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Comparison and Analysis of Advantages and Disadvantages Based on UHV AC/DC Transmission

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ABSTRACT. *The transmission of electrical energy from large firepower, hydro and other power plants to remote load center areas will encounter long-range transport problems. To achieve high-power transmission over long distances, ultra-high pressure or UHV transmission technology is required. In the transmission process, DC or AC transmission can be used. There are advantages and disadvantages of DC and AC transmission technology, in this paper, the ultra-high voltage DC and AC transmission technology will be compared and analyzed, explore the advantages and disadvantages of AC/DC transmission technology, analysis of the prospects of AC/DC transmission technology.*

KEYWORDS: *Comparison, analysis, UHV AC/DC, transmission*

1. Introduction

1.1 Background

With the continuous development of society, the demand for electric energy in China is increasing. At the same time, due to environmental considerations, the emergence of various fields such as automobiles and new types of electrical appliances in China has also exacerbated the use of electrical energy. According to statistics, China from the founding to the present, the use of electricity and other indicators of the upward trend is obvious (see figure I). High voltage and UHV lines need to be established to meet the demand.

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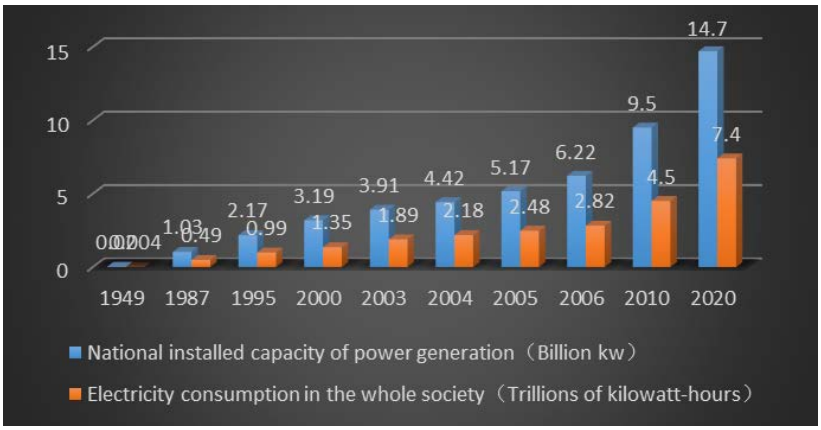

Figure. 1 Installed capacity and electricity consumption of power generation in China

As far as our country is concerned, most of our energy is concentrated in the western region, while the western region is sparsely populated, while the large power load center is concentrated in the big eastern cities. Far apart, a long range of large capacity transmission is required. This leads to the consideration of the advantages and disadvantages of AC/DC lines in high Voltage Line road.

1.2 Restatement of questions

In this paper, the comparison between high voltage and UHV HVDC transmission and AC transmission technology is introduced, the advantages and disadvantages of the two are analyzed and compared, and the application of transmission technology is explained to explain the advantages and disadvantages of UHV AC/DC transmission and its development trend. This paper analyzes the development situation of high voltage transmission mode by analyzing the problems of the two technologies, which also have many advantages, and the more appropriate techniques are used.

2. Overview of transmission Technology

2.1 General situation of HVDC transmission technology

Since the operation of the DC transmission project in the Swedish island of Kauai in 1954, hundreds of modern industrial DC transmission projects have been built and shipped in various countries around the world, with DC voltages, currents and transmission capacity spread across all levels [2]. HVDC transmission is the three-phase alternating current through the converter station rectifier into direct

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current, and then through the DC transmission line or converter station sent to another converter station, and inversely into three-phase alternating current transmission mode. It is widely used in long-distance large-capacity transmission, power system networking, long-distance submarine cables or large urban underground cable power transmission, distribution network light HVDC, and so on, and has achieved good results, gradually adopted in various fields.

2.2 Overview of ultra-high voltage AC transmission technology

AC transmission system is mainly composed of generators, booster transformers, high-voltage transmission lines, regional substations, high-voltage distribution lines, buck transformers and low-voltage distribution lines, with large transmission capacity, distance, low loss, small footprint and other outstanding advantages, in the optimization of China's power construction, to promote the development of transmission scale and so on played a huge role. And AC transmission technology can effectively avoid excessive short-circuit current, poor stability of the power grid and other problems, in UHV transmission lines are also widely used.

3. Advantages and disadvantages of HVDC technology

3.1 Advantages of HVDC Technology

3.1.1 Fast adjustment and reliable operation

HVDC transmission technology can quickly adjust the active power through the SCR converter, so that the power flow direction changes, can ensure stable output, can also achieve shock damping and sub-synchronous oscillation suppression in the event of an accident. When the AC/DC line is running in parallel, the active power can be increased briefly to reduce the rotor speed of the generator and improve the reliability of the system [3].

3.1.2 Small active loss of line

Because the DC overhead line uses only 1 or 2 wires, the active power loss is small, and because of the space charge phenomenon in the case of high current, the Corona phenomenon in the HVDC transmission line will be less than that of the AC line.

3.1.3 No capacitance current

The voltage distribution along the HVDC transmission line is stable, there is no capacitance current, and no parallel reactance compensation is required [4]. and AC circuit in light load or empty load will often appear terminal voltage higher than the first terminal voltage phenomenon, is due to the impact of charging power.

3.1.4 Limit short-circuit current

Connecting two AC transmission systems with a DC transmission line, the fixed current control of the DC system will quickly limit the short-circuit current to the

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rated power, and the short-circuit capacity will not increase due to interconnection [3].

3.2 Disadvantages of HVDC Technology

3.2.1 Lack of DC switches

Because the voltage and other parameters in the DC line are fixed value, no waveform and 0 points, so it is difficult to extinguish the arc compared with the AC circuit. In the multi-terminal control circuit, if the circuit fails, it is necessary to cut off the entire circuit inspection and repair.

3.2.2 The expensive converter device

The basic structure and wiring of DC converter station are more complicated, which is more difficult and more expensive than the replacement of AC Converter station.

3.2.3 Environmental impact

Grounding pole current flowing into the Earth may cause structural changes in the soil and soil pollution, thus affecting the growth of plants and the survival of some small animals such as earthworms.

4. Advantages and disadvantages of AC technology

4.1 Advantages of AC technology

4.1.1 Saving Line Corridor

In general, a higher voltage transmission line can replace the multi-return high-voltage transmission line, thus reducing the transmission line, improve corridor utilization rate, save costs.

4.1.2 Voltage changes are easy

AC voltage conversion is achieved through transformers and is easier than direct current. AC power can be low pressure through the booster transformer, boost to a higher voltage for long-distance transmission, and then through the buck Transformer to convert high pressure into a standard voltage for load use.

4.1.3 Low cost

When large capacity is transported over long distances, the greater the capacity, the lower the price of the conveyor unit capacity. This is because the AC substation and AC power supply relative to the DC substation is more convenient to replace, the cost is greatly reduced. AC power on the basis of electromagnetic induction can also be very economical to achieve the transformation of electricity and other energy sources, thus reducing costs.

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4.2 Disadvantages of AC technology

4.2.1 High power loss

The power loss in the AC circuit is not only reflected in the impedance, but also compared with the DC circuit, the power loss of the capacitance effect should not be underestimated. Because of the voltage fluctuation, the power loss of the AC circuit is about 1.5 times that of the DC circuit when the cross-sectional area of the wire is the same and the active power of the conveying is equal.

4.2.2 Not suitable for underwater transmission

DC allows operating voltages to be about 3 times higher than AC when insulating materials and cable line materials are the same. In operation, AC circuit in addition to impedance loss, there is electromagnetic induction loss, insulation aging will be accelerated, life will be reduced, so it is not suitable for underwater transmission.

4.2.3 Strict mode of operation

When AC transmission is made, the AC system on both sides must run synchronously. When AC long-distance transmission, the phase of the current will have obvious phase difference at both ends of the AC system, and the AC frequency often fluctuates, resulting in the operation of AC transmission in different steps. This requires a very complex way to adjust.

5. Summary of comparison of advantages and disadvantages of AC/DC transmission

- Power Generation and distribution: AC transmission has obvious advantages, substation is easy to replace, low cost, easy to convert energy. The higher the voltage, the lower the unit capacity price. DC transmission is slightly inferior in this respect.
- Power loss: Because the AC circuit in addition to the resistance loss, there will be the impact of capacitance, power loss will be greater.
- Mode of operation: The transmission system at both ends of the AC circuit must run synchronously, while the transmission system at both ends of the DC circuit does not need to operate synchronously.
- Voltage transform: The AC circuit adopts transformer to realize voltage transformation, which is easier than DC circuit.
- Impact of failure on the system: The failure of the DC line requires cutting off the entire line for maintenance, while the AC line can be achieved through equipment such as circuit breakers.
- Marine transmission: DC Transmission line loss is small, longer life, more suitable for underwater transmission.

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6. Conclusion

In this paper, through the comparison of AC/DC transmission mode in high-voltage lines, it is found that there are advantages and disadvantages of the two transmission modes. DC transmission mode is more stable operation, low power loss, but voltage conversion is not as convenient as AC transmission, and maintenance needs to cut off the entire line, more complex. Under certain conditions, the advantages and disadvantages of the two transmission modes can be transformed into each other. Therefore, in the future of high-voltage transmission, the competition between the two transmission modes will continue. However, in the transmission process, due to the small loss of DC lines, can be preferred, in the voltage conversion can be given priority to AC lines. The combination of two transmission methods to maximize the benefits.

References

[1] Huang Jun, Comparison of advantages and disadvantages of ultra-high voltage AC/DC transmission, submitted to Journal of Science and Wealth, 2016, No.02 (in Chinese).
[2] Liang Xuming, Zhang Ping, Chang Yong, Recent Advances in High-Voltage Direct-Current Power Transmission and Its Developing Potential [J], Power System Technology, 2012, 36 (4) (in Chinese).
[3] Information on www.dian168.com.
[4] Yin Zhanbao, Analysis of advantages and disadvantages of HVDC transmission and AC transmission [J], 2007, Vol.33 (in Chinese).