National Conference on Emerging Trends in Computer, Electrical & Electronics (ETCEE-2015)
International Journal of Advance Engineering and Research Development (IJAERD)
e-ISSN: 2348 - 4470 , print-ISSN:2348-6406,Impact Factor:3.134

Performance and Analysis of Buck-Boost Inverter based HVDC Transmission System

Pooja Dave[1], Pratik J Munjani[2],

[1]Post Graduate Student, [2]Associate Professor,
Department of Electrical Engineering, Atmiya Institute of Technology and Science, Rajkot, Gujarat, India

[1]poojadavek@gmail.com
[2]pjmunjani@aits.edu.in

***Abstract* — These days wind farms are built far out in the sea, which is advantageous from power generation point of view. Voltage Source Converter (VSC) based HVDC transmission which uses IGBTs and extruded DC cables is a latest HVDC technology used for low power transmission which easily integrates wind farms and solar farms to the grid. VSC-HVDC based system get high speed control of both active and reactive power with good controllability. This paper based on analysis of different type voltage source converter and proposed buck boost inverter based transmission System.**

***Keywords*- Voltage Source Converter, buck-boost inverter-based-HVDC system (BBI-HVDC), dc-side faults, discharge current.**

I INTRODUCTION

HVDC application that is growing steadily around the world is the integration of renewable resources such as wind into the main transmission grid. DC grids with multiple voltage-source converters (VSCs) are one of the technical solutions for pooling offshore wind energy and transmitting it to load centers located far away onshore [1].

HVDC technology uses line-commutated converters (LCC s) based on thyristor. Though the new VSC technology using insulated gate bipolar transistors (IGBT s) has both turn-on and turn-off capability and is being considered for new HV dc projects. The power ratings of VSC-based HV dc converters are growing and are in the range of 1,000 MW per pole. [1]

The High Voltage Direct Current (HVDC) technology was used for the first time in 1954 in the under-sea cable interconnection between the island of Gotland (Sweden) and Sweden. For this transmission, thyristor with a rating of 50 kV and 100 A were used. From its beginnings until the mid-1970s, the HVDC transmissions were based on mercury arc valves. After that, for the next 25 years, line commutated converters - using thyristor as based component - were used in the HVDC transmission systems. [1] Once with the development of the high power switching devices and their availability al low prices, the LCCs were replaced by the self-commutated converters and now the voltage source converters are more and more used for HVDC transmissions. [2]

- Considering similar insulating requirements for peak voltage levels, a DC line/cable will carry the same amount of power with two conductors as an AC line/cable with three conductors; thus, for the same power level, an HVDC transmission system will require smaller Right-of-Way, simpler towers and also the conductor and insulator costs will be reduced, in comparison with a classical HVAC transmission. [3]

-The power transmission losses (conductor losses) are reduced by about two-thirds when the DC option is used instead of the AC one

-Furthermore, when a HVDC transmission is used, the absence of the skin effect can be noticed and also the dielectric and corona losses are kept at low level, thus the efficiency of the transmission is increased

-However, the disadvantage of the HVDC transmissions regarding the costs comes from use of the converters and filters.

As a conclusion it can be said that the HVAC transmissions are more economical than HVDC transmissions when used for small distances.

The HVDC transmissions applications are: [4]

Underground/ submarine cable transmissions, long distance bulk power transmissions, asynchronous connections of AC power systems, stabilization of power flows in integrated power systems

II VSC BASED HVDC SYSTEM

Line-commutated converter-based HVDC (LCC-HVDC) and voltage-source converter-based HVDC (VSC-HVDC) are the main types of HVDC transmission systems. LCC-HVDC is inherently defensive and robust to dc fault currents due to its current regulated nature. On the other hand, there are various types of VSC-HVDC. Some of these converters are defenseless against the dc-side faults, and others can handle the dc fault effectively. [5]

VSC-HVDC is a new dc transmission system technology. It is based on the voltage source converter, where the valves are built by IGBTs and PWM is used to create the desired voltage waveform. [6] With PWM, it is possible to create any waveform (up to a certain limit set by the switching frequency), any phase angle and magnitude of the fundamental component. Changes in waveform, phase angle and magnitude can be made by changing the PWM pattern, which can be done almost instantaneously. [6] Thus, the voltage source converter can be considered as a controllable voltage source. This high controllability allows for a wide range of applications. From a system point of view VSC-HVDC acts as a synchronous machine without mass that can control active and reactive power almost instantaneously. [7] In this topology of the investigated VSC-HVDC is discussed. Design considerations and modelling aspects of the VSC-HVDC are given. The topology selection for the VSC-HVDC is based on the desired capabilities.

The basic classification of conventional VSC-HVDC based converters and their capability to suppress the dc fault current are analyzed.

III PROPOSED BUCK BOOST BASED HVDC SYSTEM

A. *Introduction*

A single-stage single-phase BBI was first proposed in. Not only does it provide dc-to-ac conversion, but also voltage boosting capability. There are two options for three-phase BBI. The first configuration consists of three single-phase BBIs sharing the same dc-link voltage. The other configuration consists of three dc-to-dc buck-boost converters.

It is obvious that the number of switches in the second configuration is lower, but with a higher voltage rating.

Additionally, its ac output voltages are unsymmetrical (i.e, contains even-order harmonic components). To avoid these problems, the first configuration [Fig.] will be employed in this paper.

The selection of BBI parameters, such as inductors and capacitors, is also presented in this paper in Section IV. In the proposed three-phase BBI, each phase consists of two bidirectional dc-to-dc buck-boost converters, and by controlling the duty cycle of each converter, a dc-biased sine-wave output can be generated as shown in Fig.

The ac side is connected to the inverter terminals which are electrically isolated from the capacitors' common point. The reference of each converter output is composed of ac and dc components. Equation (1) shows the reference voltages for the phase "a" converters assuming that (Vga = Vmax * Sinwt).

The aim of this paper is to analyze a four quadrant DC to AC switched mode inverter, using buck boost DC to AC converter, referred to as buck boost inverter or DC to AC converter. The main attribute of this inverter topology is the fact that it naturally generates an AC output voltage lower than or larger than the DC input voltage, depending on the instantaneous duty-cycle. This property is not found in the classical voltage source inverters which produce an AC output instantaneous voltage always lower than the input DC voltage

B. *Operation and Working*

The Buck Boost inverter achieves DC-AC conversion as follow: This buck boost inverter is arranged for two bi directional buck boost converter. This converter produce a DC biased sine wave output, so that each converter only produces an unipolar voltage. The modulation of each converter is 180 degree out of phase with the other, which maximizes the voltage excursion across the load. The load is connected differentially across the converters. Thus where a DC bias appears at each end of the load with respect to the ground, the differential DC voltage across the load is zero. The generating bipolar voltage is solved by a push pull arrangement. Thus converter implementation needs to be a bidirectional. This circuit shows the continuous output waveform of the inverter.

In this system buck boost inverter can control individual active and reactive power. Buck Boost is a combination of voltage source converter with wave shaping circuit and output of this inverter is a sinusoidal wavefom. In figure shows th circuit diagram of single phase buck boost inverter. The Buck Boost inverter achieves DC-AC conversion as follow: This buck boost inverter is arranged for two bi directional buck boost converter.

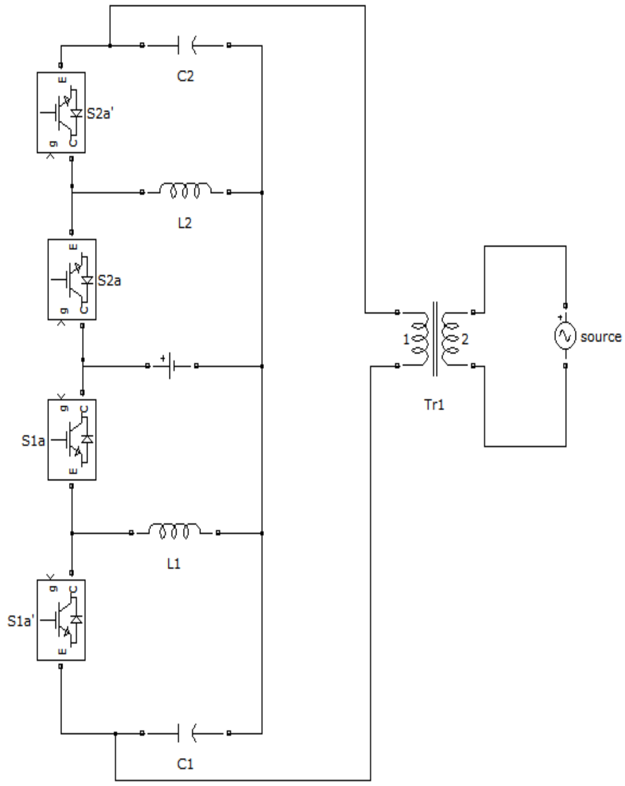

Figure 1 One phase of the three phase buck boost Inverter

In the proposed three-phase BBI, each phase consists of two bidirectional dc-to-dc buck-boost converters, and by controlling the duty cycle of each converter, a dc-biased sine-wave output can be generated as shown in Fig. . The ac side is connected to the inverter terminals which are electrically isolated from the capacitors' common point. The reference of each converter output is composed of ac and dc components.

IV BLOCK DIAGRAM OF PROPOSED SYSTEM

The basic block diagram representation of Buck Boost inverter based HVDC transmission Line

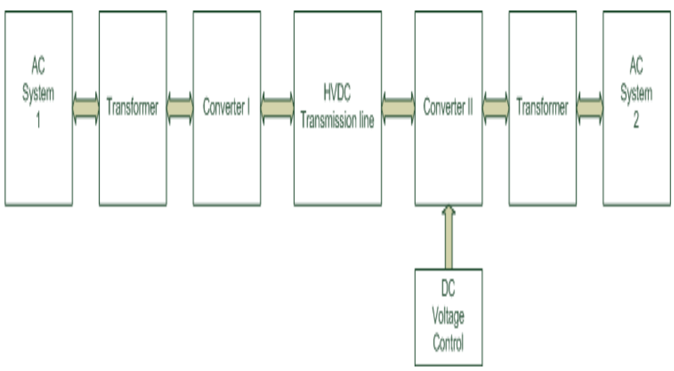

Figure 2 block diagram of proposed VSC based HVDC system

Here in this topology describes the buck boost inverter based system. In this source side connected converter I acted as a uncontrolled rectifier which convert AC source voltage in to DC. The output of converter I is given to the HVDC transmission line and at the receiving end side converter II act as a inverter which is proposed buck boost type inverter. In this output of inverter is sinusoidal ac which is either given to the load or to the grid

COMPARITION OF METHODS

Two-level VSC is the most common topology, yet it is defenseless against dc-side faults, since the freewheeling diodes act as a rectifier bridge and feed the dc fault [2]. As a result, its dc fault current emanates from the contribution of both the ac grid as well as the discharge current of the dc-link capacitor. The discharge current has a large first peak decaying with time. Therefore, the employed dc circuit breakers (CBs) should be able to withstand this high peak current.

The modular multilevel converter (MMC) is a good candidate for HVDC installations in recent years. Half-bridge MMC (HBMMC) does not have the ability to suppress dc fault current, that is, dc or ac breakers must be opened to clear the dc fault. On the other hand, the full-bridge MMC (FBMMC) is able to suppress such faults but with twice the number of semiconductor switches, which, in turn, increases the converter cost, size, and losses. Generally, the main drawbacks of the MMC are the circulating currents, the requirement of a large number of dc capacitors (sub module capacitors), and voltage balancing. Recently, research has highlighted a hybrid VSC topology which combines the features and advantages of MMC and two-level VSCs.

This can be done by combining high-voltage series-connected IGBTs (directors) and wave shaping circuits based on the same types of MMC cells. As a result, the overall rating of the VSC is shared between the series-connected IGBTs and multilevel converter which results in employment of fewer MMC cells.

V CONCLUSION

This paper proposes a BBI-HVDC system with blocking capability of ac-side fault current contribution during dc-side faults. The proposed BBI-HVDC system also provides independent active and reactive power control in both directions. The main advantages of the proposed BBI system are as follows: 1) AC fault ride through capability; 2) Complete blocking capability between the ac grid and dc-side faults via blocking the IGBT gate signals; that is, by employing a BBI topology, the semiconductor devices are protected against dc fault currents. This feature is highly desirable especially in multi terminal HVDC systems. 3) No common mode voltages; 4) Very low output stresses; 5) Voltage balancing is not needed as in the MMC and hybrid VSC; and 6) BBI has no circulating current. In this paper analysis of different types voltage source converter like two level voltage source converter multilevel or multi modular half bridge and full bridge for its defines against fault with compare to proposed buck boost inverter based HVDC system

ACKNOWLEDGMENT

I am very grateful and would like to thank my guide Mr. Pratik Munjani sir for their advice and continued support without them it would not have been possible for me to complete this paper. I would like to thank all my friends, Colleague, husband and classmates for all the thoughtful and mind stimulating discussions we had, which prompted us to think beyond the obvious.

REFERENCES

[1] R. Adapa, “High-wire act: HVDC technology: The state of the art,” *IEEE Power Energy Mag*, vol. 10, no. 6, pp. 18–29, Nov. 2012

[2] J. Yang, J. E. Fletcher, and J. O’Reilly, “Short-circuit and ground fault analyses and location in VSC-based dc network cables,” *IEEE Trans. Ind. Electron*., vol. 59, no. 10, pp. 3827–3837, Oct. 2012.

[3] M. Saeedifard and R. Iravani, “Dynamic performance of a modular multilevel back-to-back HVDC system”, *IEEE Trans. Power Del*., vol. 25, no. 4, pp. 2903–2912, Oct. 2010.

[4] M. A. Parker, L. Ran, and S. J. Finney, “Distributed control of a fault tolerant modular multilevel inverter for direct-drive wind turbine grid interfacing,” *IEEE Trans. Ind. Electron*., vol. 60, no. 2, pp. 509–522, Feb. 2013

[5] G. P. Adam, K. H. Ahmed, S. J. Finney, K. Bell, and B. W. Williams, “New breed of network fault-tolerant voltage-source-converter HVDC transmission system”, *IEEE Trans. Power Syst*., vol. 28, no. 1, pp. 335–346, Feb. 2013.

[6] M. H. Rashid, “Power Electronics” Pearson Publication

[7] R. O. Caceres, W. M. Garcia, and O. E. Camacho, “A buck-boost DC-AC converter: Operation, analysis, and control,” in *Proc. IEEE Conf. Int. Power Electron. Congr*., 1998, pp. 126–131.

[8] A.Elserougi, A. S. Abdel-Khalik, A.Massoud, and S. Ahmed, “Multi module Bi-directional Buck-Boost Inverter-based HVDC back-to-back transmission system,” in *Proc. IEEE Conf. Energy Convers. Congr. Expo*., 2013, pp. 2582–2589

[9]Y. Wang and R. marquardt, “Future HVDC-grids employing modular multilevel converters and hybrid DC-breakers,” in *Proc. 15th Eur. Conf. Power Electron. Appl.*, 2013, pp. 1–8.

[10] R. Marquardt, “Modular Multilevel Converter topologies with DC-Short circuit current limitation,” in *Proc. 8th IEEE Int. Conf. Power Electron. ECCE Asia Conf.*, 2011, pp. 1425–1431.

[11] X. Zheng, T. Nengling, Y. Guangliang, and D. Haoyin, “A transient protection scheme for HVDC transmission line,” *IEEE Trans. Power Del.*, vol. 27, no. 2, pp. 718–724, Apr. 2012

[12] Ahmed A. Elserougi, Ahmed M. Massoud, Ayman S. Abdel-Khalik and Shehab Ahmed ,“Bidirectional Buck-Boost Inverter-Based HVDC Transmission System With AC-Side Contribution Blocking Capability During DC-Side Faults” ,*IEEE transactions on power delivery*, vol. 29, no. 3, june 2014