Bidirectional Power Flow Analysis of Bipolar HVDC System

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Abstract---The success of HVDC technology applied to the interconnection of ac systems has been confined by the rapid growth in its utilisation. There are many dc links around the world, with a transmission capacity of about 36000 MW. Although most of these involve transmission by overhead line and underground cable, a significant number are bipolar HVDC links. A high level of reliability, coupled with the advantages of very fast controllability, low transmission losses, suitability for cable transmission, and asynchronous connection, all combine to ensure the future of HVDC in modern power systems. The main objective is to determine bidirectional power flow analysis. Also determine the automatic control of rectifier gate signal and automatic control of inverter gate signal. Simulation has been carried out by MATLAB software. In this paper at both the end we can connect the load as a motor and thereafter we can determine the bidirectional power flow analysis. The gate pulse is applied manually. Then after we can check the result of the system.

Keywords: Bipolar HVDC Tie Line; Bidirectional Power Flow Analysis; MATLAB Simulation

I. INTRODUCTION

The High Voltage Direct Current electric power transmission system uses direct current for the bulk transmission of electrical power, in contrast with the more common alternating current (AC) systems. For long-distance transmission, HVDC systems may be less expensive and suffer lower electrical losses. For underwater power cables, HVDC avoids the heavy currents required to charge and discharge the cable capacitance each cycle. For shorter distances, the higher cost of DC conversion equipment compared to an AC system may still be warranted, due to other benefits of direct current links. HVDC allows power transmission between unsynchronized AC transmission systems. Since the power flow through an HVDC link can be controlled independently of the phase angle between source and load, it can stabilize a network against disturbances due to rapid changes in power. HVDC also allows transfer of power between grid systems running at different frequencies, such as 50 Hz and 60 Hz. This improves the stability and economy of each grid, by allowing exchange of power between incompatible networks. High voltage is used for electric power transmission to reduce the energy lost in the resistance of the wires. For a given quantity of power transmitted, doubling the voltage will deliver the same power at only half the current. Since the power lost as heat in the wires is proportional to the square of the current for a given conductor size, but does not depend on the voltage, doubling the voltage reduces the line losses. High voltage AC-DC technology has made considerable advances in recent years. Engineers are now considering DC multi-terminal network as a feasible option. Therefore, the load flow and state estimation techniques are extended to deal with such mixed AC-DC systems. Multi-terminal DC network integrated into an existing system can improve AC equipment loading and stability, participate in load frequency control and voltage regulation, increase interchange capacity, limit short circuit capacity and contribute to the economy of electric power transmission.

II. BIPOLAR CONFIGURATION

Bipolar has two conductors, upper pole is operating in positive current and positive voltage and lower pole is operating in negative voltage and negative current. Both poles transmit a power in same direction. It is grounded at both stations. Both poles are operating at equal currents during steady state, therefore zero current through the ground. It can be operating as a single pole during fault at another pole.

Fig. 1: Bipolar schemes

Fig. 2: Monopolar HVDC Model

The configuration of the system is given in figure. The AC networks, both at the rectifier and inverter end, are modelled as infinite sources separated from their respective commutating buses by system impedances. From the AC point of view, an HVDC converter acts as a source of harmonic current. From the DC point view, it is a source harmonic voltage. The order n of these characteristic harmonics are related to the pulse number p of the converter configuration: n = kp ± 1 for the AC current, and n = kp for the direct voltage, k being any integer. In the example, p =
12, the injected harmonic are: 11, 13, 23, 25 on the AC side, and: 12, 24 on the DC side.

III. EXPERIMENTAL PARAMETER

A. Ac-1 Network Parameter:
- 3-phase source: 200KV
- Star/star-delta transformer: 200KV/600KV
- Star-star/Delta transformer: 600KV/200 KV
- Transmission line : 300 Km

B. Ac-2 Network Parameter:
- 3-phase source: 200KV
- Star/star-delta transformer: 200KV/600KV
- Star-star/Delta transformer: 600KV/200 KV
- Transmission line : 300 Km

IV. EXPECTED OUTCOMES OF PROPOSED WORK

A. Case-1: When AC-1 voltage is 200kv and AC-2 voltage is 170kv then power flow from AC-1 to AC-2 network

B. Case-2: When AC-1 voltage is 170kv and AC-2 voltage is 200kv then power flow from AC-2 to AC-1 network
The modelling of a high-voltage direct current (HVDC) transmission link using 12-pulse thyristor converters are applied to examine the system performance. The objectives of this to demonstrate the use of SimPower Systems blocks in combination with Simulink in the simulation of a complete pole of a 12-pulse HVDC transmission system. The Discrete HVDC Controller block is a generic control available in the Discrete Control Blocks library of the SimPower Systems Extras library. DC interconnection is used to transmit power from a 200 kV, 50 Hz system to a 60 Hz system.

The 12-pulse rectifier and the inverter converters connected in series. Open the two converter subsystems (Rectifier block and Inverter block) to see how they are built. The converters are interconnected through a 300-km line and 0.5 H smoothing reactors. The converter transformers (Wye grounded/Wye/Delta) are modeled with Three-Phase Transformer (Three-Winding) blocks.

V. CONCLUSIONS
From the simulation we can conclude that we can transmit the power from 50 Hz to 60 Hz system and 60 Hz to 50 Hz and we can balance the load at both AC network.

VI. FUTURE ENHANCEMENT
Now i am completed up to bidirectional power flow using bipolar HVDC system and we can transmit the power from one AC network to other. Here I am applied gate pulse is manually but in future i am generated gate pulse automatically to the rectifier as well as inverter side and we get the result.

ACKNOWLEDGEMENTS
I am very grateful to Dr. Vilin P. Parekh Principal of Parul Institute of Engineering and Technology for his continuous help and support. I also extend my thanks to Prof. Falguni Bhavsar for providing facilities for caring out the dissertation work. I heartily thank Assistant Prof. Nirav Vaghela for giving me such a chance to undertake dissertation under the subject of Bipolar HVDC tie line simulation.

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