UDC 621.316.722

N. E. Glukhenkyi
S. S. Nykyporets

ENERGY-SAVING SOLUTIONS IN THE DEVELOPMENT OFTHE POWER SUPPLY SYSTEM

Vinnytsia National Technical University

Анотація.

Обґрунтовано критерії ефективності для порівняльної оцінки керуючого впливу батарей статичних конденсаторів, що використовуються для компенсації реактивної потужності, для симетрування електричного режиму як триповідної, так і чотирипровідної мережі, а також зменшення вищих гармонік.

Ключові слова: батарея статичних конденсаторів, критерій ефективності.

Abstract

The efficiency criteria for comparative evaluation of the control effect of static capacitor batteries used for reactive power compensation, for balancing the electrical mode of both three-wire and four-wire networks, as well as for the reduction of higher harmonics are substantiated.

Keyword: battery of static capacitors, efficiency criterion.

Introduction

The main design decisions that affect the electricity losses in the power supply system during its operation should be taken into account when developing the power supply system. Among such decisions are the following.

Reactive power compensation (RPC) is the cheapest and most effective means of reducing all types of power losses. As a rule, capacitor banks are used for reactive power compensation. They have multifunctional properties, which increase the efficiency of their operation. In particular, by reducing active losses caused by unbalanced or non-sinusoidal voltages (Task Group 1).

The power of power transformers shall be justified taking into account the specific density of loads (Task Group 2).

When choosing a transformer, it is necessary to provide for the installation of modern ones, because as a result:

- use of advanced steel grades;
- improving the manufacturing technology of the magnetic system and especially the steel cutting technology;
- Improvements in the design of the core reduced losses in transformers by an average of 50% (hereinafter referred to as Task Group 3).

Projects for the reconstruction of the power supply system should consider the continued use of existing transformers (those already in operation), given that losses in transformers manufactured in recent years have been significantly reduced. This is confirmed by the table below (Task Group 4):

Table – Values of the parameters Pxx and Pkz of transformers depending on the year of their manufacture

Power, kVA	63			100			250			630			1000			1600		
Year of issue	1965	1975	2012	1965	1975	2012	1965	1975	2012	1965	1975	2012	1965	1975	2012	1965	1975	2012
Losses, PX.X, kW	0,24	0,22	0,16	0,37	0,32	0,29	1,05	0,78	0,48	1,95	1,68	0,96	2,95	2,55	1,5	3,3	2,65	1,95
Losses of power supply, kW	1,45	1,4	1,24	2,35	2,22	1,9	3,9	3,7	3,7	7,8	7,6	7,6	11,5	10,9	10,2	16,5	16,5	16,0
Weight, kg	495	485	430	430	715	645	1280	1125	1020	2765	2340	1980	3950	3560	3250	5640	5640	4600

The decision on the number of transformer substations, the capacity of transformers on them and the network layout should be made in such a way that it is technically feasible to control the number of operating transformers depending on the load that changes over time (Task Group 5).

Group of problems 1 is, by its nature, an optimization problem that can be formulated mathematically and for which mathematical programming methods can be used [1].

For problem group 2, the optimal matching of transformer power values is substantiated and specific load density, which corresponds to the minimum specific reduced costs [2]. In practice, no special calculations are required. The essence of the calculations is that, based on the specific density of loads, the recommended power of transformers is determined.

A characteristic feature of problems 3, 4 and 5 is that it is practically impossible to describe them mathematically and, as a result, it is not possible to use classical optimization methods. In practice, they are solved on the basis of human experience.

A prerequisite for solving Group 1 problems is the presence of a quantitative optimality criterion.

The purpose of this paper is to substantiate a quantitative criterion by which to evaluate the results, compare them with each other and determine the optimal option for task group 1.

Research results

Task group 1 includes the following:

A) the problem of a switchgear in an electrical network using a battery of static capacitors;

B) the problem of symmetry of the electrical mode in a three-wire network and a switchgear in an electrical network using an asymmetric battery of static capacitors;

C) the problem of symmetry of the electrical mode in a four-wire network and the switchgear in the electrical network using an asymmetric battery of static capacitors with capacitor sections connected to phase and line voltages;

D) the task of reducing higher harmonics in a three-wire (four-wire) network and switchgear in an electrical network using a battery of static capacitors contained in a power filter;

E) the problem of symmetry of the electrical mode in a four-wire network, reduction of higher harmonics and FF in the electrical network using a battery of static capacitors.

As a comparison criterion for assessing the electrical mode of the power grid for all these tasks during its operation, the value of total losses – УΣ from reactive power, components of the reverse and zero mode sequences (if there is a mode asymmetry), higher harmonics (if there is non-sinusoidality) can be accepted. This criterion, although clearly reflecting the goal set in these tasks, is described by a rather complex function of the control vector. All problems are characterized by the presence of additional active losses. On this basis,the solution of problem A) can be performed according to the criterion:

$$\Delta E\Sigma = EQ,$$

where ΔEΣ is the total additional active losses due to reactive energy transmission; EQ is the active losses due to reactive energy transmission;

task B) can be performed according to the criterion:

$$\Delta E\Sigma = EQ + E2,$$

where E2 is the total additional active losses caused by reverse-sequence currents;

task B) can be performed by criterion:

$$\Delta E\Sigma = EQ + E2 + E0,$$

where E0 is the total additional active losses caused by zero-sequence currents;

D) can be performed by the criterion:

$$\Delta E\Sigma = EQ + E\nu,$$

where $E\nu$ is the total additional active losses caused by zero-sequence currents;

D) can be performed by the criterion:

$$\Delta E\Sigma = EQ + E2 + E0 + E\nu.$$

Conclusion

The quantitative assessment of the effectiveness of the technical solution for task group 1 can be performed according to the developed criteria.

REFERENCES

1. Tereshkevych L. B. ACS in electricity consumption. Vinnytsia, VNTU, 2016. 129 p.
2. The Essential Guide to Power Supplies. Edited by Gary Bocock, Issue 1. http://www.xppower.ro/dwnd/Essential_Guide_to_Power_Supplies_full_pdf.pdf

Нікіта Євгенович Глухенький – студент групи ЕМ-22м, факультет електроенергетики та електромеханіки, Вінницький національний технічний університет, Вінниця; e-mail: hfjfj7373@gmail.com

Науковий керівник: Никипорець Світлана Степанівна **–** викладач англійської та німецької мов, кафедра іноземних мов, Вінницький національний технічний університет, м. Вінниця, e-mail: fotinia606@gmail.com

Nikita Yevhenovych Gluhenky – a student of group EM-22m, Faculty of Power Engineering and Electromechanics, Vinnytsia National Technical University, Vinnytsia; e-mail: hfjfj7373@gmail.com

Scientific supervisor: Svitlana S. Nykyporets – teacher of English, Foreign Languages Department, Vinnytsia National Technical University, Vinnytsia, e-mail: fotinia606@gmail.com