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ABOUT ONE APPROACH TO THE DECISION OF ENVIRONMENTAL PROBLEMS IN DIFFICULT SYSTEMS WITH HIERARCHICAL STRUCTURE OF MANAGEMENT

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Introduction. Numerous systems in various areas of technics represent systems with the distributed parametres. Similar systems are described by the differential equations in private derivatives of hyperbolic type.

It is known, that all these systems work in dynamic modes. Transients in these systems are defined by decisions of the differential equations in the private derivatives describing given systems.

In spite of the fact that each of these systems with the distributed parameters have the characteristic technological features, and also are characterised by technological complexities, they have the general mathematical basis. Therefore it is not casual results of the spent researches for one system, are quite successful as in that specific case, and in a general view, can be used for other systems with the distributed parameters [2].

The carried out analysis of technological features of the above-stated systems with the distributed parameters, show, that the main pipeline systems are characteristic, as difficult systems with the distributed parameters with the distributed databases with following specific technological features as: distribution of objects of management and information sources at a great distance; hierarchy of construction of a control system [3].

It is obvious, that the main pipeline systems makes special demands on development of tactics and decision-making strategy at all levels of hierarchical structure of management, identification and diagnosing of a condition of separate objects and the system as a whole.

Now in connection with increase of requirements on environment protection, and also for the purpose of economy of the electric power, the problem of the control over a condition of oil pipelines and their reliability is paid special attention.

Annually failures on the main oil pipelines (MOP) caused by occurrence of shock waves of pressure, failure on a linear part cause a stop of the pipeline and put a huge material damage to a national economy, the significant amount of a pumped over product is lost, means for oil pipeline restoration are spent, environment becomes soiled. Therefore there is a problem connected with management by an oil pipeline at occurrence in it while in service of non-stationary modes.

Operating experience MOP shows, that numerous cases, in result which because of doubtful or not enough the full information, made operative decisions, led to considerable losses of oil owing to swapping on the damaged pipeline took place; to superplanned delivery of oil to one consumer at the expense of short shipment to other consumers. Therefore there is a problem connected with management by an oil pipeline at occurrence in it while in service of non-stationary modes.

Problem statement. Basically, in known works the specified factors that limits possibility by definition optimum or close to optimum technological modes MOP are insufficiently in a complex considered and make essential impact on reliability of results.

Proceeding from the above-stated in the conditions of intensive development of pipeline transport of oil and complication of a configuration of oil pipelines for operative dispatching management, and also for optimisation of modes of their work there is a necessity for working out of more comprehensible settlement models of transients for research in studying of unsteady processes in oil pipelines and their emergency operation, characteristic for MOP, is one of actual scientific and technical problems of transport of oil.

As the existing scheme of the analysis and calculation of functioning of petrowire systems is based on the decision of the differential equations of movement of a liquid under corresponding regional conditions which allow to calculate stationary, non-stationary pressure and the oil expense. However, in many cases of it it is not enough. They not always allow to carry out the detailed analysis of the occurring physical processes of little use for the decision of such engineering problems, as correction and synthesis of systems with beforehand set processes of formation of fields of pressure, and also some problems connected with management of process when it is necessary to find the constant factors entering into the equation of movement of oil.

Thereupon in given article application of the system-structural analysis together with discrete methods is considered by working out of technological bases of management difficult MOP systems. Combination of a discrete and system-structural method allows to unify problems in difficult systems with the distributed parameters for the purpose of development of uniform schemes of the analysis and calculation of parameters of a stream [3,4]. Thus the decision of a problem of dynamics is considered as some system presented by the block diagramme. Block diagramme elements are the mathematical operators establishing rules of transformation of some influences on object in reaction generated by them.

Methods the decision. In the given work as a mathematical apparatus are used double and discrete transformation Laplas. At transition from the image to the original of functions recurrent parities [1] are applied.

Let's consider a problem connected with the structural analysis of dynamic processes in the main petrowire systems.

For construction of structural architectural models of dynamic processes in the main oil pipeline with known change of pressure in the end, it is possible to use the equation received on the basis of a discrete method [1,2].

According to structural architectural model [2], between a gradient of pressure and the expense in the field of images it is possible to present rigid communication:

$$\frac{1}{s}\overline{G}(x,s) = \alpha_3 \overline{K}_3(s) grad\ \overline{P}(x,s) \tag{1}$$

The equations (1) in the discrete form, according to [1]

$$\frac{e^q}{e^q - 1} G^*(\delta, q) = \alpha_3 K_3^*(q) grad\ \overline{P}(\delta, q),$$

Or in the field of originals looks like:

$$G[\delta, n] = \alpha_3 \sum_{m=0}^{n} K_3[m]\, gradP[\delta, n-m] - \sum_{m=0}^{n-1} G[\delta, m] \cdot 1[n-m], \tag{2}$$

Where $K_3[n] = e^{-\alpha_2 \frac{nT}{\lambda}} I_0\left(\frac{\alpha_2}{2} n \frac{T}{\lambda}\right)$ - the original of function $\overline{K}_3(s) = \frac{1}{s}\sqrt{\frac{s}{s+\alpha_2}}$. Defined on [5], $\alpha_1 = \sqrt{\frac{k_3}{k_1}}, \alpha_2 = \frac{k_2}{k_1}$, $\alpha_3 = \frac{1}{\alpha_1}$.

Communication between pressure in some section x_1 and any other section x is defined by operational function of a link of a kind

$$\overline{P}(x,s) = ch\gamma(x - x_1)\overline{P}(x_1, s), \tag{3}$$

Or it agree theorems of convolution [6],

$$P[\delta_1, n] = 2 \sum_{m=0,5\lambda(\delta-\delta_1)}^{n} K_1[m] P[(\delta-\delta_1), n-m] - \sum_{m=\lambda\delta}^{n} K_2[m] P[\delta_1, n-m] - \sum_{m=0}^{n-1} P[\delta_1, m] \cdot 1[n-m,], \tag{4}$$

Where $K_1[n], K_2[n]$ originals of functions $\overline{K_1}(s) = \frac{1}{s} e^{-\alpha_1\sqrt{(s+\alpha_2)s}(x-x_1)}$ and $\overline{K_2}(s) = \frac{1}{s} e^{-2\alpha_1\sqrt{(s+\alpha_2)s}(x-x_1)}$.

Originals of functions $\overline{K_1}(s), \overline{K_2}(s)$ according to [5] will be

$$K_{12}[n]=\begin{cases}0, & if\ n<(\delta-\delta_1)\lambda\\ e^{-\frac{\alpha T}{2}}+\frac{\alpha T}{2}\sum\limits_{m=\lambda(\delta-\delta_1)}^{n} e^{-\frac{\alpha T m}{2\lambda}}\dfrac{I_1\left(\frac{\alpha T}{2\lambda}\right)\sqrt{m^2-[(\delta-\delta_1)\lambda]^2}}{\sqrt{m^2-[(\delta-\delta_1)\lambda]^2}} & if\ \mathrm{n}\geq(\delta-\delta_1)\end{cases}$$

$$K_{21}[n]=\begin{cases}0, & if\ \ n<(\delta-\delta_1)\lambda\\ e^{-\alpha T}+\alpha T\sum\limits_{m=\lambda(\delta-\delta_1)}^{n} e^{-\frac{\alpha T m}{\lambda}}\dfrac{I_1\left(\frac{\alpha T}{\lambda}\right)\sqrt{m^2-[(\delta-\delta_1)\lambda]^2}}{\sqrt{m^2-[(\delta-\delta_1)\lambda]^2}} & if\ \mathrm{n}\geq(\delta-\delta_1)\end{cases}$$

$\alpha=\alpha_{1.}\alpha_2$.

Thus, being based on the above-stated of reasonings, it is possible to make the structural analysis of all links, making structurally architectural system models. So for example, communication between $\overline{P}(0,s)$ and $\overline{P}(l,s)$. In the field of originals will look like:

$$P[0,n]=2\sum_{m=0,5\lambda}^{n}K_5'[m]\,P[\delta,n-m]\sum_{m=\lambda}^{n}K_4'[m]\,P[0,n-m]-\sum_{m=0}^{n-1}P[0,m]\,1[n-m], \tag{5}$$

Where $K_4'[n]=\begin{cases}0, & if\ n<\lambda\\ e^{-\alpha T}+\alpha T\sum\limits_{m=\lambda}^{n}e^{-\alpha\frac{T}{n}m}\dfrac{I_1\left(\alpha T\sqrt{m^2-\lambda^2}\right)}{\sqrt{m^2-\lambda^2}}, & n>\lambda\end{cases}$

$$K_5'[m]=\begin{cases}0, & if\ n<0,5\lambda\\ e^{-\frac{1}{2}\alpha T}+\frac{1}{2}\alpha T\sum\limits_{m=\lambda}^{n}e^{-\frac{1}{2}\alpha\frac{T}{n}m}\dfrac{I_1\left(\frac{1}{2}\frac{\alpha T}{\lambda}\sqrt{m^2-0,5\lambda^2}\right)}{\sqrt{m^2-0,5\lambda^2}}, & n<0,5\lambda\end{cases}$$

Originals of functions $K_4'(s)=\dfrac{1}{s}e^{-2\gamma\ell}$, $K_5'(s)=\dfrac{1}{s}e^{-\gamma\ell}$.

It is known, that $ch\gamma\ell=\frac{1}{2}\left(e^{\gamma\ell}+e^{-\gamma\ell}\right)$, then $\frac{1}{ch\gamma\ell}=\frac{2e^{-\gamma\ell}}{1+e^{-2\gamma\ell}}$. It is possible to assume, that pressure in an index point it is connected with pressure in a final point operator $2e^{-\gamma\ell}/\left(1+e^{-2\gamma\ell}\right)$. The link characterised thus, can be transformed to more simple link, the captured feedback which is shown on fig. 1. Such approach allows to increase информативность the block diagramme.

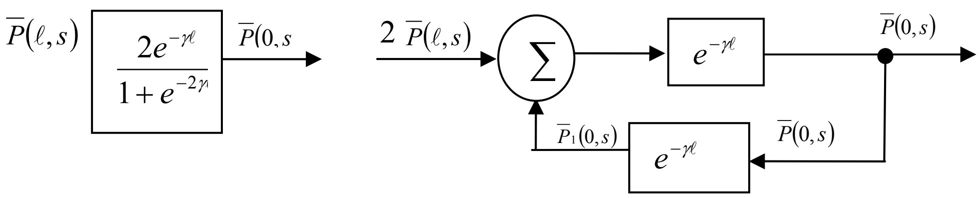

Fig. 1. Equivalent transformation of a link

For the pseudo-return problem connected with definition $\overline{P}(\ell,t)$ after some intermediate transformations to areas of originals it is had:

$$P[\delta,n]=\sum_{m=0}^{n}P[0,m]\cdot 1[n-m]+\sum_{m=0,5\delta\lambda}K_{20}[m]P[0,n-m]-2\sum_{m=\delta\lambda}^{n-1}P[\delta,m]K_{19}[n-m] \tag{6}$$

The decision of a direct problem connected with definition $P(x,t)$ agrees the block diagramme agrees a discrete method and the theorem of convolution looks like:

$$P[\delta, n] = \sum_{m=0}^{n} P[0, m]1[n-m] + \sum_{m=0,5\delta\lambda}^{n} K_{20}[m]P[0, n-m] - 2\sum_{m=\delta\lambda}^{n-1} P[\delta, m]K_{19}[n-m] \quad (7)$$

For a pseudo-return problem in the field of originals it is had

$$P[0, n] = 2\sum_{v=0,5\delta\lambda}^{n} K_{22}[m]P[\delta, n-m] - \sum_{m=\delta\lambda}^{n} K_{21}\{m\}P[0, n-m] - \sum_{m=0}^{n-1} P[0, m]1[n-m], \quad (8)$$

Where $K_{19}[n], K_{20}[n], K_{21}[n], K_{22}[n]$ – originals of images $\overline{K}_{19}(s) = \overline{K}_{22}(s) = \frac{1}{s}e^{-\gamma x}, \overline{K}_{20}(s) = \overline{K}_{21}(s) = \frac{1}{s}e^{-2\gamma x}$ defined under the table of images [5].

Conclusions. Proceeding from the above-stated, having studied methods of construction of structural architectural models, their transformation, it is possible to raise structural architectural models, formulations and the decision of direct, return and pseudo-return problems. Investigating physical sense of operational transfer functions and their originals of separate links of structural architectural models, it is possible to solve problems of identification, the analysis and synthesis of difficult systems with the distributed parametres with hierarchical structure of management.

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