The state of the art of electronic power system under different disturbance conditions

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Abstract. As a new generation of electric power system, the electronic power system has advantages such as flexibility and large capacity that the traditional power system does not have, but the high performance is accompanied by the increased difficulty in operation. The characteristics such as multi-coupling and nonlinear make the situation to be considered by the electronic power system more complicated, and the application and analysis will be hindered. In this paper, the stability analysis of electronic power system will be discussed from the large disturbance, small disturbance and power imbalance.

Keywords: Electric electronic power system; Stability analysis; Multiple perturbations; Strong coupling; nonlinearity.

1. Introduction

The development of renewable energy has gradually become the priority in future planning with the development of science and technology in China. Electric energy is renewable energy's primary conversion energy, so upgrading power system which is a tool for energy conversion has become one of the first goals for improvement now. The flexibility and large capacity of the electronic power system will greatly optimize the process of power generation, transmission and distribution and electricity consumption, which will be a major reform in the history of the power system. The power electronic equipment derived from it will gradually replace the traditional electromagnetic transformation equipment represented by synchronous/asynchronous generators. Although electric electronic power system has many obvious advantages, its complexity in application analysis also becomes an inevitable obstacle in this revolution [1]. At present, from the existing experiments on electric power electronic system, the following six problems are summarized: (1) the morphological characteristics of the source network charge are complicated; (2) Unable to accurately grasp the change and state of electrical volume; (3) It is impossible to analyze the more complex and widespread faults in the electronic power system with the traditional power system analysis method; (4) Weak anti-disturbance ability (5) a dedicated operation state evaluation system is needed for the electric power electronic power system developed in recent years (6) Traditional simulation methods need to be optimized to operate the new power grid form. This paper will summarize some electronic power system due to various disturbances in the application of problems and combined with the actual analysis [2].

2. Stability analysis of electric power system under normal conditions of disturbance

2.1. Stability analysis and application under small disturbance

(1) The dynamic characteristics of diversified power electronic equipment, the dynamic characteristics of the network under multi-scale excitation and the interaction between equipment are different from the traditional power system in that there are new characteristics in the evolution process, in which the characteristics of multi-scale equipment have a decisive influence on the analysis of small disturbance stability. The control of the time scale is also one of the differences between the electronic power system and the traditional power system in the case of small

disturbances. The traditional power system only uses a passive circuit to control the dynamic process of the electromagnetic scale [3]. Because of their diversity, the electronic power system has certain control over the electromagnetic time scale and electromechanical time scales, such as DC voltage and AC voltage control. Because the control response time of electronic power systems at different scales is affected by the network parameters, the expected time scales are out of the controllable range, and the multi-scale dynamic characteristics of the network must be included as one of the determining factors [4]. In conclusion, the multi-time scale coupling interaction is a key problem that must be faced and solved to transform the stability analysis from a traditional power system to an electronic power system in the case of small disturbance.

(2) The nonlinearity of equipment characteristics, and the fluctuation range of the system during operation are the unique decisive factors in the stability analysis of electric power systems under the condition of small disturbance [5]. Nonlinear: compared with the traditional power system, the electronic power equipment has more nonlinear links, which makes the electronic power system more affected by the change of operating point. So in the electronic power system of the system operating range and system transport.

2.2. Stability analysis and Application

The differences between the stability analysis of electronic power system and traditional power system under large disturbance are as follows: (1) Network transient behavior: The electronic power system has its unique characteristics of multi-time scale, so compared with the analysis of the network transient process of the traditional power system, the power electronic equipment will not take the algebraic processing as the main way, and when recording the internal potential excitation, the variable amplitude and frequency instead of the constant amplitude and frequency. (2) nonlinear coupling between different scales: Because the multi-time system characteristics and quantity of electronic power system are far more than the nonlinear links of traditional power system, the coupling of electromechanical and electromagnetic scales must be taken into account, which makes the steady-state analysis of electronic power system under different time scales interfered by complex coupling relations, and it is impossible to use the analysis method of traditional power system to solve the control problem of electronic power equipment. (3) Multi-scale controlled transient processes: Under the influence of multi-scale control, compared with the traditional power system, the electronic power system has a greater influence on control and various control factors, which are not only affected by natural circuit processes and mechanical movements, such as common control factors, speed control, Dc voltage control and other control factors of power electronic devices will also be considered in the process of transient stability analysis. (4) Corresponding features of sequential switching: Because power electronic equipment can be switched between different control states at different voltage currents, or resistance access or short-circuited to different hardware circuits, such as Crowbar and Chopper, electronic power systems can be characterized by sequential switching responses to grid failures under different control switching conditions. (5) Transformation of algorithm equation: in the qualitative or quantitative analysis of electric power systems, the concept of acceleration and deceleration are used in traditional power system analysis will no longer be useful. Before the traditional power system to stabilize [6].

3. Stability analysis of electronic power systems under power imbalance disturbance

The voltage and frequency of traditional synchronous machines are determined by the mechanical rotation, while the output frequency of electronic power equipment is mainly determined by the controller of the equipment. The electronic power system has the characteristics of multiple time scales [7]. Therefore, under the disturbance of power imbalance, the output frequency of power electronic equipment must have the dynamic characteristics of multi-time scale response. From the response relationship between excitation and output grid frequency under power imbalance, there is

a high-order characteristic between the equivalent inertia and the stiffness coefficient. To make the coupling between active power and reactive power stronger, and thus increase the dynamic process of voltage and frequency, power electronics equipment will use the appropriate control mode [8]. The nonlinear characteristics of electric power electronic equipment can also be reflected in the control output response under unbalanced power. Under the disturbance of unbalanced power, the operating point will change, and the control output response based on this will also change, and the change of control output response reflects the nonlinear characteristics of electric power electronic equipment.

Because the coupling of the output frequencies of electronic power systems, such as voltage dynamic and frequency dynamic, is stronger and more complex than that of traditional power systems, it is more challenging to analyze the dynamic process of voltage and frequency of electronic power systems in the case of unbalanced power disturbance than that of traditional power systems [9]. Due to the multi-time scale characteristics and nonlinear control characteristics of electronic power systems, and the input of active and reactive power also affects the frequency of internal potential amplitude, it is difficult to judge the dynamic characteristics of internal potential amplitude frequency in electronic power equipment [10]. Therefore, we must analyze the voltage and frequency dynamic processes in electric power systems in a simplified equipment model in the future.

Different from the traditional period, the combination of fast time scale dynamics and internal potential amplitude frequency of electric power electronic equipment makes the network appear obvious [11].

4. Optimization scheme for electronic power system

It is not difficult to see from the above conclusions that there are three characteristics of electronic power system no matter in the condition of small disturbance, large disturbance or power imbalance: Multi-time scale, strong coupling and nonlinear are the core to solve the application and analysis of electric electronic power system, and also the main difference from the traditional power system. In order to completely replace the traditional power system, it is necessary to build a research method of electric electric power system based on these three characteristics. I have two opinions on this.

(1) A large number of experimental data are used to form default conditions: First, the electric electronic power system is simplified as far as possible to make it as close to the traditional power system as possible. After the experiment, the differences in experimental results are obtained, and the rules are summarized according to the differences between the two. Based on the traditional power system research methods, the rules are added and taken as one of the default conditions of the experiment. After summarizing the rules of the most simplified electronic electric power system, based on this condition, add different equipment to the most simplified electronic electric power system, and ensure that the measured data is within the estimated range, continue to summarize the algorithm or formula, and continue to add after the total connection, until it reaches the technical upper limit of the current electronic electric power system. In this way, we can get a specific analysis method and algorithm based on the electric power electronic system.

(2) Completely abandon the traditional power system analysis method, but from the multi-time scale, strong coupling, nonlinear three characteristics, from the broad level of summary, because these three characteristics are not only the application of electronic power system is an inevitable problem, but also the electronic power system compared with the traditional power system, the most prominent function. So the most purpose of developing electric power electronic power system is to use these three characteristics, but also can only use these three characteristics to analyze.

5. Conclusion

Based on the important development projects of power electronic equipment in China's power system, this paper roughly analyzes some important problems encountered at first and then analyzes respectively in the case of small disturbance and large disturbance after comparing with the traditional

power system. The obstacles encountered in the application of electronic power system in the case of unbalanced power and some solutions, compared with synchronous/asynchronous generators and other traditional point-and-point equipment, electronic power equipment has the characteristics of multi-scale, strong coupling, nonlinear, which also makes it difficult to grasp the dynamic process, phenomenon and mechanism differences, and other problems. Finally, the paper puts forward some solutions roughly and provides its views from two aspects of how to solve the problems in the electronic power system of the basic theory and key technology innovation according to the previous experimental experience, providing references for the relevant management departments, research and development institutions.

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