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Discussion on the Problems of 1000kV UHV Transmission

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Abstract. The construction of UHV power grid obtain the senior government officials' attention and affirmation, but it is not applause in power industry. There not only have the supporters of the applause, but also the questioned voice of the opponents .The use of 1000kv UHV transmission can improve the transmission power, reduce the line voltage drop and improve the voltage quality. From the simple system power - angle characteristic equation, increasing the possible limit power of the generator is beneficial to improve the stability of the system. 1000kv transmission line over-voltage is more serious than the general high-voltage lines, we can use lightning arrester limit DC device over-voltage level. The use of lower protection level of high-performance arrester can reduce the insulation level of equipment, and then make a few suggestions in the coordination of insulation.

The Benefits of Increasing the Voltage Level of the Transmission Line

Long-distance transmission is generally three-phase sine alternating current, the transmission power can be calculated by using

$$P = UI\cos\varnothing \quad (1)$$

It can be seen from the formula that if the transmission power unchanged, the higher the voltage, the smaller the current, so you can use the wire with smaller cross-section to save non-ferrous metals. When transporting power, the current flows the wire and it will produce a certain voltage drop. If the current decreases, the voltage drop will decrease as the current decreases. Therefore, improving the transmission voltage, even to 1000kv, and selecting the appropriate wire, can not only improve the transmission power, but also reduce the voltage drop of line and improve the voltage quality.

1000kv Voltage Level of Transmission is Conducive to Improving the Stability of the System

From the simple system power - angle characteristic equation,

$$P_m = \frac{E * U}{X_\varepsilon} \quad (2)$$

P_m ----- The limit power of the generator.

E -----Power supply electromotive force.

U ----- Terminal voltage.

X_ε -----The total reactance between the power supply and the receiver.

we can see that in the case of a certain transmission power, the greater the limit power of the generator, the higher the static stability limit, the better the static stability. And we can increase the power supply potential and the terminal voltage to improve the static stability limit. So improving the line rated voltage level can improve the static stability limit and improve the level of static stability.

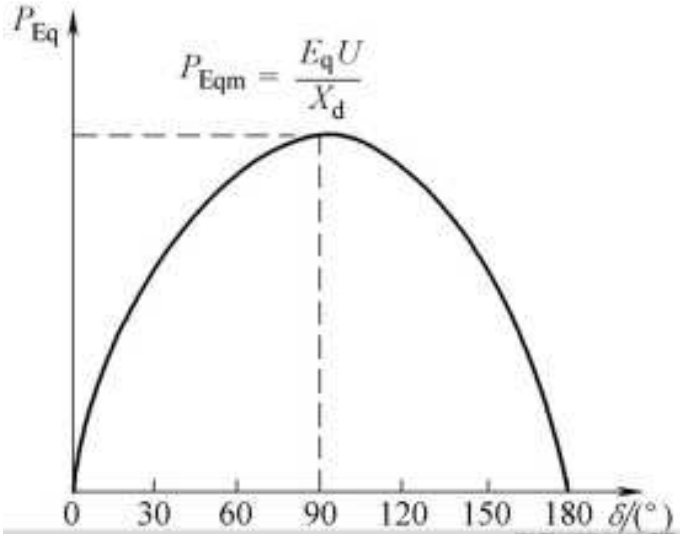

Figure 1. Power angle characteristic curve

The Overvoltage of 1000kv Transmission

1000kv transmission line parameters and system capacity characteristics make its overvoltage more serious than the average UHV line. Therefore, the overvoltage is the key issue of 1000kv UHV transmission technology, and it is also the decisive factor of 1000kv UHV transmission design. As the UHV transmission line insulators can withstand low over-voltage margins, the overvoltage causes insulator breakdown and we must replace the insulator. The combined economic losses caused in the power system are very large.

For high-voltage DC converter equipment, whether it is operating over voltage, or lightning over-voltage, are limited by lightning arrester connected to the protected device directly or indirectly. Arrester is the important measure to limit the overvoltage level of DC device. Operating overvoltage is the most important basis for judging the insulation level of UHV transmission lines. Three types of operating overvoltage to be considered mainly is closing, opening and grounding short-circuit overvoltage. To limit the close and open over-voltage in the overvoltage study of the UHV system in a reasonable range, we can consider the following measures: 1) Metal oxide surge arresters. 2) The closing resistance of the circuit breaker limits closing over voltage. 3) By controlling the circuit breaker closing phase angle in the voltage near the zero-crossing amplitude to reduce the closing over-voltage.

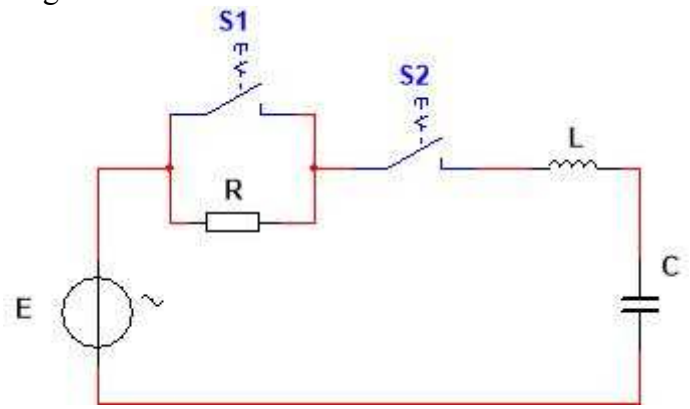

Figure 2. Circuit breaker closing no load line with parallel resistance

Insulation Method for 1000kv DC Transmission

For 1000kv DC transmission station equipment, in order to reduce the insulation level, insulation method should be in-depth, detailed, reasonable and accurate. The protection characteristics of the arrester is the key to suppressing overvoltage levels and the basis for determining the level of

impulse insulation of the DC device. To reduce the insulation level of the device, we need to use a lower level of protection of high-performance arrester. High-performance arrester can be started from two aspects: ① to improve the anti-aging performance of the arrester, that is, to improve the arrester charge rate; ② to further reduce the protection level of the arrester without changing the charge rate ,that is, to reduce the pressure ratio of the arrester.

Table 1 Parameters of 1000 kV AC MOA

Rated voltage	8mA DC reference Voltage peak	1kA/2kA Operation residual voltage peak	20kA Lightning residual voltage peak
828	1114	1406/1460	1620

Table 2 Recommended values of MOA charge rate in DC converter station

Type of arrester	DC line DB	Valve top CB2	12 Pulsating bridge CB1	6 Pulsation M2 and M1	Valve V
Charge rate/%	85	85	85	85	90

In the process of insulation, we need to determine a reasonable coordinate current of arrester through simulation calculation. For the combined and protected current by two arresters, we should use the respective current flowing through the series arrester when the maximum operating overvoltage occurs. It is recommended that we should not use standard series values provided in the standard forcedly under operation shock insulation level of 1000kv transmission project converter station equipment, and the rounding can be taken appropriately on the basis of the insulation research results. In view of the long distribution of 1000kv lines and the uneven distribution of overvoltage amplitude along the line, it is suggested that the line tower insulation configuration should be analyzed synthetically combined with the overvoltage amplitude of line, distribution characteristics and comprehensive analysis of altitude along the line. Using sub-design principles will make the cost of the tower more economical and reasonable.

Conclusion

The development and use of 1000kv special high pressure is inevitable. There are a lot of limit in application environment, equipment manufacturing and line design, but at the same time the benefits it brings cannot be ignored. It can improve the transmission power, reduce the line voltage drop, ameliorate the voltage quality and improve the stability of the system. So we can apply it appropriately and also pay attention to those problems that possibly happen. The overvoltage of 1000kv UHV transmission is more serious than the average UHV line. It can be limited by the arrester and circuit breaker closing resistance. We can use the appropriate arrester and sub-design principles to control the insulation level. Only in this way can we save resources as possible, reduce economic losses and ensure safety.

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