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Flexible AC Transmission Systems Controlled by an Intelligent Energy System

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ABSTRACT: The intellectualization of the electricity industry should be seen as a tool to promote the country's energy policy. In industrialized countries, active-adaptive networks called “smart grids" (SmartGrid) are being created. The basis of SmartGrid is the technology of controlled alternating current transmission systems, referred to in IEEE terminology as Flexible Alternative Current Transmission Systems (FACTS).

FACTS is a promising technology that transforms electrical grids from a passive device into an actively customized device for controlling the modes of electrical grids. The first generation of FACTS provided voltage regulation (reactive power) and the necessary balancing of reactive power in the grids. Modern FACTS devices regulate the operating parameters and are able to regulate not only the magnitude but also the phase of the voltage vector in the grid. The world's largest energy companies are working extensively on the use of FACTS technology to control EPS modes.

KEY WORDS: FACTS, smart grids, intellectualization, active-adaptive networks, technology

I. INTRODUCTION

The main objective of FACTS technology can be formulated as a scientific and technical breakthrough in the field of power electronics for high, ultra-high and ultra-high voltages to improve the control of power flows on the side of high, extra-high and ultra-high voltage networks in both steady-state and transient EPS modes.

The new reality of creating power transmission networks with power electronic control has led to new ways of developing and creating electrical systems and has changed the approaches and procedures for planning backbone and distribution power transmission networks. These developments have the potential to change the nature of energy market operations by enabling high-speed control of power flows. Because of its promising economic and technical advantages, FACTS technology is being targeted for support by electrical equipment manufacturers, power system manufacturers and research organizations around the world.

The most important fact is that FACTS technology opens up new opportunities for the management of power flows in both existing and new or modernized power lines. These capabilities arise from the ability of FACTS technology actuators to control interrelated parameters that determine the operation of power lines, including resistance, current, phase shift angles between voltages at network nodes, attenuation of oscillations at various frequencies, etc. FACTS devices can provide the transmission capacity of power lines up to the permissible limit of the thermal resistance of the wires.

The use of FACTS technology offers you the following advantages:

- the possibility of specified control of the flow of electricity to meet the wishes of the consumers, to ensure optimum distribution of the flow of electricity and to take the system out of emergency operation;
- Extending the use of cheap power sources;
- Improving dynamic stability;
- Increasing the capacity of power transmission lines up to the limit of the thermal resistance of the wires;
- Creating reliable connections between the systems;
- Improvement of power lines;
- Changing the reactive component of current flows;
- Providing the possibility of automatic control of EPS with feedback.

II. MATERIALS AND METHODS

FACTS technology is a family of devices that can be used individually or in combination with other devices to control the interrelated parameters of the power grid. The purpose of FACTS technology is to improve the stable control of power flows in electrical energy systems. One of the main elements of FACTS is the RQM reactive power source (Fig. 1), which is capable of generating and consuming reactive power depending on the required mode of operation and the specific characteristics of the electrical power system [1,2,5].

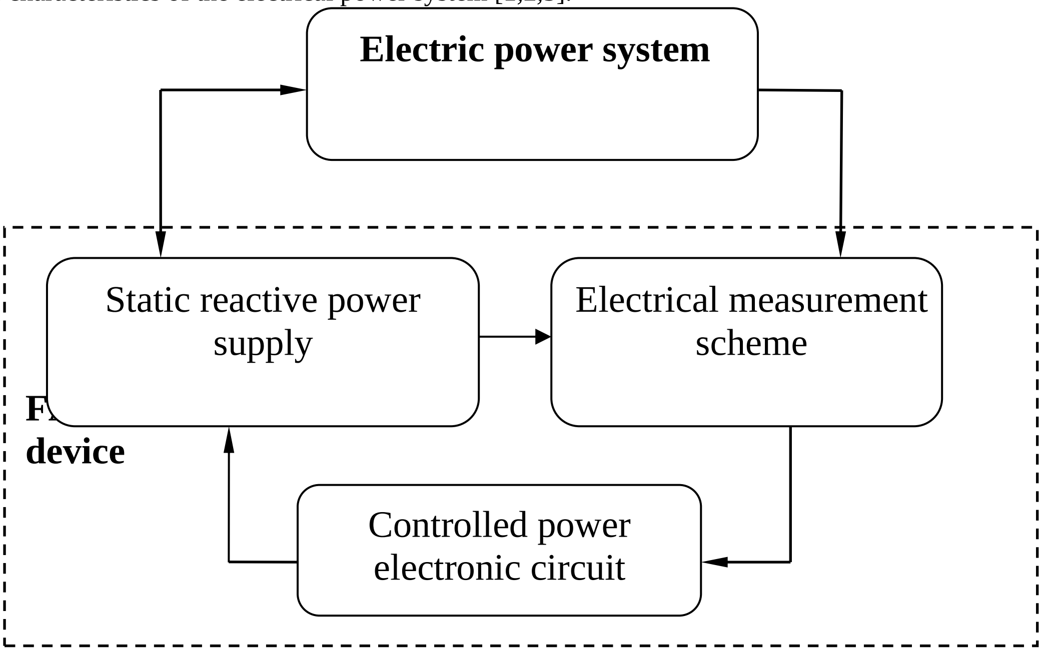

Figure 1. General scheme of FACTS device

To realise the above possibilities, FACTS devices can be connected to the network in series, in parallel and in combination [1,2,4].

In general, FACTS technology enables different corrective actions depending on the conditions of a particular control task and is categorised into different types.

There are following types of FACTS devices*:*

SSSC (*Static Synchronous Series Compensator*);
TCSC(*Thyristor Controlled Series Capacitor*);
SVC(*Static Var Compensator*);
STATCOM(*Static Synchronous Compensator*);
UPFC(*Unified Power Flow Controller*);
IPFC (*Interline Power Flow Controller)*.

The most important functions of FACTS technology are: Voltage regulation (correction), load balancing, increasing the dynamic stability limit, limiting transient overvoltages, power factor correction, increasing the transferability of EUL, etc.[1,2,4].

Below you will find an overview of some of the possibilities of FACTS technology:

Adjusting the voltage. As can be seen from Figures 2 and 2.1, the voltage at the node can drop considerably when the load increases and trigger an avalanche. In this case, the installation of FACTS technology on the load bus prevents the voltage on the load bus from falling below the permissible value[1,2].

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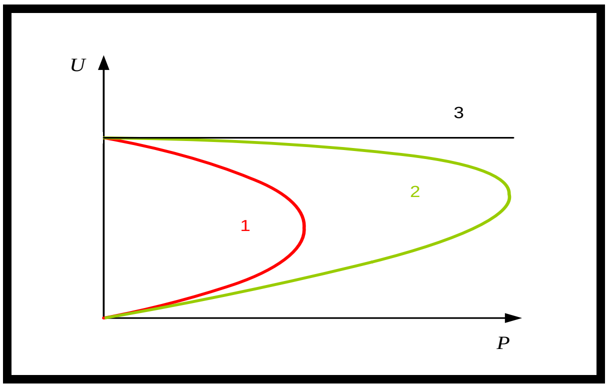
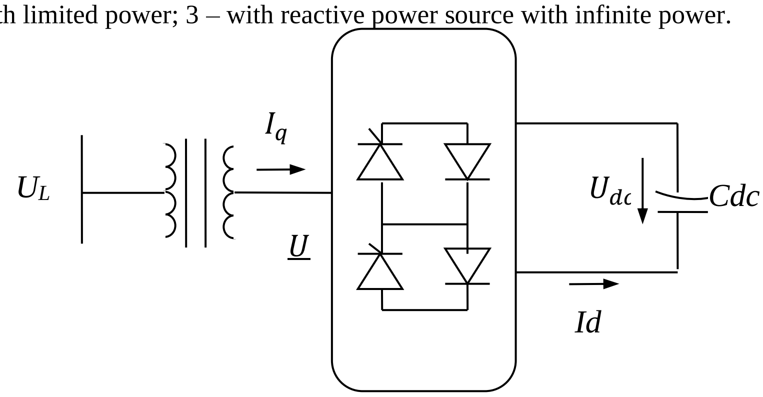


Figures 2. voltage changes at the receiving end of the power line: 1 – without reactive power source; 2 – with reactive power source with limited power; 3 – with reactive power source with infinite power.



Figures 2.1. A STATCOM circuit that regulates the voltage at the end of a power transmission line

Raising the limit of dynamic stability. If the generation power compensator is selected under the condition that the reactive power is zero, then the necessary compensation is provided over the entire operating range of the FACTS device to maintain the voltage and increase the dynamic stability limit [1,2].

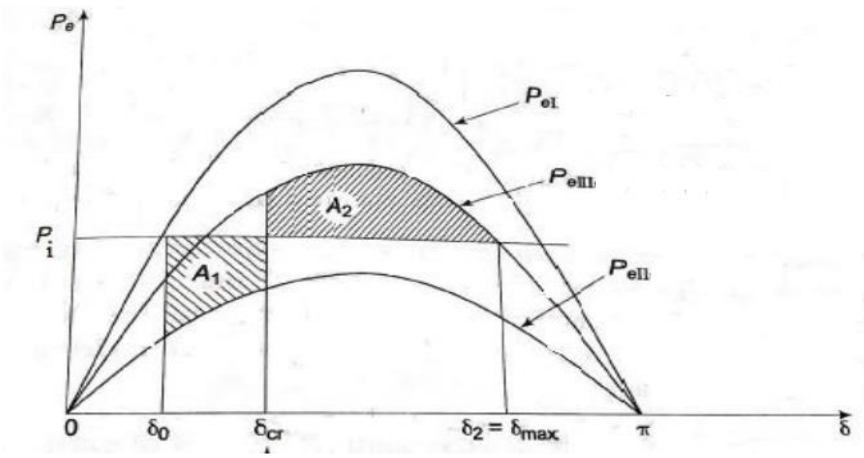


Figure 3. Increasing the dynamic stability limit with FACTS devices

Suppression of oscillations in the electricity system. In the longitudinal compensation of the inductive resistance of the power transmission line, subsynchronous resonances may occur caused by the resonance of the capacitance of the capacitor banks and the equivalent resistance of the power transmission line and the generator at frequencies below the main frequency. As a result, the amplitude of the oscillations increases until the generators are out of synchronisation. FACTS devices provide effective damping of the subsynchronous resonance at this point[1,2].

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Limitation of overvoltages. The use of choke coils with circuit breakers in several 1000 km long transmission lines does not lead to the desired result in the compensation of charging capacities. The use of a FACTS device in the form of a switching reactor makes it possible to limit overvoltages at the end of the power transmission line [1,2].

Load balancing. Unbalanced loads in electrical networks lead to voltage imbalance, overloading of the elements and additional losses in electrical machines. The use of cross-reactive power compensators balances the load in the EET and increases the Cosph. Load balancing with Cosph or voltage regulation can only be carried out with FACTS devices that are able to regulate the phase reactive power. This is confirmed by the circuit in Figure 4[1,2].

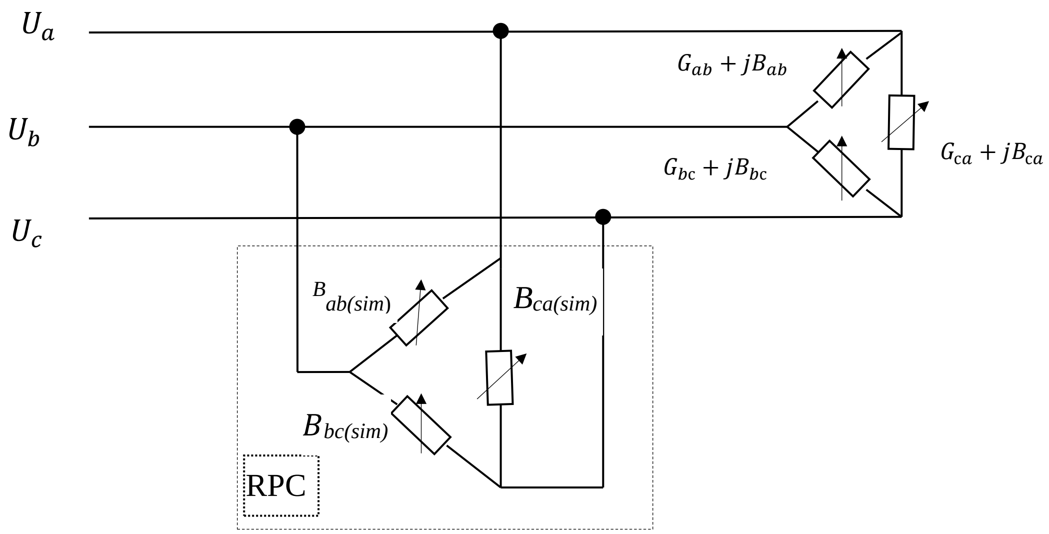

Figure 4. Load balancing with FACTS devices

IV.CONCLUSION

The reliable operation of a large power grid and ensuring system stability is an important issue. To solve such problems, controlled (flexible) alternating current transmission systems (FACTS - Flexible Alternative Current Transmission Systems) are used today. At the same time, innovative FACTS technologies are being introduced. Also serves to ensure the normal operation of the power system based on boundary conditions.

REFERENCES

1. M, Sh. Misrikhanov, Sh. V. Khamidov. “Technologies of controlled flexible alternating current transmissions and their application in electric power systems” - Tashkent: “Navro’z”, 2019, 217 p.

2. Misrikhanov M.Sh., Khamidov Sh.V. Prospective development of the electric power industry of the Unified Energy System of Central Asia with the introduction of FACTS devices and renewable energy sources. Methodological issues in the study of the reliability of large power systems: Vol. 70. methodological and practical problems of power system reliability. In 2 books. / Book 1 / Edited by N.I. Voropai. Irkutsk: ISEM SB RAS. 2019. -s.37-45.

3. Misrikhanov M.Sh., Ryabchenko V.N., Khamidov Sh.V. Calculation of power flows in electrical networks with FACTS devices/FGBOUVO "Ivanovo State Energy University named after V.I. Lenin". – Ivanovo, 2018. -208 p.

4. Misrikhanov M. sh., Ryabchenko V. N., Khamidov sh. V. Calculation of power flows in electric networks with FACTS devices/ IVANOVO state power ENGINEERING University named after V. I. Lenin. – Ivanovo, 2018. -208c.

5.Shukhrat Khamidov, Sunnatilla Tillaev, Bahrom Normuratov. “Improving the reliability of UPS Central Asia implementation of FACTS devices”- Rudenko International Conference “Methodological problems in reliability study of large energy systems” (RSES 2020).

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