International Journal For Technological Research In Engineering
Volume 2, Issue 5, January-2015 ISSN (Online): 2347 - 4718

METHODOLOGY OF HVDC TRANSMISSION SYSTEM

Kulveer Singh[1], Hartej Singh Saini[2], Harinder Singh Sandhu[3]
[1,2]M.Tech (EE), [3]Assistant Professor
AIET Faridkot

Abstract: This paper present the overview of status of hvdc systems in the world today and discuss about the technology of hvdc systems, methodology of hvdc transmission, types of hvdc transmission, comparison between hvdc transmission and hvdc, advantage of hvdc system

I. INTRODUCTION

The history of electricity takes us to the first commercial electricity generated (by Thomas Alva Edison) in which direct current (DC) was used for electrical power. The very first transmission systems were also direct current systems. The drawback mainly included the fact that DC power at low voltage was difficult to be transmitted over long distances, hence giving rise to extra high voltage (EHV lines) carrying alternating current. With the development of high voltage rating valves, it was possible to transmit DC power at very high voltages over long distances, known as the HVDC transmission systems. HVDC transmission system was first installed in the year 1954,(100kV, 20MW DC link) between Swedish mainland and the island of Gotland, since then a huge amount of HVDC transmission systems have been installed. HVDC has been in commercial use for 60 years. The biggest advantage being ease of long distance and bulk power transmission, it has facilitated the transmission of electricity from power rich states to power deficit states which coincidentally happen to be economically poor and economically rich respectively. HVDC systems may be less expensive and suffer lower electrical losses. Hvdc have less space for tower it is use for bulk power because it have less loss in transmission line.

A. Methodology for hvdc transmission system

HVDC system is the conversion of electrical current from AC to DC (rectifier) at the transmitting end and at the receiving end the electrical current is the conversion from DC to AC (inverter).the Fundamental process that occur in an HVDC system. The two methods is use for achieving conversion. The conversion of power between AC and DC became possible with the development of power electronics devices [1]. The mercury-arc valves are use for conversion of hvdc lines. Starting in the 1970s, semiconductor devices are use in conversion as thyristors, MOS-controlled thyristors (MCTs), insulated-gate bipolar transistors (IGBT) and integrated gate-commutated thyristors (IGCTs)

B. Natural Commutated Converter

Natural commutated converters are most used in the HVDC Systems. The thyristor is use for this conversion process. This is a controllable semiconductor that can carry very high currents (4000 A) and is able to block very high voltages (up to 10 kV). Thyristors is connecting in series. It is possible to build up a thyristor valve, which is able to operate at very high voltages. It is operated at net frequency (50 Hz or 60 Hz) and by means of a control angle. Thyristor valve is possible to change the DC voltage level of the bridge. This ability is the way by which the transmitted power is controlled rapidly and efficiently.

C. Capacitor Commutated Converters (CCC)

An improvement in the thyristor-based commutation, Capacitor Commutated Converters concept is characterised by the use of commutation capacitors. It is inserted in series between the converter transformers and the thyristor valves. The commutation capacitors are improving the commutation failure performance of the converters when connected to weak networks.

D. Forced Commutated Converters

This type of converters introduces a spectrum of advantages as e.g. feed of passive networks (without generation), reactive power, power quality and independent control of active. The valves of these converters are built up with semiconductors. It has ability not only to turn-on but also to turn-off. They are known as VSC (Voltage Source Converters). Two types of semiconductors are used in the voltage source converters: the IGBT (Insulated Gate Bipolar Transistor) or the GTO (Gate Turn-Off Thyristor). Both of them have been in frequent use in industrial applications. The VSC commutates with high frequency. The operation of the converter is achieved by Pulse Width Modulation (PWM). It is possible to create any phase angle and amplitude by changing the PWM pattern, which can be done almost instantaneously. PWM offers the possibility to control both active and reactive power. This makes the PWM Voltage Source Converter a close to ideal component in the transmission network. It acts as a motor or generator without mass. That can control active and reactive power almost instantaneously.

II. TYPES OF HVDC TRANSMISSION

A. HVDC-LCC converters.

The first HVDC transmission link was commissioned in 1954.it was use for commercial HVDC transmission It utilized line-commutated current-source converters (LCC). Mercury-arc valves are use with (LCC) they were followed during the late 1960's.the similar converters using semiconductor thyristor valves. Thyristor valves have standard equipment for DC converter stations. The turn-on of the thyristors in an LCC is controlled. it is control by a gate signal while the turnoff occurs at the zero crossing of the AC current. AC network voltage is determined. Thyristor devices are now during forward conduction, charges are internally stored. At turnoff these charges must be removed before the valve can re-establish a forward voltage blocking capability. the HVDC inverters require a certain minimum time, the recovery time, with negative voltage before forward blocking voltage is applied. That condition is achieved by inverter is operated with a certain commutation margin angle. When sufficient recovery time is not provided then converter may suffer a commutation failure [2]. The main reason of commutation failures originate from voltage disturbances. The Voltage disturbance due to AC system faults. Commutations can failure if the connected system has limited short circuit capability. The connected system cannot provide the required voltage for the commutation process. the current is always lagging the voltage, this type of converter, either in rectifier or inverter operation, continuously absorbs reactive power as a part of the conversion process. The shunt compensation is required to compensate for some or the entire converter VAR requirement The amount of reactive power is absorbed. It is determined by the DC control strategy, the active power flow through the converter is in the order of 50%.

B. Voltage source converters

A new generation of HVDC converters based on forced-commutated voltage source converters .VSC was developed during 1990's. VSC-HVDC systems represent recent developments in the area of DC power transmission technology [3]. The experience with VSC-HVDC at commercial level developed over the last 13 years. The first VSC-based PWM-controlled HVDC system using IGBTs. It was installed in March 1997.the conventional LCC and the new VSC have the fundamental difference. That the VSC makes use of components that can turn-off the current, and not just turn it on. Typical turn-off devices as switching elements are IGBTs. The current in a VSC can be turned off. Then in the connected AC network, the commutation voltage is not required. Therefore, in this type of converter the AC current can be leading or lagging the AC voltage, which means that the converter can consume or supply reactive power which is connected AC network. A VSC is operating as a static compensator. It can also provide reactive power compensation to the network it is occur during steady-state operation, dynamic and transient condition.

III. COMPARISION BETWEEN HVDC &HVAC

Sr. no.	Item	HVDC	HVAC
1	Long-Haul OHL Bulk Transmission Capacity	High (> 1~2GW)	Limited
2	Long-Haul Transmission Stability	No Limit	Limited
3	Right-of-Way for Bulk Transmission OHL	Low	High
4	Long-Haul Transmission Loss	Low	High
5	Insulation / Clearance	Low	High
6	System Connection	Asynchronous	Synchronous
7	Power Flow Control	Easy and Fast	Difficult
6	Multiple terminal (Tapping)	Difficult and Costly	Simple and Easy
7	Short Circuit Limitation	Effective	Not Effective
8	Pollution Effect	More Pronounced Higher insulator creepage is required	Relatively less

IV. ADVANTAGES OF HVDC SYSTEM

The advantage of HVDC is the ability to transmit large amounts of power over long distances. The capital costs and loss is less than ac.the High Voltage Direct Current transmission allows use of energy sources, which area is remote from load centers.

A. Long Distance Bulk Power Transmission

HVDC transmission systems are more economical than ac transmission for long-distance. HVDC transmission systems often provide bulk-power delivery from remote resources such as hydro-electric power station, coal-base power plants or large-scale wind farms [5]. HVDC transmission system has smaller losses than AC transmission if the same amount of electric power is delivered. the HVDC transmission system is more advantage if the distance is at least more than 450 km [4].The main reason is the cost of transmission line .the cost of hvdc line is less than ac system.30% is saving in line construction.ac long line is subjected to the intermediate switching stations and reactive power compensation, which increases the substation cost.

- HVDC transmission is give higher power delivery over longer distances uses fewer lines than AC transmission.
- Hvdc system only requires two conductors, but ac systems have double circuit AC lines with three conductors.
- The power transfer capacity of hvdc system is more than three times of an AC system.
- The Insulation requirement for a hvdc system is only one-third as compare to AC system.

- The tower construction of hvdc is also more economical than an AC system.
- HVDC transmission is use in undersea power transmission. Long undersea AC cables have a high capacitance.

B. Asynchronous Interconnection

HVDC transmission networks which are link with two AC systems which can be totally different frequency. The HVDC transmission networks have asynchronous interconnection. This allows many benefits.the more economical and reliable system operation. the back-to-back converters with no transmission line are used for interconnecting two asynchronous systems.This is link acts as effective firewall against propagation of cascading outages in one network to another [5].

C. Offshore Transmission

For large offshore wind farms, the cable route length is 50km.HVDC transmission should be considered. Between 60 and 80 km, HVAC and HVDC are expected to be similar in cost. It depends on the difference of specific project. When cable length is increase upto 100km.HVDC is better option. Because HVAC transmission systems have power loss and the compensation of large amount of reactive power [4]. Otherwise, the HVDC option will have the least amount of cables connecting the wind farm to shore than HVAC

V. CONCLUSION

Recent studies indicate that hvdc systems are very reliable. The very large investment is in India and chine. The high voltage direct current will very important in the future, especially in big and new industries countries. Hvdc is very important issue in transmission energy. Problem of cascade blackout which can reduced by application of hvdc. The scheduled unavailability of energy is about 5.39%.hvdc offers powerful alternative to to increase stability of a power system. The system operating flexibility is improved. The loss is reducing. To keep the losses to a minimum, the control system shall be designed to keep as high voltage as possible. Hvdc system is used to transmit electricity over long distances by overhead transmission lines or submarines cable. With the hvdc systems, the power flow can be controlled rapidly and accurately as to both power level and direction. Then performance and efficiency is improved.

REFERENCE

[1] Roberto Rudervall ABB Power Systems Sweden ,J.P. Charpentier World Bank United States, Raghuveer Sharma, ABB Financial Services Sweden “High Voltage Direct Current (HVDC)Transmission Systems Technology Review Paper” Presented at Energy Week 2000, Washington, D.C, USA, March 7-8, 2000
[2] Kimbark E. W. ‘Direct Current Transmission’, book, John Wiley & Sons, 1971.
[3] R. Rudervall, J.P. Charpentier, R. Sharma, “High Voltage Direct Current (HVDC) Transmission Systems Technology Review Paper,” Energy Week, Washington, D.C, USA, March 7-8, 2000.
[4] Chan-Ki Kim, Vijay K. Sood, Gil-Soo Jang, Seong-Joo Lim and Seok-Jin Lee, “HVDC TRANMISSION-Power Conversion Applications in Power Systems.” 2009: IEEE Press..
[5] M. P. Bahrman, P.E., “HVDC Transmission Overview, Transmission and Distribution Conference and Exposition,” 2008. T&D. IEEE/PES.

