SELF-OPTIMISATION OF MODES OF ELECTRO POWER SYSTEMS AS DISPLAY OF A PRINCIPLE OF THE LEAST ACTION

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PRINCIPLE OF THE LEAST ACTION AS A METHOD OF OPTIMISATION OF DIFFICULT SYSTEMS

Being the system of cybernetic type electric energy systems (EES) has the property of self-optimization. Self-optimization means natural automation, the property of the systems and their parts of self-regulation so that the increase of their level is provided with the transition to most energy efficient state or most efficient functioning mode. Transition of the system from one state to another is subordinated by the principle of the least action (PLA), which can be formulated in the following manner. After deviation from optimum functioning mode inversely directed action, i.e. counteraction appears in the system, this action is trying to turn the system back into optimum state.

Thus, for any system at a random moment of its existence qualitative optimum is the norm, the depth of this optimum is determined by the degree of ideality of the system (in our case, by the closeness of EES to uniform state).

Technological losses of electric energy (while generation, transmission and energy distribution) can be considered as characteristic feature of ESS needed for evaluation on the degree of its closeness to ideal state.

CONDITIONS OF OPTIMUM CURRENT DISTRIBUTING IN EPS

Normal modes EPS are optimum under condition of achievement of a minimum of criterion function in which quality total losses of active capacity in them are accepted, that is

$$\Pi = f(x,\ u,\ t) \to \min, \tag{1}$$

$$x \in D_x,\ u \in D_u,$$

where **x** - parameters of mode EPS; **u** - parameters of regulating devices; $\mathbf{D}_x$, $\mathbf{D}_u$ - admissible areas of change of parameters **x** and **u**.

To problem (1) there corresponds a definition problem current distributing, providing a minimum of losses of active capacity EPS during each moment of time t in the presence of restrictions on values of currents in branches and generating sites. Optimum current distributing it is defined:

$$\begin{bmatrix} \mathbf{I}_a \\ \mathbf{I}_p \end{bmatrix} = \begin{bmatrix} \mathbf{C}_r & 0 \\ 0 & \mathbf{C}_r \end{bmatrix} \begin{bmatrix} \mathbf{J}_a \\ \mathbf{J}_p \end{bmatrix} \tag{2}$$

$$\mathbf{I} \in \mathbf{D}_I,\ \mathbf{J} \in \mathbf{D}_J, \tag{3}$$

where $\mathbf{I}_{ao}$, $\mathbf{I}_{po}$ - vectors of optimum active and jet making currents in branches; $\mathbf{J}_a$, $\mathbf{J}_p$ - vectors of active and jet making central currents; $C_r = r_в^{-1} M_t' \left(M' r_в^{-1} M_t' \right)^{-1}$ - a matrix of factors т current distributing settlement scheme EPS in which resistance of branches are presented only by their active components (r-equivalent circuit EPS); **M ’** - the matrix of connections of branches in sites in which the lines corresponding to balancing sites are deleted.

SEARCH OF THE OPTIMUM STATE OF THE SYSTEM

In practice economically ideal status of the system calculated on (2), lays, as a rule, out of admissible area **D**. On fig. 1 the example of such case is resulted. Input in admissible area is carried out as a result of movement of system from a point $x_э$ [$x_{1э}$, $x_{2э}$] with is minimum possible in the set conditions value of losses of capacity in a point x_o [x_{1o}, x_{2o}] with great value of losses. We will notice, that at use gradient methods computing process is under construction on the contrary - lifting, and descent from level of the big losses (a point of initial approach $x^{(0)}[x_1^{(0)}, x_2^{(0)}]$) on level with smaller losses is carried out not.

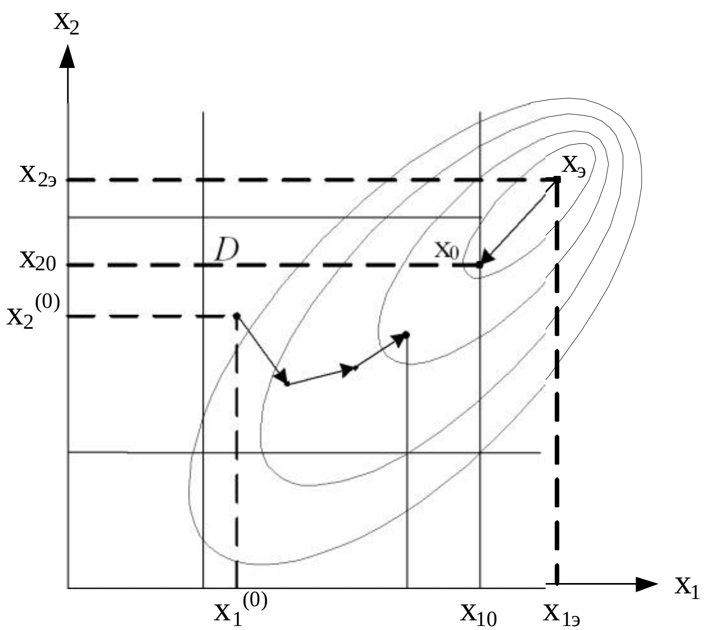

Fig. 1

Thus, it is possible to draw conclusions, that for maintenance of a minimum of losses of active capacity in EPS active and jet currents in it should be distributed depending on active resistance of its elements. It responds a principle of the least action according to which transition of system from one status to another is carried out at the least power consumptions. Using PLA, it is possible to solve a number of problems of optimum control of modes EPS. We will show it on an example of problems of the most favourable distribution of loading between power stations.

OPTIMUM DISTRIBUTION OF LOADING BETWEEN ELECTRIC POWER SOURCES.

Optimisation of modes EPS is spent by criterion of expenses for fuel (or the total expense of conditional fuel) at set for each moment of time to loading EPS

$$З_B = \int_0^T \sum_{i=1}^{s} B_i(P_i) ц_i dt \to \min, \qquad (4)$$

$$З_{Ri} = V_i T c = B_i(P_i) ц_i T, \qquad (5)$$

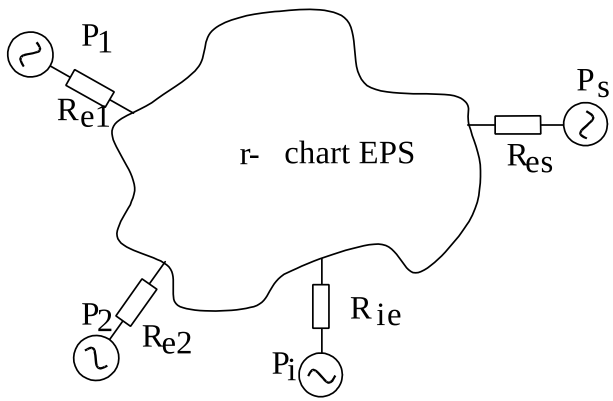

Fig. 2

$$V_i = \frac{P_i^2}{U_i^2} \cdot R_{ei} \qquad (6)$$

then

$$\frac{P_i^2}{U_i^2} \cdot R_{ei} \cdot c = B_i(P_i) ц_i \qquad (7)$$

from where

$$R_{ei} = \frac{B_i(P_i) U_i^2 ц_i}{P_i^2 c} \qquad (8)$$

$$V_\Sigma = \sum_{i=1}^{s} 3 R_{ei} I_i^2 \to \min$$

subject to the condition

$$P_1 + P_2 + \ldots + P_s - P_{нс} - V_c = 0 \qquad (9)$$

$$P_{i\min} \le P_i \le P_{i\max}, \quad i = \overline{1,s}, \qquad L = \sum_{i=1}^{s} B_i(P_i) \frac{ц_i}{c} + \lambda\left(\sum_{i=1}^{s} P_i - P_{нс} - V_c\right)$$

subject to the condition $\partial L / \partial P_i = 0, \; i = \overline{1,s}$

$$\frac{ц_i b_i}{1 - \sigma_i} = idem, \; i = \overline{1,s} \qquad (10)$$

CONCLUSIONS

1. Electro power systems as artificial systems are not optimum from the point of view of losses of the electric power during its manufacture, transportation and distribution. Their perfection is carried out in decision-making process on their development and reconstruction, and also during operation by optimum control of modes of their work. For working out of strategy of development, reconstruction and operation EPS on uniform methodological principles there can be used principle of the least action.

2. Process of optimum distribution of loading between energy sources in a power supply system probably to model with use of a principle of the least action. Thus the energy source in model is represented active resistance, cost of losses of the electric power in which is equalled to expenses on manufacture of the same quantity of the electric power. Definition of optimum loading of stations is reduced to calculation of established mode EPS on its r-equivalent circuit.