Simulation study on power system short circuit fault based on EMTP

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Abstract: Electromagnetic transient simulation program EMTP is a common simulation commercial software in power system. It can effectively analyze and study power system. In this paper, EMTP is used to build the power system simulation model, and a variety of short-circuit faults in the power system are simulated and analyzed. The results show that the results accord with the actual theory, and the waveform can accurately and intuitively investigate the dynamic characteristics of power system faults. In addition, through the simulation comparison and analysis between different faults, it can be seen that the three-phase short-circuit fault is the most serious fault in the power system, which should be avoided in the actual production and life. This shows that EMTP is a powerful tool for power system simulation research, and provides a reference for the actual equipment selection requirements of the project.

1. Introduction
With the rapid development of the power industry, the scale of the power system is expanding, and the structure and operation mode of the system are becoming more and more complex. As a result, many large-scale power scientific research experiments are difficult to carry out, especially the accidents and faults that do the greatest harm to equipment and personnel in the power system, such as short-circuit fault. Therefore, power system digital simulation has become an important means of power system research, planning and design [1-3]. When analyzing and solving faults, it is difficult to carry out simulation experiments in actual equipment. On the one hand, it is difficult to achieve under actual conditions; On the other hand, experiments are not allowed from the perspective of power system security. In this case, it is particularly important to find the digital simulation software closest to the actual operation state of power system. EMTP is the simulation software that can be used for electromagnetic transient analysis of power system [4].

2. Modeling and Simulation of power system short circuit fault
The power system [5] simulated in this paper is shown in Fig. 1. Among them, three-phase AC power supply voltage is 275kv, short-circuit reactor capacity is 15000 MVA, line: \( R = 0.015\% , X = 0.08\% , Y / 2 = 27.5\% \) , transformer: 275 / 66 / 21kV, load: \( 100 + j148 \) (MVA). The simulation start time is 0s, the end time is 0.1s, and the fault time is 0.04 to 0.1s.
2.1. Normal power system
The simulation model of normal power system is shown in Fig. 2. The voltage and current waveforms of each phase at M2 are shown in fig. 3 and fig. 4 respectively.

![Simulation Model of power system under normal conditions](image)

As can be seen from Fig. 3 and Fig. 4, when the power system is normal, ABC three-phase is symmetrical, the voltage and current are equal respectively, and the phase difference is 120 degrees.

2.2. Single phase (phase A) grounding short circuit
The simulation model of single-phase (phase A) grounding short circuit is shown in Fig.4. When phase A grounding short circuit occurs, the voltage and current waveforms of each phase of fault at M2 are shown in Fig. 5 and Fig. 6 respectively.
It can be seen from Fig. 6 and Fig. 7 that when phase a grounding short circuit occurs within 0.04 ~ 0.1s, the phase A to ground voltage drops rapidly to zero, and the phase voltage waveforms of phase B and phase C basically do not change; The phase A current increases rapidly into short-circuit current, and the phase B and phase C currents do not change, which is always 0.

2.3. Two phase grounding short circuit (BC)

Fig. 8 Simulation model of two-phase grounding short circuit (BC)
It can be seen from Fig. 9 and Fig. 10 that during the fault time of 0.04 ~ 0.1s, the voltage of two phases B and C suddenly changes to 0V, the current of two phases B and C changes, and the current of phase A suddenly changes to 0.

2.4. Two phase short circuit (BC)

It can be seen from Fig. 12 and Fig. 13 that during the fault time of 0.04 ~ 0.1s, the voltage of two phases B and C at the fault point is equal, the current of phase a suddenly changes to 0, and the short-circuit current in two phases B and C is equal and in the opposite direction.
2.5. Three phase grounding short circuit

As can be seen from Fig. 15 and Fig. 16, in case of three-phase grounding short circuit fault, the three-phase voltages of phase a, phase B and phase C rapidly drop to 0; The three-phase currents of phase a, phase B and phase C rise rapidly to short-circuit current.

From the above simulation results, it can be seen that the waveform diagrams of normal conditions, single-phase grounding short circuit, two-phase grounding short circuit, two-phase direct short circuit and three-phase short circuit are in line with the actual theoretical analysis [5-6]. In addition, through the simulation comparison and analysis between different faults, it can be seen that the three-phase short-circuit fault is the most serious fault in the power system, which should be avoided in the actual production and life.

3. Conclusion

As one of the authoritative power system transient calculation and simulation programs in the world, EMTP has the advantages of wide application, powerful function and simple operation [7]. In this paper, EMTP is used to build the power system simulation model, and a variety of short-circuit faults in the power system are simulated and analyzed. The results show that the results accord with the actual theory, and the waveform can accurately and intuitively investigate the dynamic characteristics of power system faults. In addition, through the simulation comparison and analysis between different faults, it can be seen that the three-phase short-circuit fault is the most serious fault in the power system, which should be avoided in the actual production and life. This shows that EMTP is a
powerful tool for power system simulation research, and provides a reference for the actual equipment selection requirements of the project.

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