$.

The problem (21) belongs to the problem class of optimal stochastic control of non-linear discrete-continuous type and of a large scale. At present time there are no general methods of solving this problem, so we consider a particular method of solution of this problem which allows for specifics of its informational supplying, also conditions of physical realizability and the structure of the control vector.

2. Structurization of the Problem Class of Operative-dispatch Control of the Transport Modes and Natural Gas Distribution in the GTS

Conditions of physical realizability of the selection and processing information systems define discrete nature of the information about values of realizations of random components of vectors $X(t,\tilde{\omega})$ and $Y(t,\tilde{\omega})$ on inputs and outputs of the GTS, which comes at discrete instants of time $k = 1,2,...,K$ with a step $\Delta t = T / K$. In this case discrete analogue of the problem (21) is of the form of

$$J(K) = \underset{\omega}{\mathrm{M}} \left\{ \sum_{k=1}^{K} J\,\left[X(k,\omega), Y(k,\omega), U(k)\right] \right\} \to \min_{U(k)\in\Omega} \quad (22)$$

Persistence of the GTS control system, which is related to considerable time and energy losses on changing of the structure of the GTS (structures of LS and CS), results in necessity of making the decision $U_0^*(k)$, $k = 1,2,...,K$ at a null instant of time, i.e. until observation of realization of random vectors $X(t,\omega)$ and $Y(t,\omega)$ $k = 1,2,...,K$. After observation of realization of $X(t,\omega)$, $Y(t,\omega)$ at the instants of times $k = 1,2,...,K$ the ability to calculate the value $J\,\left[X(k,\tilde{\omega}), Y(k,\tilde{\omega}), U(k)\right]$ appear, and, on its basis calculate deflection of the actual mode from the planned one and correct the primary solution $U_0^*(k)$. Thus, it is needed to find an optimal solution of the problem (22) $U^*(k)$, $k = 1,2,...,K$ of the form of sum of two vectors

$$U^*(k) = U_0^*(k) + \delta U^*(k),\ k = 1,2,...,K \quad (23)$$

where $U_0^*(k)$ is a control vector which determines an optimal plan of transport mode and natural gas distribution in the GTS; this plan is calculated at the null instant of time until observation of realization of random conditions of the problem.

$\delta U^*(k)$ is a control vector which determines an optimal compensation of the plan and it is calculated in each instant of time $k=1,2,...,K$ after observation of actual realizations of random conditions of the problem.

Conditions of physical realizability of the process of control over transport modes of the GTS determine the structure of vectors $U_0^*(k)$ and $\delta U^*(k)$:

$$U_0^*(k)=\left\langle d_0^*(k), b_0^*(k), \beta_0^*(k)\right\rangle, \tag{24}$$

$$\delta U^*(k)=\left\langle \beta^*(k)\right\rangle,\ k=1,2,...,K, \tag{25}$$

This is concerned to the fact that it is not reasonable to change the structure of linear sections of gas-main pipelines and the structure of compressor stations shops in a real-time mode; moreover, it is impossible in most occasions. In other words, it is not advisable to use these variables for operative compensations of the plan mistakes.

At present time it is only possible to operatively change the parameters of operating of GCU CS relative to their planned values (settings). That's why only these variables are components of the vector of optimal plan compensation $\delta U^*(k)$.

The problem (22) under conditions (24), (25) belongs to the class of multiple-steps problems of non-linear stochastic programming at a tough statement, and a solution should be a pure strategy one, of the form of decision rule of a order zero which links unknown components of the control vector with the parameters of the GTS and parameters of stochastic processes $X(k,\omega), Y(k,\omega)$.

We consider, that at the null instant of time $k=0$ we know all the previous history (informational condition of the system) $X(k,\tilde{\omega}), Y(k,\tilde{\omega}), U(k)$, $k=0,-1,-2,...$. Then for $k=1,2,...,K$ we can get estimations of conditional expectations $\hat{X}_0(k), \hat{Y}_0(k)$ of vectorial stochastic processes $X(k,\omega), Y(k,\omega)$ and their correlation matrixes $K_X(k), K_Y(k)$, i.e. predictions of future values $X(k)$ and $Y(k)$ that are calculated at the null instant $k=0$ with prediction $k=1,2,...,K$. It is also considered, that estimates $\hat{Y}_0(k)$ and $\hat{K}_Y(k)$ are calculated with some fixed values $U_0(k)$, $k=1,2,...,K$.

While expanding $J\left[X(k,\omega), Y(k,\omega), U(k)\right]$ in a Taylor series relative to a nominal trajectory $\left\langle \hat{X}_0(k), \hat{Y}_0(k), U_0(k)\right\rangle$ with saving all the terms not above the second one and applying the mathematical expectation operation to the both parts of the derived equality, we get:

$$\underset{\omega}{\mathrm{M}}\left\{J\left[X(k,\omega), Y(k,\omega), U(k)\right]\right\} = J_0\left[\hat{X}_0(k), \hat{Y}_0(k), U_0(k)\right] + \partial J_0\left[\sigma^2_{X(k)}, \sigma^2_{Y(k)}, \sigma^2_{U(k)}\right], \tag{26}$$

$$\partial J_0\left[\sigma^2_{X(k)}, \sigma^2_{Y(k)}, \sigma^2_{U(k)}\right] = \frac{1}{2}\left[\sum_{i=1}^{W}\left(\frac{\partial^2 J}{\partial X_i^2(k)}\right)_0 \sigma^2_{X_i(k)} + \sum_{i<j}\left(\frac{\partial^2 J}{\partial X_i(k)\partial X_j(k)}\right)_0 K_X(k) + \right.$$

$$\left. + \sum_{j=1}^{n}\left(\frac{\partial^2 J}{\partial X_i^2(k)}\right)_0 \sigma^2_{Y_i(k)} + \sum_{j<p}\left(\frac{\partial^2 J}{\partial Y_j(k)\partial Y_p(k)}\right)_0 K_Y(k) + \sum_{i=1}^{l}\left(\frac{\partial^2 J}{\partial U_i(k)}\right)_0 \delta^2_{U(k)}\right]$$

$$\delta J_0\left[\sigma^2_{X(k)},\sigma^2_{Y(k)}\,\sigma^2_{U(k)}\right]=\frac{1}{2}\left[\sum_{i=1}^{W}\left(\frac{\partial^2 J}{\partial X_i^2(k)}\right)_0\sigma^2_{X_i(k)}+\sum_{i<j}\left(\frac{\partial^2 J}{\partial X_i(k)\partial X_j(k)}\right)_0 K_X(k)+\right.$$

$$\left.+\sum_{j=1}^{n}\left(\frac{\partial^2 J}{\partial X_j^2(k)}\right)_0\sigma^2_{Y_i(k)}+\sum_{j<p}\left(\frac{\partial^2 J}{\partial Y_j(k)\partial Y_p(k)}\right)_0 K_Y(k)+\sum_{i=1}^{l}\left(\frac{\partial^2 J}{\partial U_i(k)}\right)_0\delta^2_{U(k)}\right]; \quad (27)$$

where

$$\sigma^2_{X_i(k)}=\underset{\omega}{M}\left\{X_i(k,\omega)-X_{i0}(k)\right\}^2,\quad i\in W \quad (28)$$

is a variance of random value relative to its conditional mathematical expectation $Y_{i0}(k)$;

$$\delta^2_{iU(k)}=\left\{U_i(k,\omega)-U_{i0}(k)\right\}^2, i\in KC, \quad (30)$$

is a square of deviation of the i-th component of the control vector $U_i(k)$ from its nominal value $U_{i0}(k)$.

If we substitute (2) into (22), we get

$$J(K)=\sum_{k=1}^{K}\left\{J_0\left[\widehat{X}_0(k),\widehat{Y}_0(k),U_0(k)\right]+\delta J_0\left[\sigma^2_{X(k)},\sigma^2_{Y(k)},\sigma^2_{U(k)}\right]\right\}\to\min_{\langle U_0(k),\delta U(k)\rangle\in\Omega} \quad (31)$$

Thus, solution of the stochastic problem (22) can be get in two steps as a result of resolving two deterministic problems.

On the first step, until observation of realization of random conditions, the problem of operational planning of transport modes and natural gas distribution in the GTS is being solved:

$$J_0(K)=\sum_{k=1}^{K}J_0\left[\widehat{X}_0(k),\widehat{Y}_0(k),U_0(k)\right]\to\min_{U_0(k)\in\Omega} \quad (32)$$

The solution of the problem (22) allows to get at the null instant of time the optimal control vector $U_0^*(k)$, which determines the structures of all the LSs and CSs and parameters of CSs that guarantee realization of the optimal transport mode and natural gas distribution in the GTS on a time interval $[0,T]$.

On the second step, after each observation of realizations of random conditions at null instants of time $k=1,2,...,K$, the following problem is being solved:

$$\delta J_0(K)=\sum_{k=1}^{K}\delta J_0\left[\sigma^2_{X(k)},\sigma^2_{Y(k)},\sigma^2_{U(k)}\right]\to\min_{\delta U(k)\in\Omega}; \quad (33)$$

it is a problem of stabilization of transport mode and natural gas distribution in the GTS.

The problems (32), (33), as this follows from the (31), are roughly linked between themselves and actually are the solution of one problem (22). A feature of this solution is the fact that the optimal plan $U_0^*(k)$ should be the one so the problem of the second step (33) is resolvable for all $k=1,2,...,K$ and all possible realizations of random values. Thus, resolvability conditions of the second step problem induce additional limits on a constraint region of the problem of planning regime Ω_0.

The problem of operative planning is being solved in a conventional real-time mode by the use of facilities of IAS ADA in ADA DC “Ukrtransgas” with specification on all the six GMAs.

The problem of stabilization of transport mode is being solved in a real-time mode by the use of facilities local automatics (SAC and ACS TC of technological objects and machines of the GTS).

Conclusion

1. Stochastic models and methods of solving the problem of operative-dispatch control of the gas-transport system are considered.
2. It is shown that the problem of operative-dispatch control of the gas-transport system is reduced to solving of two linked problems:
   - operative planning of the conditions according to the forecasting of the basic disturbing factor of the gas-transport system. This factor is gas consuming;
   - stabilization of gas-transport system conditions with local automatic machinery after supervision over actual NG consuming in each GDS.
3. Conversion of operative planning problem is carried out and it is shown that its decision can be received as a result of solving the two interconnected problems:
   - structural and parametric optimization of the LS GTS (local subsystem of GTS);
   - coordination of boundary conditions determined the LS GTS work regime.

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