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CALCULATION OF THE PAYBACK PERIOD FOR THE INTRODUCTION OF REACTIVE POWER SOURCES INTO POWER SUPPLY SYSTEMS

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ABSTRACT

At present, the sources of reactive power are widely used in telecommunication facilities that have windings (electric motors, transformers, etc.) in the design. To manage these sources, necessary to introduce new technical means and elements, including microprocessor blocks. Combined control of reactive power sources and voltage regulation with the help of a microprocessor-based unit of electric receivers of telecommunication objects turns out to be technical and economical not only for reactive power sources, but also for lowering transformers of the power supply system.

KEYWORDS: *Compensation, Electric Motors, Transformers, Reactive Power, Microprocessor Control Units, Active Power, Connection, Voltages.*

INTRODUCTION

Receivers and converters of electrical energy, which have windings in their construction (power converters, transformers, electric motors, etc.), consume not only active power, but also reactive power. When electricity is transmitted through the electrical networks of the power supply system (PSS) of reactive power (RP), they generate losses of active power, for which the consumer pays. An alternative to an additional payment for electricity is the installation of reactive power sources (RPS) in the electrical network [1-2].

At most facilities with high-voltage electrical equipment, reactive loads are compensated by overexcitation of existing synchronous compensators (SC) with high voltage (6-10 kV) or by placing in the power grid of PSS capacitor installations - high-voltage (WCD) and low (NCB) voltage [3-11].

As shown by the analysis, the loss of electricity in the UK, due to the generation of PM by them, is minimal in the operation of electric receivers with a small consumption of PM. The growth of PM output is accompanied by a sharp increase in electricity losses, which primarily heat SK units. Studies have also shown that the use of any power, as well as high-voltage CS with a power below 1,600 kW, is uneconomical in low-voltage systems [3, 6,7].

It should be noted that even with excess PM of high-power high-voltage CCs and generators that allows to observe contractual parameters with the electricity supplier, the consumer is not immune from unjustified losses of the latter. The remark is typical especially for electrical loads with extended high voltage electrical networks and a large number of reducing power transformers (T) 10 (6) / 0.4 kV of PSS objects.

MAIN PART

As experience of operation of electric networks and electric receivers of objects of PSS has shown, cosine capacitor installations for them are more widespread RPS. The power of a reactive power source is proportional to the square of the voltage, frequency and its capacitance [2-14]:

$$Q_k = U^2 \cdot \omega \cdot C, \quad (1)$$

where: Q_k - reactive power of the condenser unit;

U - voltage of the electrical network TK;

ω - angular frequency;

C-capacity of the condenser unit.

The use of embedded microcomputers in the block of microprocessor combined automatic control of reactive power sources makes it possible to reduce damage from damage to electrical and electrical equipment and to improve the quality of generated electricity.

Connection of capacitor installations for compensation of reactive power at different voltages of PSS objects is shown in Fig.1.

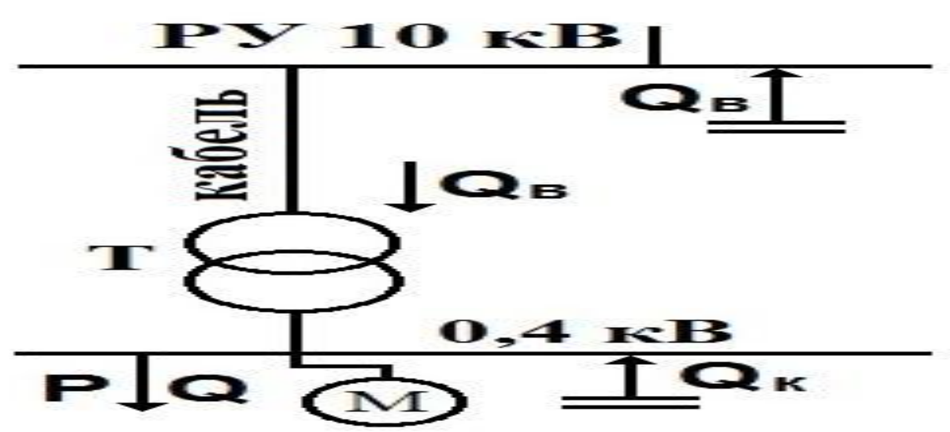

Fig.1. Scheme of capacitor installations for compensation of reactive power at different voltage levels of electrical networks.

For an example we will determine the additional losses of active power ΔP in T and cable lines of PSS with a length of 400 m with a cross section of 50 mm^2.

Suppose, before the installation of the NSC at the PSS site, there were loads: load factor, time of maximum power losses: τ = 5000 h.

After the installation of the NSC, the load of the PSS facility will have the following values:

The current flowing through the electrical networks of the PSS facility is determined as follows:

$$I_1 = \frac{S_1}{U\sqrt{3}} = \frac{860}{(10{,}5 \cdot 1{,}73)} = 47\ A; \quad (2)$$

$$I_2 = \frac{S_2}{U\sqrt{3}} = \frac{707}{(10{,}5 \cdot 1{,}73)} = 39\ A. \quad (3)$$

Additional power losses in the HV cable:

$$\Delta P_K = 3R_K\left(I_1^2 - I_2^2\right) = 3 \cdot 0{,}248(472 - 392) = 0{,}52 \text{ кВт}. \quad (4)$$

Additional power losses in T of the PSS object depend on its load losses:

$$\Delta P_T = \Delta P_{КЗ}\left(K_{З1}^2 - K_{З2}^2\right) = 10{,}6(0{,}862 - 0{,}7072) = 2{,}54 \text{ кВт}. \quad (5)$$

Total power loss:

$$\Delta P = \Delta P_K + \Delta P_T = 0{,}52 кВт + 2{,}54 кВт = 3{,}06 кВт. \quad (6)$$

The energy savings for PSS facilities for the year will be:

$$\Delta Э = \Delta P \cdot \tau = 3{,}06 \cdot 5000 = 15300 \text{ кВт} \cdot \text{ч}. \quad (7)$$

The increase in the capacity of T and the cable lines of PSS objects can be taken into account with corresponding shares of their cost.

For power transformer TC:

$$\Delta K_T = K_T(S_1 - S_2)/S_1 = 500000 \cdot (860 - 707)/860 = 88953 \text{ сум}. \quad (8)$$

For cables with a long-lasting current

$I_Д = 130\ A$:

$$\Delta K_K = K_K(I_1 - I_2)/I_1 = 62000 \cdot (47 - 39)/130 = 3815 \text{ сум}. \quad (9)$$

Payback period of the NCB:

$$T_{OK} = (K_{КУ} - \Delta K_T)/(C_{ср} \cdot \Delta Э) = (160000 - 88953 - 3815)/(0{,}77 \cdot 15300) = 5{,}7 \text{ года}. \quad (10)$$

The indicator of the effectiveness of this measure is determined as follows:

$$Пэфф = \left(\frac{T_{ОК\ НОРМ} - T_{ОК}}{T_{ОК\ НОРМ}} \right) \cdot 100\% = \left(\frac{8-5,7}{8} \right) \cdot 100\% = 28,75\%. \quad (11)$$

CONCLUSION

1. The specific value of the WKB is half that of the NCB. However, the constant component of costs for WKB is higher due to the greater cost of connecting them to the electrical networks of PSS objects.

2. Parameters of the regulated NCU - the number and power of the control stages, the power of the unregulated part - are determined by the daily schedule of consumption of PM by electric receivers.

3. Combined control of reactive power sources and voltage regulation with the help of IRM proves to be effective only for NKR, included behind the large inductive resistance of step-down transformers of PSS objects.

4. To change the voltage by one percent of the nominal value, it is necessary to change the PM after transformer, behind the transformer, behind the cable line length, behind the cable line length.

As shown by the conducted studies, the proposed method of selection and application of reactive power sources and microprocessor combined control allows them to reduce by 28.7% the payback period of the implemented technology and the elements of electricity consumption management and to increase the efficiency of energy saving measures implemented in the PSS objects.

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