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HETEROGENEITY OF TRANSPORT ELECTRIC NETWORKS

Iurie DEDIU

Technical University of Moldova, dediu@mail.ru

***Abstract* – in this paper is presented the algorithm of the calculation of the matrix of the integrated factors of heterogeneity of the electric networks and the case study with determination of the factor of heterogeneity of the transport electric network TEST.**

Keywords: *heterogeneity, transport electric network.*

1. INTRODUCTION

Heterogeneity of power electric system is one of the main causes of the nonoptimal mode and additional losses of the electric power by its transmission and distribution. Heterogeneity of power electric system also brings to such unfavourable phenomena such as reducing of the quality of electric power, additional loading of the low-voltage transmission, lowering levels of the static and dynamic stability of the power electric system, what in its turn lowers transmitting capacity of the system as a whole.

Heterogeneity is a design factor of power electric system, therefore it has a negativ influence on these modes all the time of the functioning of the system.

For the achievement of the wishing effect it is necessary to reviewing the strategy of designing and reconstruction of the power electric networks thus as every step of reconstruction will be directed to the achievement of system effects, i.e. to approximate the power electric system to state of homogeneity. In connection with this arises the problem of definition of such of factor of heterogeneity which will describe an optimality of the power electric system in ensemble and will be determinated through a constructive parameters of the system.

Reduction of the level of heterogeneity of power electric system is obtained with installation of longitudinal compensation, reactors and with changing the construction of power transmission lines. Solving the problems of heterogeneity requires essential capital investments and may be used when heterogeneity is stipulated by a low number of elements or it is necessary in other purposes the reconstruction of the existing power electrical networks.

The realization of united Europe power electric market necessitates optimization of functionary of nationals power electric systems by the way of opening the access to consumers/suppliers to production companies with competitive prices.

In these conditions it is observed the increase of level of using of transport electric networks which will support some flows of power generated by commercial aspects, unforeseen on the step of dimensions.

Analysis effectuated demonstrate that exists a congestion of network in the transport capacity of lines of interconexion between Republic of Moldova and Rumania and Republic of Moldova and Ukraine. In this case it is considered opportune extending lines of interconexion between Republic of Moldova and Rumania and Ukraine.

2. DEFINITION OF THE INTEGRATED FACTOR OF HETEROGENEITY

In the homogeneous power electric system distribution of the current in the permanent mode may be presented as the sum of two vectors

$$\underline{I} = \underline{I}_e + \underline{I}', \tag{1}$$

where I_e – is a vector of the economic currents in the branches, determined as a result of calculation of the mode by the scheme R;

$I' = NI_{lev.}$ – is a vector of the additional currents in the branches which are overlapped on I_e adduce to execution of the second low of Kirchhoff.

N – is a matrix of incidence of independent cycles – branches;

I_{lev} – is a matrix-column of the levelling currents.

I_e – is a matrix-column of currents through branches of homogeneity of power electric system.

The problem of optimization of watt losses consists in reduction of current of the matrix I'.

In accord to

$$\underline{I}' = \underline{I} - \underline{I}_e = C\underline{J} - C_R\underline{J} = (C - C_R)\underline{J}, \tag{2}$$

where J – is a vector of currents defined nodes;

$C = Z_l^{-1} M_t Y^{-1}$ - is a square matrix of current distributions injected in independent nodes;

$C_R = R_l^{-1} M_t Y_R^{-1}$ - is a square matrix of current distributions injected in independent nodes which is determinated by the scheme R;

$Z_l = R_l + jX_l$ - is a diagonal matrix of impedances of branches;

M_t – is a matrix of incidence of independent transposed branches-nodes;

Y and Y_R – is a matrix of admittances of nodes which corresponds to schemes Z and R.

The problem of reducing of watt losses may be formulated in the following way

$$I' = (C - C_R)J \Rightarrow 0. \quad (3)$$

Since the matrix C is complex, but the matrix C_R – is real, then (3) is executed when $C \Rightarrow C_R$, i.e.

$$C_{react}=0,\ C_{act}=C_R, \quad (4)$$

where C_{act}, C_{react} – are components of matrix C.
The first condition in (4) is necessary, but the second - is valuable.
Presenting the matrix C by active and reactive resistances and admittances of nodes

$$C = (G_l - jB_l)M_t(R_n + jX_n) =$$
$$= (G_lM_tR_n + B_lM_tX_n) + j(G_lM_tX_n - B_lM_tR_n),$$

where R_n – is a matrix of active resistances of nodes;
X_n – is a matrix of reactances of nodes;
R_l – is a diagonal matrix of active resistances of branches;
X_l – is a diagonal matrix of reactances of branches.

From the last expression receives

$$C_{reac} = (G_lM_tX_n - B_lM_tR_n),$$

or

$$C_{reac} = G_l\left(M_tX_nR_n^{-1} - X_lR_l^{-1}M_t\right)R_n. \quad (5)$$

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$$\gamma = M_tX_nR_n^{-1} - X_lR_l^{-1}M_t. \quad (6)$$

Relation (6) is the matrix of integral factors of heterogeneity of power electric system.
Matrix γ is a square matrix, the number of lines is equal to the number of branches, but the number of columns to the number of independent nodes.
Element ij says about the influence of parameters of the branch i on the node j. If in the node j are connected homogeneous branches, than the elements of this column are equal to zero. For homogeneous power electric networks all elements of the matrix γ are equal to zero. In its turn the elements of column j – are nonzero, if in that node are connected homogeneous branches. I.e. the elements of the matrix γ say about the influence of parameters of the equivalent schemes on integrated factor of heterogeneity of power electric network.
Analysing the elements of the matrix γ may be elaborated actions about reduction of integrated factor heterogeneity of power electric networks for the purpose of reduction power and energy losses.
For the quantitative estimation of heterogeneity of power electric networks it is used the integrated factor of heterogeneity, which is determined by the relation

$$d\gamma = \rho\left(M_tX_nR_n^{-1} - X_lR_l^{-1}M_t\right) = \sqrt{\sum_{i=1}^{n}\sum_{j=1}^{m}\gamma_{ij}^2}. \quad (7)$$

3. CASE STUDY

Using (6) we calculated matrix γ for transport electric network TEST, which scheme is presented in fig.1.

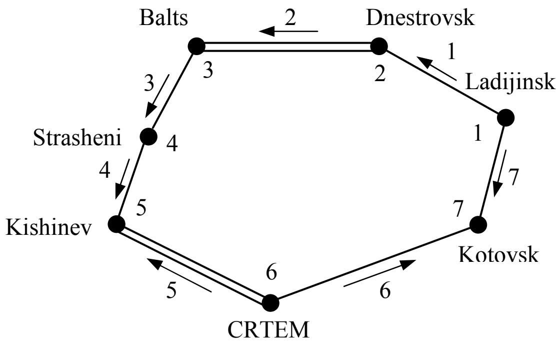

Figure 1: Scheme TEST of the transport electric network

In table 1 are indicated the results of the calculations of integrated factors of the heterogeneity for four variants of section PTL-330 kV Balts-Dnestrovsk-2.

Section PTL - 330 kV Balts-Dnestrovsk-2	$d\gamma$
2ASO-300	2,6282
2ASO-400	**1,7391**
2ASO-500	2,4941
2ASO-600	4,1178

Table 1: Results of calculations of integrated factors of the heterogeneity

4. CONCLUSIONS

In this paper is presented the factor which describes the level of heterogeneity of power electric system in ensemble. This factor may be used at the step of reconstruction of power electric system for the purpose of reduction of watt losses and improvement of the quality of electrical energy.
For schemes with a simple configuration changing of parameters of the single line adduces to essential variation of the integral factor of the heterogeneity of power electric system.

References

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