OPTIMIZATION MODES OF POWER NETWORKS

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ABSTRACT

Nowadays in the optimization of power networks is system development of operation and optimization of branch circuits which are based on linear programming problems. One of its categories is traffic problem. The paper discusses the formulation of setting and solving problems used in the design of the most efficient power supply systems in the real sector of economy. The construction of arithmetic models of problems is carried out.

Keywords: Optimization, power networks, transport problem, power transmission lines, power supply system, power plants.

Various kinds of decision-making problems lead to a variety of optimization tasks. The goal of solving optimization problems is to find the most suitable option. One of the tasks directly related to finding the optimal solution is the transportation problem. The transportation task is the task of finding the ways of transporting the product from the points of production to the points of consumption with the minimum transportation cost.

The general mathematical terminology of the transport problem can also be applied to problems in the field of energy. In this case, the product refers to the electrical power supplied from the power source to various consumers via power transmission lines (PTL). The power source can be power plants or electrical substations, the consumers can be industrial, city-wide, agricultural and industrial consumers of electricity. In such tasks, we optimize the costs of the power supply scheme consisting of power transmission lines connecting the energy source nodes with the energy consumer nodes. This paper discusses three types of transport optimization problems used in the design of power supply systems:

1) classical formulation of the problem;
2) transport problem with power transit;
3) transport problem taking into account transmission capacity.

Let classical formulation of the problem:

The classical formulation of the transportation problem, optimizing the cost of the electrical circuit, is as follows:

For example, in the designed electric power supply system there is $j=1,2,\dots,m$ consumer nodes and $i=1,2,\dots,n$ power supply nodes. The energy capacity of each of the energy sources is power units (p.u.), and the capacity of each of the energy consumers is p.u. The two-sided configuration of the nodes of energy sources and energy consumers is given initially. The unit cost of transmitting a unit of power from node to node is conventional unit/ power units (c.u./p.u.). It is necessary to determine the optimal power supply circuit, which ensures minimum costs when using the electrical grid.

$$z = \sum_{i=1}^{n} \sum_{j=1}^{m} z_{ij} x_{ij} \qquad (1)$$

Creating a mathematical model and finding the most optimal solution to problems of this type is similar to the well-known formulations of the classical problem of transportation. It is necessary to minimize the objective function.Where x_{ij} is the required values of the transmitted power from source A_i to consumer B_j .At the same time, for each i -th power source, the sum of powers flowing through power transmission lines to all $j=1,2\dots,m$ consumer nodes must be equal to the power A_i of this source.

$$\sum_{j=1}^{m} x_{ij} = A_i \qquad i = 1,2,\dots,n \qquad (2)$$

At the same time, for each j -th consumer, the sum of the capacities flowing along the power lines from all $i=1,2,\dots,n$ power sources must be equal to the power B_j of the given consumer node

$$\sum_{i=1}^{n} x_{ij} = B_j, \qquad j = 1,2,\dots,m \qquad (3)$$

The last two equalities take into account the performance of the power balance for each node. In addition, they are also limitations of the linear model of the transportation problem. The number of restrictions should be equal to the number of nodes of sources and consumers $n+m$. The search for the optimal solution of the problem can be accomplished, for example, using the potential method or with the help of the MS Excel spreadsheet processor.

In comparison with transport problems in the classical formulation, transport problems with power transit (intermediate traffic) are more general tasks and have unlimited potential possibilities for increasing the efficiency of the power supply circuit. In the actually implemented schemes of electrical networks, it is often the most advantageous to transfer power through intermediate (so-called transit) nodes. Such transit nodes can be both a power supply node and a consumer node.

In contrast to the classical formulation of the transportation problem, transit power is indicated by a variable with two identical indices. This double number corresponds to the node number through which the power flows .

Characteristic features of the transportation problem with power transit are as follows:

1. all n nodes of sources and nodes of consumer are numbered : $1,2\ldots(n+m);$
2. as a rule, intermediate (transit) power x_{ij} can be transmitted through any i-th node;
3. unit cost of transit power transmission is $z_{ii}=0$;
4. transport matrix has the shape of a square $(n+m)\times(n+m);$
5. transit variables x_{ii} enter the solution of the problem with a negative sign;
6. regardless of the values, all transit variables are basic.

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