

# Current Situation and Application Prospect of VSC-HVDC

Hanwen Bi<sup>1, a</sup>

<sup>1</sup>School of North China Electric Power University, Baoding 071000, China

<sup>a</sup>15140863936@163.com

## Abstract

VSC-HVDC is a high voltage HVDC transmission technology based on converter valve modulation technology, which adopts IGBT and other fully controlled devices. VSC can control the amplitude and phase of output voltage of converter station, and then control the exchange of active power and reactive power between converter station and AC system. From the perspective of AC system, VSC can be equivalent to a motor or generator without moment of inertia, and can realize independent control of active power and reactive power in four quadrants of PQ plane almost instantaneously, which is one of the basic characteristics of VSC. At present, VSC-HVDC has played an important role in wind farm interconnection, grid interconnection, island and weak grid power supply, and urban power supply. Flexible HVDC is mainly divided into two-level flexible HVDC transmission and modular multi-level flexible HVDC transmission technology (MMC). Because of its low loss and easy maintenance, MMC will gradually become the main transmission form of flexible HVDC.

## Keywords

VSC-HVDC; voltage; power; transmission.

## 1. INTRODUCTION

VSC-HVDC marks a totally new generation of HVDC technology with fully controlled power electronic devices, voltage source converters and new modulation technology. It has the characteristics of no reactive power compensation and grid support commutation, small area and environmental impact, which is suitable for grid-connected renewable energy generation, island and urban power supply, especially in the wind power grid connection. VSC-HVDC technology also has strong technical advantages in improving power system stability, increasing dynamic reactive power support, improving power quality, solving problems caused by non-linear load, impulsive load and three-phase unbalance, and ensuring power supply for sensitive equipment. It is an important equipment for the construction of intelligent power grid, which plays a significant role in promoting the construction of a strong smart grid and the economic, safe and reliable operation of the grid.

## 2. BASIC MEANING AND FUNCTION OF VSC-HVDC

VSC-HVDC is short for Voltage Source Converter based on High Voltage Direct Current Transmission. Unlike current source converter type HVDC based on phase-controlled commutation technology, the converter in flexible DC transmission is a voltage source converter (VSC), and its biggest feature is the use of a shutdown device (usually For IGBT) and high frequency modulation technology.[1]

The active power and reactive power of the output can be independently controlled by adjusting the magnitude of the converter outlet voltage and the power angle difference from the

system voltage. In this way, through the control of the converter stations at both ends, the mutual transmission of active power between the two AC networks can be realized, and the converter stations at both ends can independently adjust the reactive power absorbed or emitted by each of the two, thereby the joint communication system gives reactive support.

### 3. CURRENT DEVELOPMENT OF VSC-HVDC

Flexible DC transmission technology is the commanding point of power electronics application technology in the world today. At present, only ABB company has commercial flexible HVDC transmission projects in the world. China started relatively late in the research of VSC-HVDC technology, which lags behind the international advanced level. However, due to the great advantages of flexible HVDC transmission, many domestic research institutions and universities have actively carried out research work on flexible HVDC transmission, and achieved remarkable results.

VSC-HVDC has the following advantages:

(1) VSC-HVDC can quickly realize power flow reversal without changing the polarity of voltage, so it is easier to connect multiple converter stations, and then realize multi-terminal HVDC transmission.

(2) VSC-HVDC can supply power to weak system and passive system, which is suitable for new energy grid-connected and does not need the support of thermal power units; LCC needs to connect AC power grid with enough short-circuit capacity to operate normally, so it can not supply power to weak system and passive system.

(3) There is no commutation failure in VSC-HVDC, which reduces DC fault.

(4) Active and reactive power of VSC-HVDC can be controlled independently, and the control forms are more flexible and diverse to meet the actual operation requirements.

(5) VSC-HVDC is easier to realize modularization and maintenance is convenient and fast. However, the weaknesses of flexible HVDC transmission are also prominent:

(1) Firstly, the transmission capacity of flexible HVDC is lower than that of LCC and much lower than that of HVAC due to the rated power of devices.

(2) Because of the low inertia of flexible HVDC transmission and the rapid development of faults, it is necessary to cooperate with ultra-high-speed protection, including the application of DC devices such as DC circuit breakers.

(3) Multi-terminal flexible HVDC transmission has high control flexibility, but it also brings the characteristics of complex control system, especially the control of multi-terminal flexible HVDC transmission is more complex.

(4) The electromagnetic transient model and the electromechanical transient model of flexible HVDC transmission have much room for improvement.[2]

### 4. PROBLEMS TO BE SOLVED IN THE STUDY OF VSC-HVDC

At present, there are still some urgent problems to be solved in VSC-HVDC.

First, how to achieve high voltage, high capacity power transmission and conversion. So to solve these problems, one is to improve the cycle ability of fully controlled power electronic switch devices, such as ABB put forward the concept of DC plus aviation, so the current market demand of component factories is also large. Many of our core components are foreign. We have design technology and engineering achievements, but our core equipment is not yet capable of R&D. Secondly, for its valves, multi-physical plant simulation, seismic, thermal, fluid, is another necessary technology. For flexible HVDC transmission, unlike conventional HVDC, we should first import technology, digest and absorb it, then localize it, and then autonomize it. At present,

the degree of autonomy has been very high. Converter valve enterprises have reached 45. From the national point of view, all enterprises of flexible DC are doing it independently from the beginning. Valve style, structure, each enterprise has its own characteristics. The problem of modular multi-level control has a high requirement for the fast transmission of data in our control system. [3]

Moreover, from the current research of relevant scholars, there are also some problems in flexible HVDC transmission.

(1) When the flexible HVDC system is connected to the weak system, there is a problem of stability, and the transmission power of the converter station will be limited.

(2) The control modes of multi-terminal flexible DC and DC power grids, as well as the fault characteristics under different control modes, need further study. The more terminals, the more complex the control operation is.

(3) DC circuit breaker and DC transformer need further development in technology and economy.

## 5. CONCLUSION

Flexible HVDC transmission plays an increasingly important role in the fields of new energy grid connection and absorption, asynchronous interconnection, island power supply and long-distance transmission in China. The application of flexible HVDC technology has made multi-terminal HVDC transmission system a reality, and will further promote the formation of HVDC grid. With the continuous improvement of R&D and manufacturing level of fully controlled power electronic switch devices, HVDC switches and DC cables, and the progress of control and protection technology, it is expected that in the next five to ten years I will be able to provide a reference for the future development of HVDC system. China will usher in the period of rapid development of flexible HVDC project construction. It is expected that a regional HVDC power grid with 500 kV grade 5 or above will be built around the world based on flexible HVDC.

In terms of reliability, at present, the reliability of flexibility is high. Firstly, there is no commutation failure in flexible transmission. Secondly, the existing flexible transmission system uses DC cable, which has a low failure rate of DC line. If flexible DC transmission adopts overhead transmission mode, in order to deal with DC line faults, flexible DC transmission should adopt DC circuit breaker to improve the reliability of flexible DC transmission, but at the same time, due to the high price of DC circuit breaker, it is lack of economy.

As far as the current technical means are concerned, flexibility is not the inevitable choice for HVDC transmission. According to the actual engineering needs and the characteristics of different transmission modes, appropriate transmission modes should be selected. Nowadays, with the vigorous advocacy of new energy generation, flexibility is an important means of grid-connected new energy, and will also be a focus of future research. With the progress of technology, flexibility will become a major means of transmission.

## REFERENCES

- [1] WEN Jun, ZHANG Yigong, HAN Minxiao, et al. HVDC based on voltage source converter---a new generation of HVDC technique[J].Power System Technology, 2003, 27 (1): 47-51.
- [2] ZHANG Linshan, YANG Qing, CUI Yufeng, et al. Application of flexible HVDC transmission technology in urban grid [J]. Yunnan Electric Power, 2010, 38 (4): 13-34.
- [3] XU Zheng, TANG Geng, HUANG Hongyang, et al. Two new technologies for eliminating the problems with multiple HVDC infeeds [J].Southern Power System Technology, 2013, 7(1): 6-14.