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E. Bashirova, N. Svobodina

THE EVALUATION OF METAL OIL AND GAS EQUIPMENT IN A CURRENT CONDITION BY MEANS OF TRANSFER FUNCTION PARAMETERS

The equipment used for oil refining, dealing with highly explosive, inflammable and toxic atmospheres at surplus pressure and high temperatures, its operation term considerably exceeds normative one, is potentially dangerous and increases emergency situations, thus it is very important to define technical condition and the possibility of secure operation by scientifically proved methods at the end of normative operation term [7]. The modern definition of technical diagnostics as a field of scientific-technical knowledge, the essence of which is the theory, methods and means of faults detection and search of technical origin, includes the methods and means of undestroyable control.

Nowadays a wide range of undestroyable control methods and items, among which important electromagnetic ones, are used to solve the diagnostic tasks of oil and gas equipment.

A prosperous direction for solving the diagnostics tasks of oil and gas equipment is the usage of electro physical and mechanical properties interconnection in constructive steels. The mechanical and electro physical properties of metals interconnect with each other on the level of crystal lattice. The deformation of crystal structure, the fault origin and extension are followed by the alteration of mechanical and electro physical metal properties [4]. This way of interaction is necessary to use for the detection of actual metal condition in the operation process.

If metal is a non-linear system, it is possible to apply well-known methods of condition control such as the analysis of transfer function by incoming effect and system reaction. This way permits not to absorb into consideration but it makes possible to descript a current condition of the system, which is characterized as stable and non-stable. A stable condition means an operating capacity of the system that is the system is descripted by admissible values of the tested parameters at a certain period of time. Any system [5] must be operating first of all, that is must function properly and be non-sensitive to the external influence of different kind. The system must be stable for any practical task. Stability is the property of the system to return to the initial or close set cycle after outcoming, which is the result of some effect.

The processes in the system are described by means of non-linear system differential equations, which can be solved in certain rare cases. Though the equations of large number systems can be linearized. Then the system processes are described as linear differential equations such [6]:

$$a_n y^{(n)}(t) + a_{n-1} y^{(n-1)}(t + ... + a_0 y(t)) = b_m x^m(t) + ... + b_0 x(t). \qquad (1)$$

The solution of a differential equation is connected with calculating difficulties, that is why the system research is carried out by means of indirect methods based on Laplace operational methods and Fourier transformation. The following basic characteristics are used for this purpose: transfer function, transition function and impulse-transition function, complex coefficient transfer and frequency characteristics.

The transfer function is in a more wide use, when it is extracted from the following correlation: give Laplace transformation to the equation, we have:

$$D(p)Y(p) = N(p)X(p) + M_H(p), \qquad (2)$$

where

$$D(p) = a_n p^n + a_{n-1} p^{n-1} + ... + a_0; \qquad (3)$$

$$N(p) = b_m p^m + b_{m-1} p^{m-1} + ... + b_0; \qquad (4)$$

Y(p) - Laplace transformation for outcoming signal of the system; *X(p)* - Laplace transformation for outcoming signal; *Mн(p)* - polynominal, showing initial conditions.

Enter the following signs:

$$W(p)=N(p)/D(p);W_н(p)=M(p)/D(p). \quad (5)$$

Then the expression (2) has the following form:

$$Y(p)=W(p)X(p)+W_н(p). \quad (6)$$

This equation connects outcoming signal image with incoming signal image and with initial condition of the system. The function *W(p)* characterizes the dynamic properties of the system, it does not depend on the controlling effect and is fully defined by the system factors *ai* and *bi*, this function is called a transfer one, and the function *Wн(p)*- a transfer one relatively initial state of the system.

On zero initial conditions transfer function is equal the correlation of outcoming signal image by Laplace to Laplace transformation of incoming signal. Transfer function is a fractional rational function relatively Laplace operator transformation [6]:

$$W(p)=\frac{b_m p^m + b_{m-1} p^{m-1} + ... + b_0}{a_n p^n + a_{n-1} p^{n-1} + ... + a_0}. \quad (7)$$

For the realization of this method an input effect on the system is to be graduated and impulse. An impulse influence may be presented as a total influence of harmonic components. The frequency methods, which contain mathematical logic of Fourier and Laplace transformations, may be applied for solving tasks at a pulse excitation of transformer.

An important point in system status analysis is the construction of its mathematical model. The models variety defines different ways to solving and analysis. If model is rather simple and described by means of a simple linear equation, it is rational to apply time domain. But if the equation is rather difficult, it appears that the transition to frequency domain simplifies calculating actions a lot. It is possible for some models to get frequency characteristic analytically, but impossible to find a solution in time domain [8].

The convertion of time domain into frequency domain is possible in general for the models, which linear in time domain. Though a satisfactory empiric model can be formed in frequency domain directly.

Empirical transfer functions can be observed on experimental data directly. By the response to impulse incoming signal transfer function, gain coefficient and phase angle (phase lag, phase difference) can be estimated.

The transfer function on some external action does not depend on the law of variation of this action and is only defined by the system properties itself [5].

The mathematical method of Laplace transformations, it is possible to analyze transfer function as the connection between incoming and outcoming signals of electromagnetic converter at any moment time.

In considered case the subject research is the metal characterized as a non-linear system. The linear approximation based on the following points is used to simplify such systems analysis:

1. If characteristic equation of linear system has all roots with negative material parts, actual system will be stable. The terms of the second and upper powers, deleted when equation linearization can not change the system stability.

2. If characteristic equation of linear system has just one root with a positive material part actual system will be non-stable. The terms of the second and upper powers, deleted when equation linearization can not provide stability to the system.

3. If characteristic equation of linear system has just one zero root or a couple of imaginary conjugate roots, the reaction of actual system can not be defined by its linearized equation. In this case the terms of the second and upper powers deleted when equation linearization can radically change the description of actual system process [1].

The method of phase trajectory can be used for the non-linear system research, the essence of which is the following. If any system is described by the differential equation of n-order, its state is defined at every moment time by the value of regulated quantity x or any other quantity and its (n – 1) derivatives. Multidimensional coordinates space of researched quantity x and all its derivatives is called phase space.

The point M in a phase space with current coordinates values, defining the state system (or phase) is called representation point. At any change of system condition representation point coordinates vary. Its mechanical trajectory in a phase space is called a phase trajectory. The initial system conditions define the initial position of representative point in a phase space. The collection of phase trajectory, found for different initial conditions, with special points and trajectories presents a phase portrait, characterizing all possible conditions of a research system.

The method of phase trajectories is practically used for the systems of the second and third order. For the third order equations a phase space is a three dimensional space, two coordinates make phase plane, one variable makes phase line.

The phase trajectory method has a geometrical evidence and in combination with other methods presents a full representation [1] of possible system changes.

The use of mentioned above methods in research, analysis and the estimation of current condition in metal oil and gas equipment makes it possible to evaluate the actual metal condition developed processes treatment and analysis in it at any moment time.

REFERENCES

*1 **Anisimov I.V**. The basis of automatic control of processes in oil and oil refining industry.-L.: Chemistry, 1968.- 408p.*

*2 **Bessonov L.A.** The theory of electric engineering.- M.: Higher school, 1993.- 683p.*

*3 **Voronov A.A.**   The theory of automatic control.-M.: Energy, 1980.- 312p.*

*4 **Grib V.V.** The diagnostics of technical equipment condition of oil gas chemical industries.- M.: ЦНИИТЭнефтехим, 1998.- 180p.*

*5 **Kargu L.I., Litvinov A.P.** etc.   The basis of automatic regulation and control.- M.: Higher school, 1974.- 439p.*

*6 **Konovalov G.F.**   Radioautomatics.- M.: Higher school, 1990.- 335p.*

7Technical means of diagnostics: Reference/ Edited by V.V.Kluev.- M.:Mashinostroenie, 1989.- 672p.

*8 **Himmelblau D**.   The discovery and diagnostics of troubles in chemical and oil chemical processes.- L.: Chemistry, 1983.- 352p.*