

Due to the high demand for electricity, it is necessary to use nuclear energy. For several reasons, nuclear power plants are more environmentally friendly, more productive and until what other energy sources can not solve the problem of lack of energy. Therefore, the future of nuclear power, and do not be afraid to use it!.

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The basic voltage and reactive power control devices

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The target of this paper is to present the main devices of automatic voltage regulation in the power system. The basic function and principles of operation of these devices are described in this paper.

To ensure a reliable supply of energy imposes mandatory requirement to maintain a certain level of voltage. The voltage level is closely related to the reactive power. Increasing or decreasing the voltage level occurs due to increase or decrease of the amount of reactive power into the grid. Therefore, the control of voltage and reactive power is one of major issues in the power system operation. After that, basic units of voltage regulation and reactive power in the network are considered.

Automatic voltage regulator of synchronous generators (AVR).

The automatic voltage control of synchronous generators occupies an important place among numerous automatic control systems for energy systems. Originally, the sole task of AVR was to maintain a constant voltage on the terminals of generators, but the development of electric power systems expanded the task list relating to AVR.

Automatic adjustment is based on three principles:

- perturbing effects;
- controlled deviation;
- combination of the above principles.

The simplest AVR performing voltage regulation of generations is a compounding device by full load current. It is also least accurate, so it is usually connected to the controller of voltage deviation, which should provide sufficient accuracy voltage regulation of generator, thereby yielding a device with a combined principle of regulation.

Phase compounding devices are more accurate, but they are hardly ever used without a voltage regulator. Increase of the unit capacity of synchronous generators and emergence of high-frequency excitation systems have promoted the development of AVR of proportional action. This type of device provides voltage regulation in the full range of possible changes in its normal operating condition, as well as the force driving in emergency mode.

However, the advent of AVR proportional action has not stopped development of systems of automatic voltage regulator. Energy systems grow, length of transmission lines increases as a result requirements of AVR are increased so automatic excitation regulator of

strong action was developed. These regulators use the principle of regulation by the deviation and have a high speed and rather complex control algorithm.

Nowadays, there are many variations of functional structure of automatic excitation regulator (AER) of strong action, but all of them can lead to a common one, consisting of three parts: a sensor arrangement, logical (computer) and the executive.

Sensor arrangement part of the regulator contains three main discriminating elements: voltage, frequency and excitation current, and two additional ones: discriminating element of reactive and active currents. So as regulatory impact may be built by:

- voltage deviation from the target value;
- the first derivative of the voltage;
- the first and second derivatives of the current power line;
- change and the first derivative of the frequency.

Discriminating elements produce signals to reject their control parameters and transmit them directly to the adder and logic part that coordinates signals derived from mode parameters. The adder receives signals from discriminating elements, the logical part and the element of settings change, after that the adder generates a regulating effect to the digital pulse position actuator control, which in turn generates pulse currents of thyristors. Fundamentally, the same algorithm is used in microprocessor controllers; their feature is the computing part, which consists of two microprocessors.

The main functions performed by modern AER include:

- automatic control of excitation current;
- forced excitation relay;
- current limitation of the rotor at boosting of the double level;
- automatic unloading generators overcurrent rotor and stator reactive current;
- change in the target voltage during synchronization of generators;
- limitation of excitation reduction at the consumption of reactive power;
- adjustment of reactive power generators operating in parallel (group controlled excitation);
- regulation on the deflection of the rotor current in the run- turbine generators of a nuclear power plant (NPP);
- generator protection overvoltage in case of load shedding.

Tap change under load device (TCUL) and STATCOM.

For distribution networks mainly optimal mode of voltage and reactive power is determined by ensuring the required quality of electricity delivered to consumers with minimum losses and stability of asynchronous load. For distribution networks voltage regulation is possible only if there is sufficient provision of reactive power load in the corresponding node. For voltage regulation it is expedient to use a regulating and compensating device. Currently, the most common among them are transformers with a Tap change under load (TCUL), and static and synchronous compensators. The transformer itself is not a source of reactive power. Voltage regulation of transformers with tap-changer is due to changes in the transformation ratio of the transformer, causing a change of reactive power flow through the transformer. Therefore, regulating the voltage by such transformers is effective only if there is a local source of reactive power.

Classic adjustable reactive power source is synchronous compensator. The disadvantages of these machines include the relatively high cost and limited range regulation of reactive power consumption mode. However, restrictions on their adjustment range were minimized

by developing automatic control of synchronous compensators and designing compensator with two excitation windings.

Alternative to the synchronous compensator is static thyristor compensators (STC). Creation of them is result of development of semiconductor technology. Advances in power electronics led to the possibility of creating a new type compensator called STATCOM.

The STATCOM uses algorithms relating to vector control of voltage converter. In general vector control involves measurement of the instantaneous values of voltage and current three-phase system, converting them into orthogonal components of selected system axes d and q, the computation of control actions required in this coordinate system and then transforming them into three-phase system to be implemented in the form of control signals applied to the control object.

Reactive power control system of STATCOM is performed by generating an ideal voltage by the converter. The current in the inductive reactance lags in phase by an angle $\pi/2$ from the voltage across the defined difference of network voltage U_c and converter U_n . If these voltages are in phase $U_c > U_n$ current will be inductive and STATCOM system consumes reactive power from the network. When $U_c < U_n$ there is the capacitive current that contributes to the generation of reactive power. Thus, the STATCOM controls reactive power by varying the voltage at the output of the converter U_n .

Similarly, for the active power control by the STATCOM it is necessary to change the phase of the voltage U_n relative to the network voltage U_c .

The paper presents only basic voltage control devices. In general voltage and reactive power regulation is an intensive process demanding the use of innovation technologies and profound knowledge of electrical engineering.

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Energetics: energy modernization and clean energy

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Introduction

Energetics Incorporated, a wholly owned subsidiary of VSE Corporation, is a full-service technical and management consulting company serving public- and private-sector clients. Also it is a firm helping clients solve today's complex global challenges: energy modernization, energy efficiency, clean energy and climate changes. Energetics is headquartered in Columbia, Maryland, USA with offices in Washington, DC and Arlington, Virginia.

The history of the company.

Energetics was founded in 1979 by a small group of engineers in Columbia, Maryland. They named the company "energetics", because it is a branch of mechanics that deals with energy and its transformations. In 1995, Energetics was acquired by VSE Corporation,