Enhancement Of HVDC Power Transmission System Using Series Capacitor Compensation With Fuzzy Logic Controller

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ABSTRACT

This paper introduces significant performance enhancements to the ac filter less LCC HVDC by including fixed series capacitors at the primary side of a converter transformer. Different HVDC converter topologies have been proposed, built and utilized all over the world. The two dominant types are the line commutated converter LCC and the voltage source converter VSC. By the addition of series capacitor scheme the amount of active power that can be transmitted is increased by more than 60% especially under severe unbalanced fault such as single phase fault and also reduces the amount of commutation failure by reducing the voltage level of the capacitor which results into reduced costs and losses. Finally the proposed system is done in MATLAB simulation software with fuzzy logic controller.

Keywords: HVDC, LCC HVDC, Flexible LCC HVDC, Commutation failure, active power transfer, energy storage, fuzzy logic controller

INTRODUCTION

In this dynamic and ever changing world of technology electric power supply is the key for development and success. The basis of quality power is reliable and efficient power system. The power system is the network which consists of generation, distribution, transmission and utilization. There are more problems and disturbances in distribution system when compared with remaining three systems. Power is transferred to long distances by converting to DC so they are problems while transferring from AC to DC.

The HVDC technology is a high-power electronic technology used in electrical power systems. It is an efficient and flexible method to transmit large amount of electric power by over long distances by over long distances by over head transmission lines [1]. It can also be used to inter connect asynchronous power system. The fundamental process that occurs in HVDC system is transforming from

AC to HVDC system are converters, smoothing reactors, harmonic filters reactive power supplies DC lines and AC circuit breakers. Converters are classified into two types line commutated converters and voltage source converters. Conventional device has only turn-on control its turn-off depends on the current coming to zero as per circuit and system conditions. Some other types of semiconductor device IGBT both turn-on and turn-off can be controlled and they can be used self commutated converters. For this reason an HVDC converter using HVDC IGBTs is usually referred as voltage source controller. The transfer of power to the parallel AC lines can cause overloading problem [2].

The problem that occur while converting are commutation failure, lack of active power and harmonics. This problem can be eliminated by placing series capacitor at the primary side of converter transformer. Due to lack of active power it result in the tripping of generators at the rectifier side [1].In particular this should be achieved This is further improved by adding fuzzy logic controller at the inverter side of HVDC system.

2.ANALYSIS

Most of the previous researches has been focusing on the mitigation or elimination of CF while there is a lack of focus on increasing the active power transfer during any fault. This method works by estimating the DC voltage reference and transmitting it to rectifier side through a cable which can be seen in the block diagram shown:

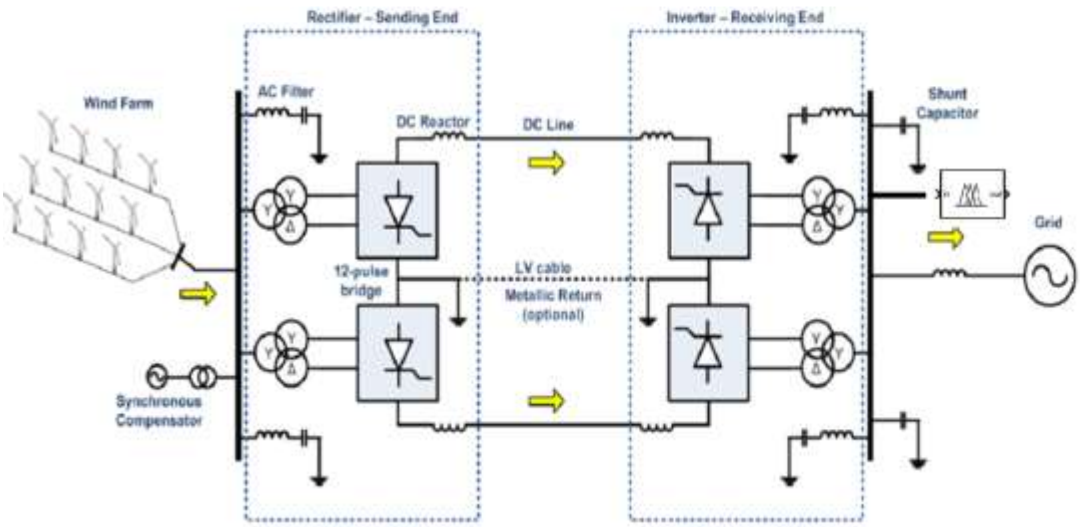

Fig 2.1 Block diagram of the system

2.1 DESIGN OF HVDC:

The basic design for practically all HVDC converters is the 12-pulse double bridge converter which is shown in Figure below. The converter consists of two 6-pulse bridge converters connected in series on the DC side. One of them is connected to the

AC side by a YY-transformer, the other by a YD transformer. The AC currents from each 6-pulse converter will then be phase shifted 30°.

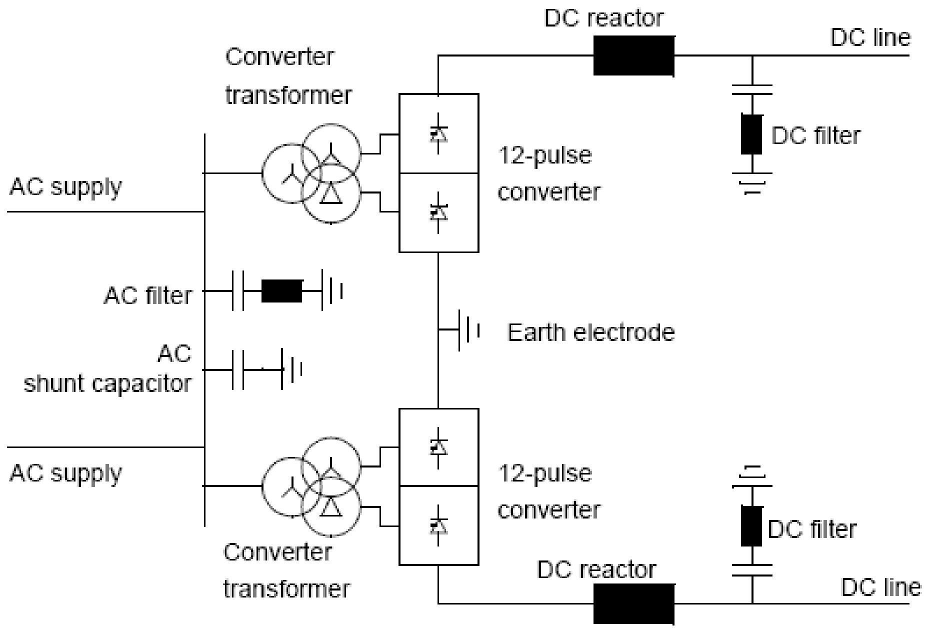

Fig 2.2 Design of HVDC

2.2 BRIDGE RECTIFIER:

Bridge rectifiers are the circuits which convert the AC (alternating current) to DC (direct current) using the diodes arranged in the bridge circuit configuration. They usually comprise of four or more number of diodes which cause the output generated to be the same polarity irrespective of the polarity at the input side.

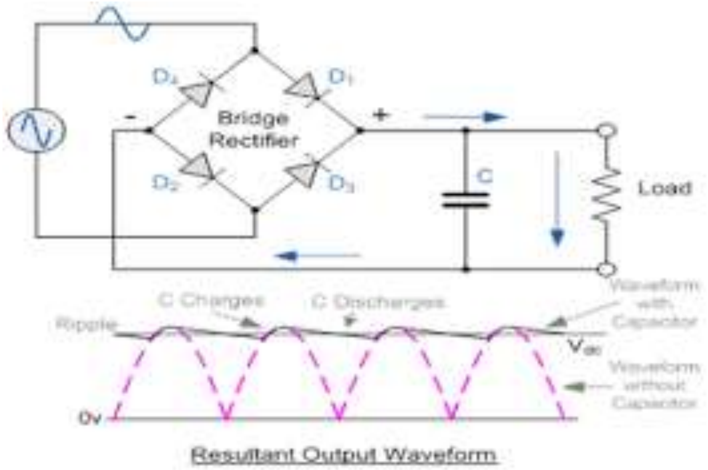

Fig 2.3 Design of bridge rectifier

2.3 CONVERTER TRANSFORMER:

The converter transformer steps up the voltage of the AC supply. Using a star to delta connection of the transformer windings, the converter can operate with 12 pulses for each cycle in the AC supply which helps to eliminate the harmonic current components. Converter transformers produce more noise than the three phase power transformers which is the major thing needed to be considered in the siting of the HVDC converters

Fig 2.4 Converter transformer

2.4 RECTIFIER CONTROL EMPLOYING PWM TECHNIQUE:

Here in this rectifier control, a PWM technique is employed. The major advantage of using the pulse width modulation technique is the reduction of higher order harmonics. It also makes it possible to control the magnitude of the output voltage and improve the power factor. PWM rectifiers are also used in distributed power generation applications such as fuel cells and wind mills. In contrast to the diode bridge rectifiers , PWM rectifiers achieve bidirectional power flow. It can be operated under line voltage distortion and Line frequency variations.

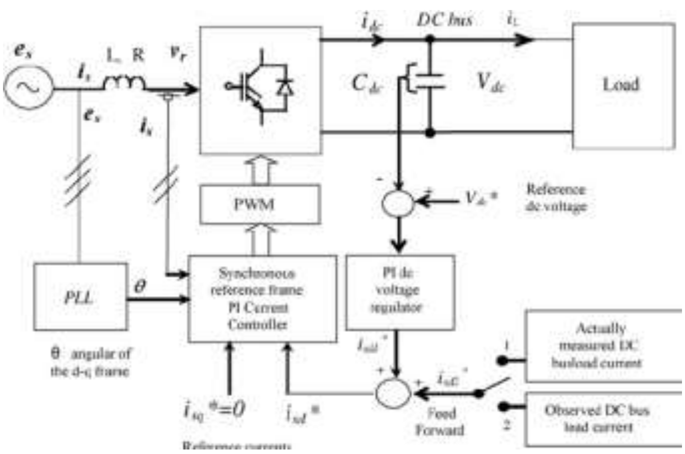

Fig 2.5 Rectifier control employing PWM technique

2.5 INVERTER CONTROL EMPLOYING FUZZY LOGIC CONTROLLER:

In the view of the control, fuzzy logic controllers are designed to enhance the system stability. By the use of fuzzy logic controller in the inverter side there will be uniform voltage regulation. In case of any three phase faults a good voltage regulation can be achieved as compared to the PI controller. The fuzzy based algorithm is employed in the inverter control in order to optimise the duty cycles of the IGBT and to enhance the outputs with lower harmonic contents and unity power factor

3. SIMULINK MODEL

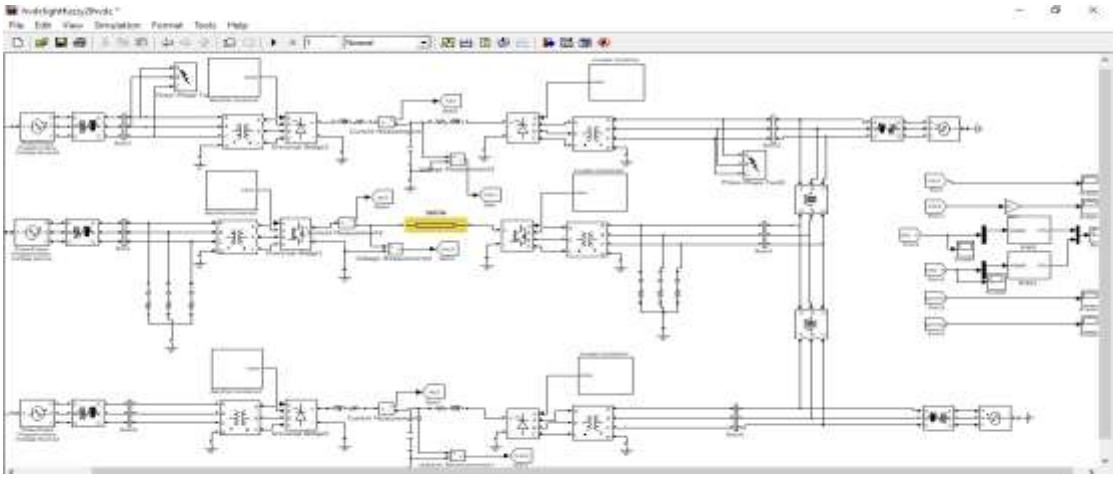

Fig 3.1 INVERTER EMPLOYING FUZZY LOGIC CONTROLLER

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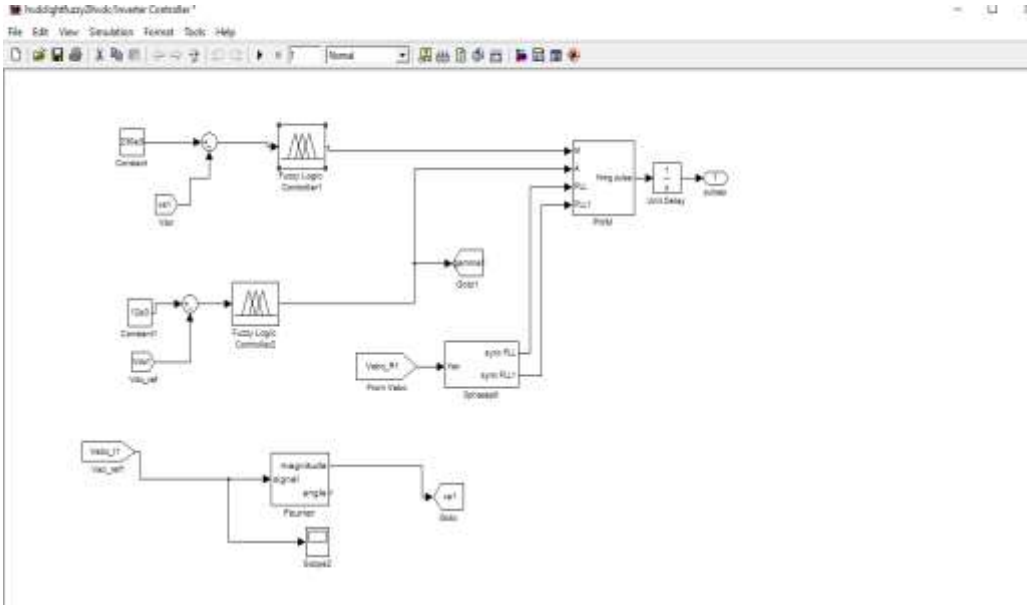

Fig 3.1 Simulink model

Fig 3.2 Uniform voltage regulation from fuzzy logic controller

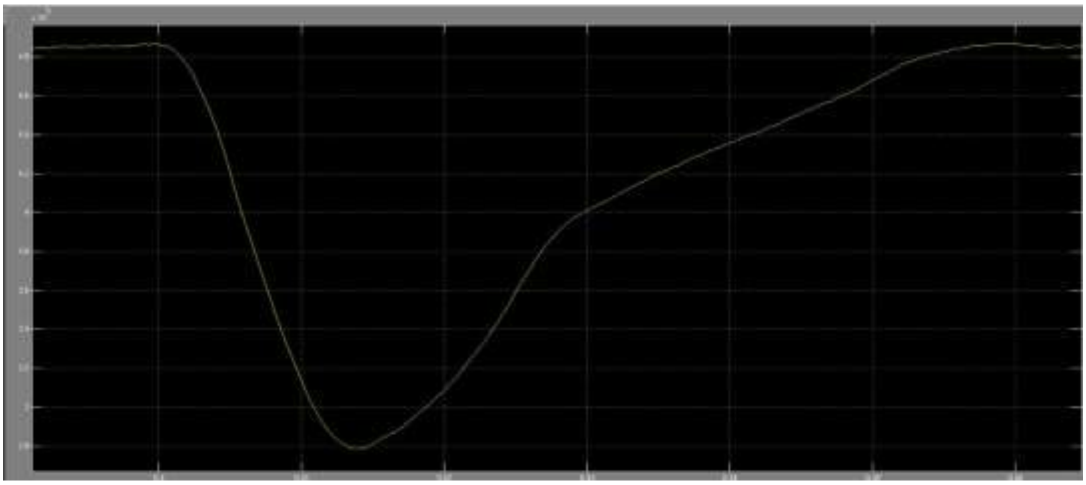

Fig 3.3 Output of DC voltage

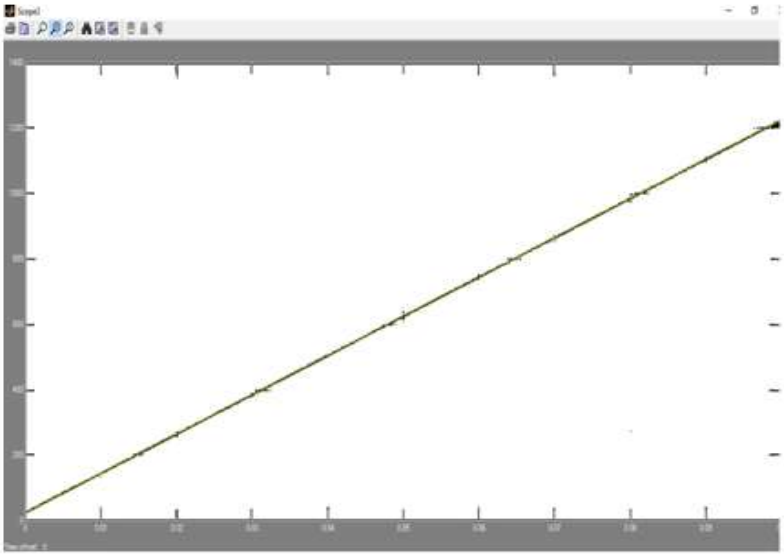

Fig.3.4 Active power Vs voltage during faults

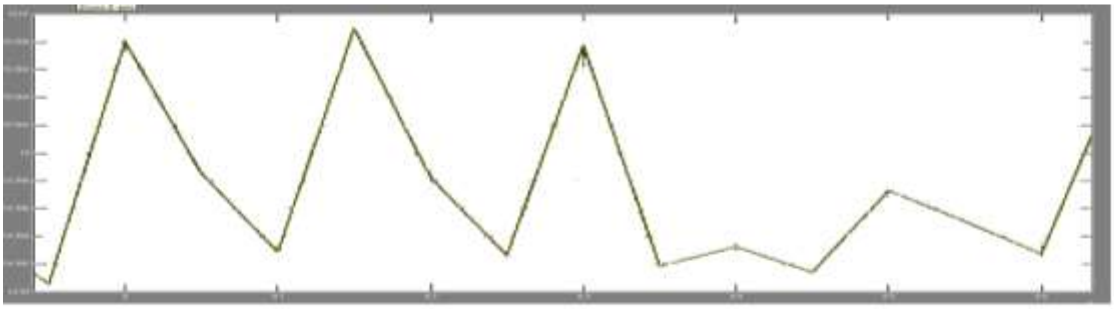

Fig.3.5 Voltage across series capacitor

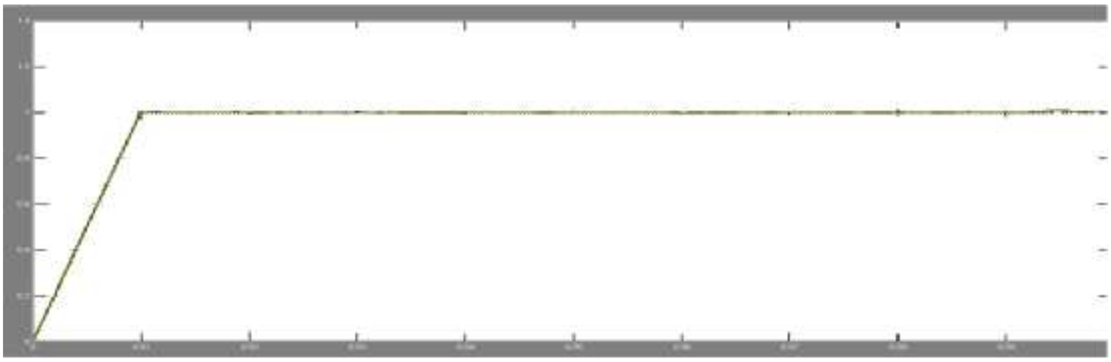

Fig.3.6 Magnitude of output current

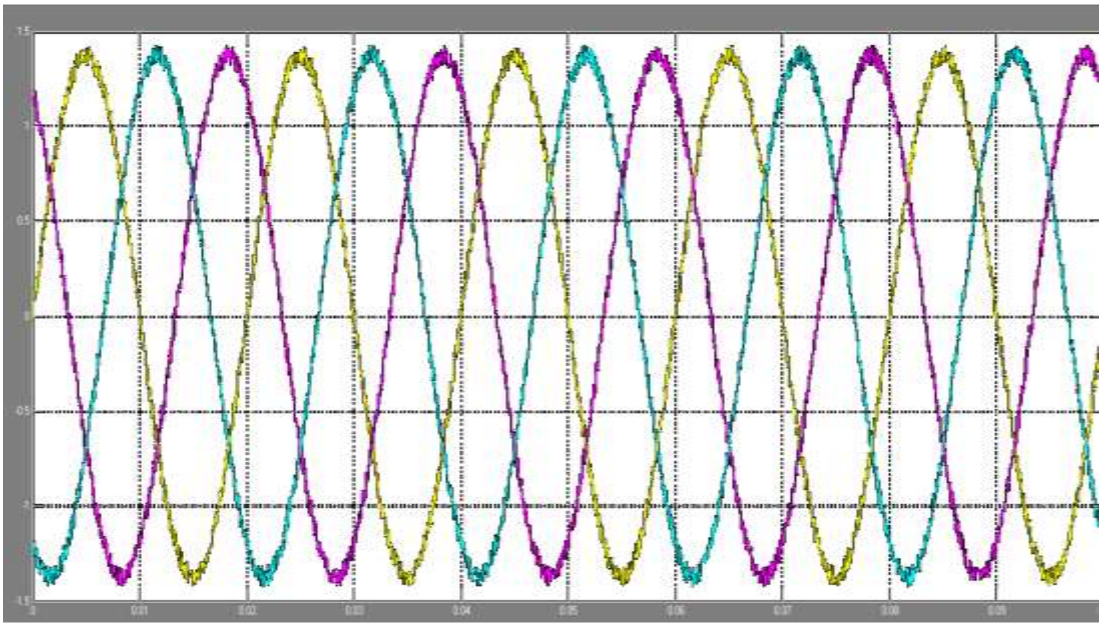

Fig.3.7 Inverter AC bus voltage

CONCLUSION

The Enhancement of series capacitor compensated AC filter less LCC HVDC with fuzzy logic controller has been implemented in this paper. This system can significantly

1.Decrease the required voltage level from the controllable capacitors for CF (Commutation Failure) elimination.

2.Increase the amount of active power transfer that can be transmitted under unbalanced faults by more than 60% or even more. Simulation results for three phase faults have been presented to validate the technical performance of the HVDC system. Finally the uniform voltage regulation is shown by the use of fuzzy logic controller in the inverter.

Future Enhancement:

From the economic perspective, cost analysis of the proposed method has also been carried out to show that the superior technical performance can be achieved with reduced cost. This is mainly due to the reduced equipment cost and reduced capitalized cost of losses from the controllable capacitors. Finally the possible solutions for various practical issues have been discussed. As this paper is focused on the point to point HVDC system, one future research direction is the evaluation and application of the proposed method in multi-infeed HVDC systems, where detailed technical and economical performances will be further analyzed.

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