APPLICATION OF AUTOMATIC THYRISTOR REACTIVE POWER COMPENSATORS IN AGRICULTURAL DISTRIBUTION NETWORKS

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Introduction

Rural power grids of 0.4 kV have unstable characteristics. The length of the line varies from 250 to 900 m, power - from 8 to 32 kW, wire cross-section - from 16 to 70 mm2, distributed over a large area. They have sharply uneven load schedules in time and in phases. All this increases energy losses in the networks. Technical losses in them amount to 20...25% of the useful energy consumption. At the same time, half of them are due to the consumption of reactive energy from the grid, that is, a low power factor [1].

The use of ordinary unregulated systems for the correction of the power factor in enterprises of the type under consideration is extremely inefficient due to sharply alternating loads. In addition, in such conditions, the phenomena of under- and overcompensation are possible, which can only accelerate the wear of reactive power consumers in production. The use of automatic reactive power compensation units (ARPCU) makes it possible to solve the problem of a low power factor much more efficiently.

Schematic diagram

One of the varieties of ARPCU are capacitor units with thyristor contactors. They provide operational correction of the power factor for devices with a sharply variable load and stabilization of the supply voltage. This type of capacitor installations differs from conventional regulated installations in that switching of capacitor sections is carried out by thyristor switches. The use of thyristors instead of mechanical contractors allows you to get a higher switching speed and reduce the time and labor costs for maintenance and replacement of wear-prone contactors. Thyristor switches are not subject to mechanical wear, are silent and are able to switch almost instantly.

Based on the analysis of known reactive power sources, the scheme of a regulated reactive power source [2] is selected, shown in Figure 1. It has high speed, high efficiency coefficient, low content of higher current harmonics.

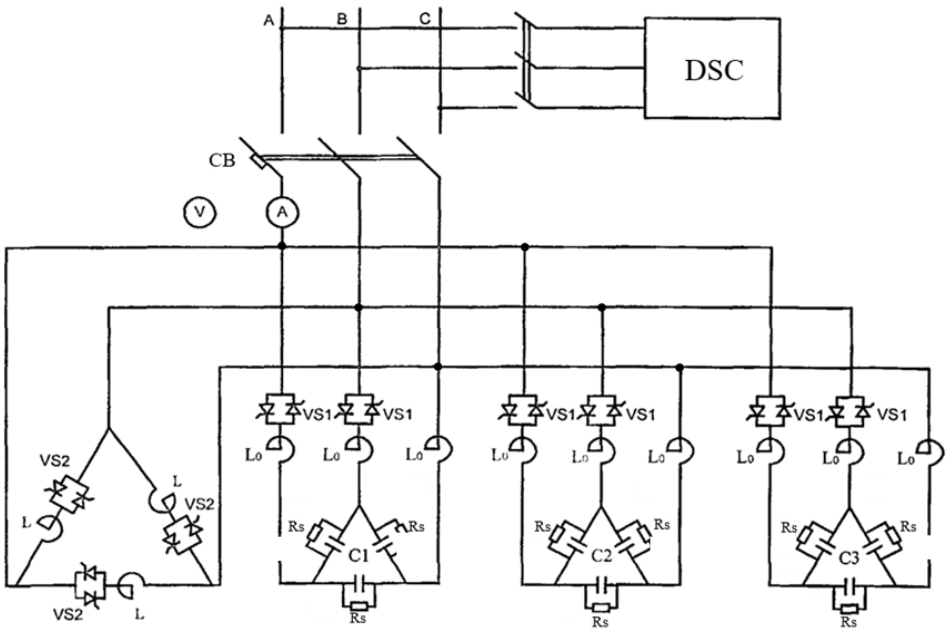

Fig. 1. Schematic diagram of a regulated reactive power source

The circuit contains capacitor banks and regulated reactors (inductors). It is advisable to use such sources for centralized voltage regulation, i.e. to install them on low-voltage substation buses. The main elements of the scheme:

L - regulated reactors;
Lo - current-limiting reactors;
VS - thyristor switches;
C1=C2=C3 - capacitor banks;
RS - shunt resistors;
CB - circuit breaker;
DCS - digital control system.

The use of thyristor switches for switching capacitors in compensating devices provides the necessary performance. In addition, with the help of thyristor switches, it is possible to limit or even eliminate overvoltages on capacitors and improve transients in capacitances when they are switched on and off.

To ensure reliable operation of the VS1 key thyristors, it is necessary to limit the rate of current rise through them di/dt. In other words, to reduce the influence of the load current on the shape of the output voltage curve, current-limiting Lo reactors are connected.

The VS1 thyristor switches are located only in two phases, which reduces the power loss in the capacitor bank switching device by one third, since such a device has large energy losses and is a source of higher harmonics. Thyristor switches are used to turn on capacitors, control pulses are fed to the valves during each half-cycle, automatically turning on the capacitor at the moment when the voltage at the terminals of the capacitor is equal to the mains voltage

The second feature of the scheme is that the L source reactors with series connected VS2 thyristor regulators are connected according to the triangle scheme.

The power of three reactors L is equal to the power of one stage of the capacitor bank. The protective element of the entire source is an automatic switch. To ensure the discharge of the capacitance of the capacitors, shunt resistors Rs are provided. The central control system of the DCS receives power from the same three-phase network through a separate switch CB.

Conclusion

Thyristor capacitor installations are the best solution when it is necessary to compensate for the reactive power of the load in a short period of time. The main element of the considered device, ensuring the fulfillment of its functional tasks, is an automatic control system. Condenser installations with thyristor switches are used in enterprises with a sharply variable load, which can reasonably be attributed to agricultural enterprises [3,4].

The advantages of the presented installation include: reducing losses in the power supply system, increasing the available capacity of the enterprise, lower voltage drops on the elements of the power supply system, minimizing anomalies in the power grid such as flicker and voltage drop, no moving parts, increasing the service life of capacitors by at least 1.5 times [5].

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