USING MATHEMATICAL PROGRAMMING METHODS FOR MODELING OF ELECTRICAL GRIDS

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The reliability and the quality of power supply are largely determined by operation conditions of electrical grids. The considerable importance has the optimization for various criteria of a power flow distribution in distribution gears and electrical lines. One of these criteria is the transmission capacity of the electrical grid under given constraints of the quality of an energy supply for electricity consumers.

Therefore, we believe it relevant to build the model of the grid in general terms to search for the optimum distribution of power flows in all parts of the grid to ensure its maximum capacity, under given constraints of the quality of an energy supply for electricity consumers.

For mathematical modelling the search for optimal distribution the power flow in the steady-state conditions of the grid operation we can use the elements of the theory of electrical circuits and mathematical programming. To avoid the extra complications for some model's parameters we will accept approximate values that are sufficient for practical calculations. The most common types of the power grids are radial and trunk ones and their modifications.

The independent variables are only power of the consumers in case we are interesting in only the reserve the power of the given (existent) consumers. Voltage losses in the constraints summarize on whole circuit from the current source to the consumers.

The system of constraints in this case is made up from three parts:

1) constrains on the total balance of currents of electric transmission lines, that are expressed from total capacities to all distribution gears of the grids (considering the all loads in three-phase lines are symmetric);

2) constrains on voltage losses in each circuit from the current source to the consumers;

3) constraints on feasible loads on each electric transmission line.

The objective function is the sum of capacities of all consumers.

$$\Phi(S) = \sqrt{\left[Re\,F(S)\right]^2 + \left[Im\,F(S)\right]^2} \to max\,,$$

where $F(S) = \sum_{j=1}^{m} \sum_{k=1}^{n_j} S_{jk}$, and S_{jk} - full capacity of each consumer.

Considered way of optimization modelling the electrical grids in conjunction with the computing and software capabilities of modern computers allows a detailed study of electrical grids for the purpose of decision-making for their maintenance and modernization.

A similar method can be realized using spreadsheets Excel Solver add-in that is included in package of office software MS Office.