# Descriptive approach to High Voltage D.C. Transmission

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*Abstract*— **Rise of new energy era include a strategy to build a state of the art transmission system is evident. The most likely replacement for the conventional AC transmission is HVDC. It is proven technology with many benefits over conventional technology and has a vast array of application like subsea transmission, interconnection of asynchronous AC grid and many more possibilities. Its most likely implementation is for transmission of long distance bulk power with great efficiency. In this paper we have provided a simulation in matlab of HVDC transmission system based on 12 pulse inverter and rectifier with their controller.**

***Keywords*— HVDC transmission simulation, twelve pulse rectifier and inverter, Matlab simulation.**

## I. INTRODUCTION

The first implementation HVDC transmission was done in 1954 at Gotland, Sweden. With the success of this a contract for Eel river DC link was established in Canada. It was the first application of solid state valves of HVDC transmission. Now a days we are seeing voltages for DC transmission line rising up to 600kv for the distance of 785km in Brazil. The HVDC transmission is the greatest achievement for bulk power transmission for a longer distance with high reliability.

## II. MILESTONE ACHIEVED IN HVDC

The first HVDC link with mercury arc valves and HVDC submarine cable was commissioned in 1954 at Gotland. This was the major breakthrough in both cable and converter technologies.

The first HVDC transmission project using silicon controlled rectifier was installed in 1972 at Canadian Eel river which made HVDC developed actively.

In 1979, the first microcontroller based control equipment for HVDC was installed. The rapid development of power electronics technology and microelectronics technology was possible because of the successful development of high power thyristor after 1970, the thyristor converter valve has several benefits over mercury arc valve like less costly, high reliability, less maintenance, and simple construction.

In 1998, the first capacitor commutated converter (CCC) was installed in Argentina –Brazil interconnection. The first voltage source converter for transmission was installed in 1999 in Gotland Sweden.

Some of the historical breakthrough won in HVDC technology are based on voltage source converter (VSC) technology and fully controlled power electronics devices, gate turn off thyristor (GTO) and insulation gate bipolar transistor (IGBT) are important platform of a new generation of HVDC technology.

## III. MAIN FOCUSING POINT IN EXISTING PERIOD

1. Development of modular multi-level converter and
2. MMC-HVDC operation and control.
3. DC transmission system with Multi-Terminal.
4. Reactive power compensation theory in power system.

## IV. HVDC TRANSMISSION

In the modern times of absolute certainty there were many question raised about practically and implementation possibilities of DC transmission line over the proven technology of AC transmission system. The answers for all all the doubts were instantly recognized by observing consistent reduction of transmission losses and increase of regulation governed by the size of conductor, but AC and DC conductors have their own flaw, either used for overhead transmission or under water line can have low losses but their cost are more because of the increase in cross section area. The selection of conductor for DC transmission over AC transmission is generally prefer because of its high economy due to following reason:

The overall cost of construction of tower for DC transmission over AC transmission is much less for the transmission of the same amount of power per unit distance. In contrast to this fact the cost of construction of DC converter station is higher than the cost of building terminating station for AC transmission line. However the building cost of DC transmission per watt is less than AC transmission for higher distance. This fact graphically represented in figure 1. It has lower adverse effect on environment as compared to AC line.

If transmission is by submarine or underground cable, the breakeven distance is much less than overhead transmission. It is not practical to consider AC cable systems Exceeding

50km but DC cable transmission systems are in service whose length is in the hundreds of kilometres and even distances of 600 km or greater have been considered feasible.

Some AC electric power systems are not synchronized to neighbouring networks even though their physical distance between them is quite small. This occur in japan where half the country is 60 Hz network and the other is a 50Hz system. It is physically impossible to connect the two together by direct AC methods in order to exchange electric power between them. However, if a DC converter station is located in each system with an interconnecting DC link between them, it is possibility to transfer the required power flow through the AC system so connected remain.

## V. ADVANTAGE AND DISADVANTAGE OF HVDC TRANSMISSION

*ADVANTAGE*

- Economical for long distance.
- Simple line construction with greater power per conductor.
- Ground return is possible.
- Reactive compensation is not required.
- Corona loss, radio interference are less compare to AC line.
- DC cable can work on higher voltage gradient.
- Line losses are smaller.

*DISADVANTAGE*

- Initial cost is high due to installation of converter and DC Switchgear.
- Converters required considerable reactive power.
- Harmonics are generated which requires filter.
- Reactive power required by load is to be supplied.
- Externally no reactive power can be transmitted over DC.

## VI. ECONOMICAL COMPARISON

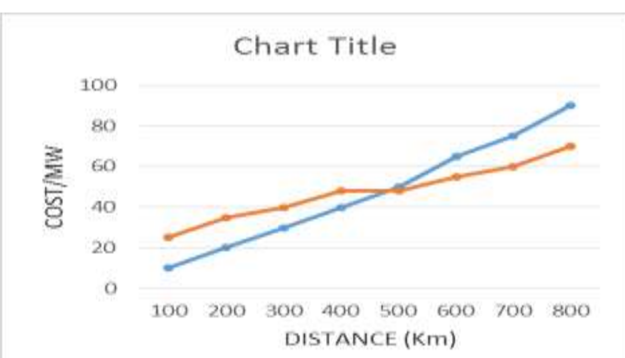


Fig 1: Cost Comparison between HVAC and HVDC

BLUE LINE: A.C. TRANSMISSION

ORANGE LINE: D.C. TRANSMISSION

## VII. HVDC SUBSTATION

HVDC substation are used for converting A.C. power generated in generating station into DC by using rectifier. In HVDC substation or converter substation rectifier and inverter are placed at both ends of the lines. The substation which converts DC into AC is called inverter station.

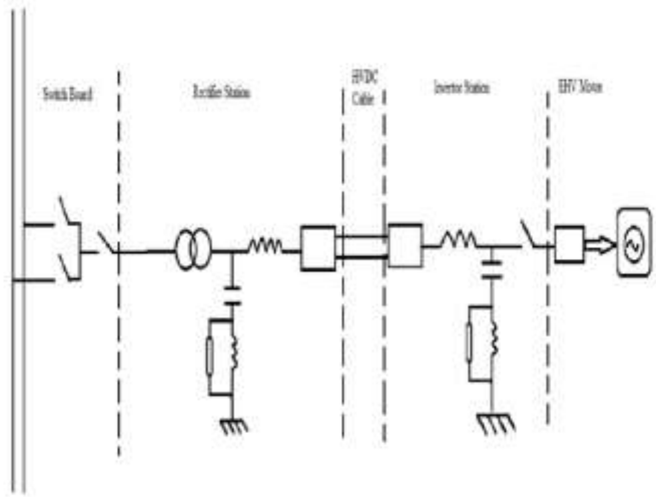

Fig 2: HVDC SUBSTATION

## VIII. CONVERTER STATION

HVDC converter station uses thyristor valves for the conversation of DC to AC and vice-versa. The valve consist of 12 pulse converter. Converter transformer are used to connect this valves to AC system. The valve are installed in the building and converter transformer are placed just outside.

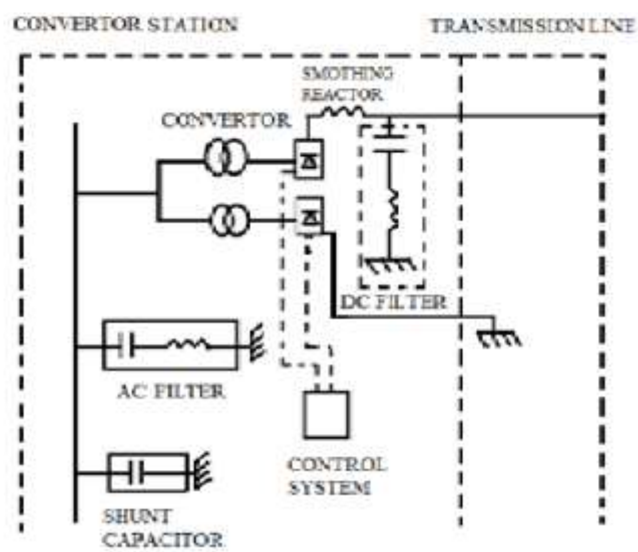


Fig 3: Converter Station

# IX. MATLAB SIMULATION

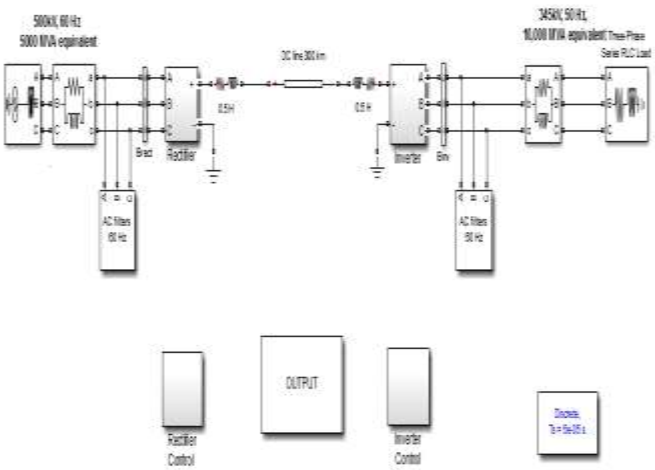


Fig 4: Main Circuit simulation

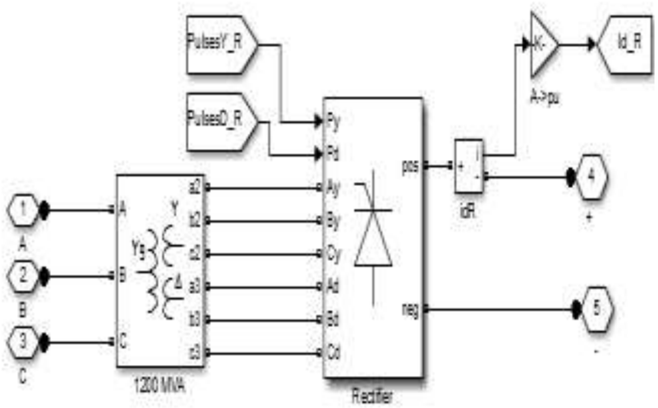


Fig 5: Rectifier Station

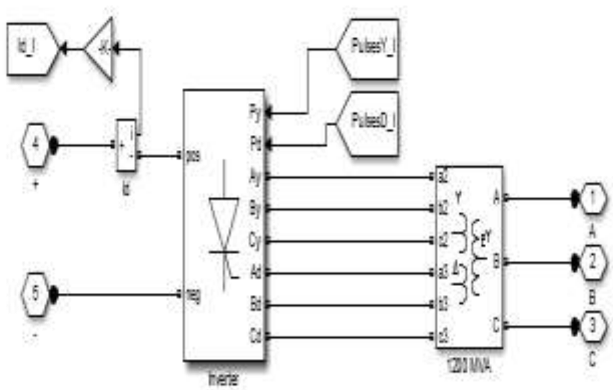


Fig 6: Inverter Station

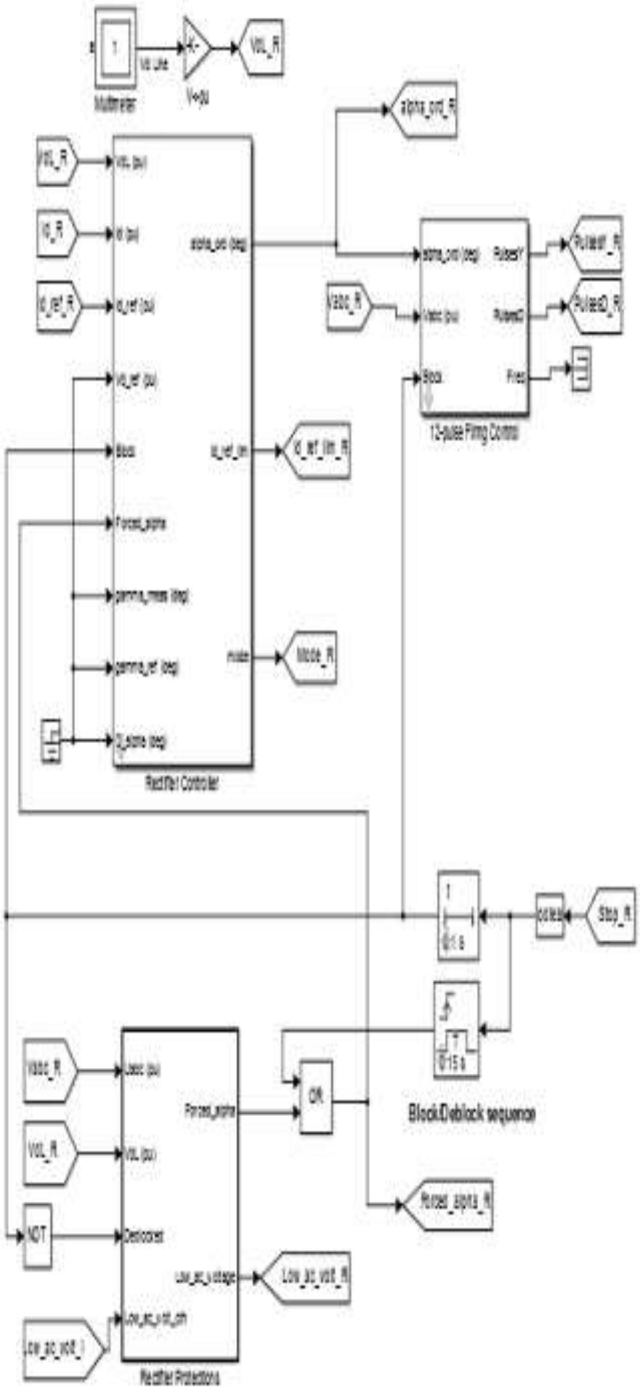


Fig 7: Rectifier Controller

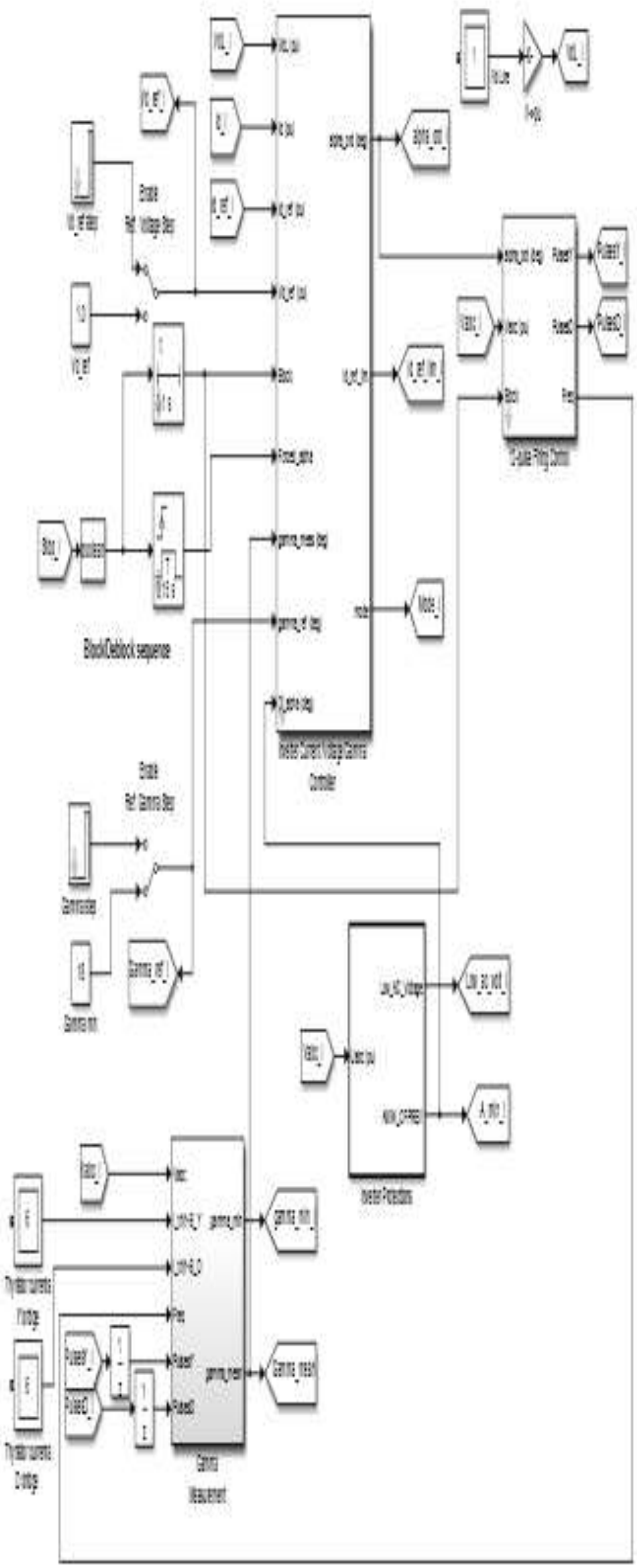

Fig 8: Inverter controller

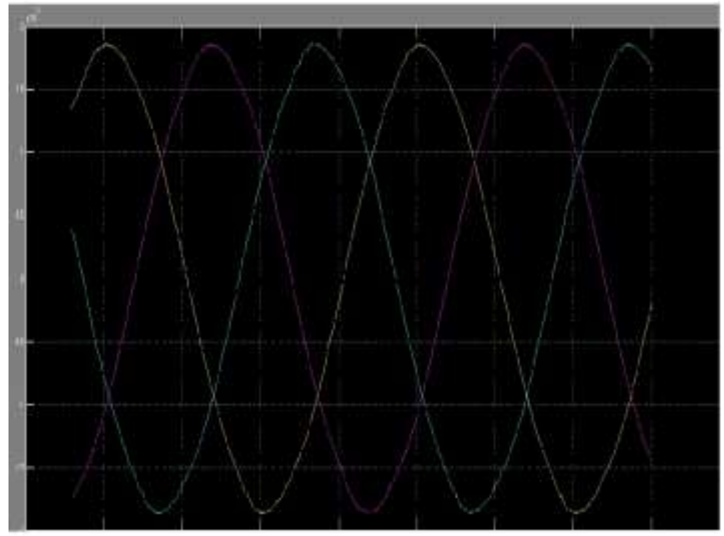

Fig 9: Rectifier input

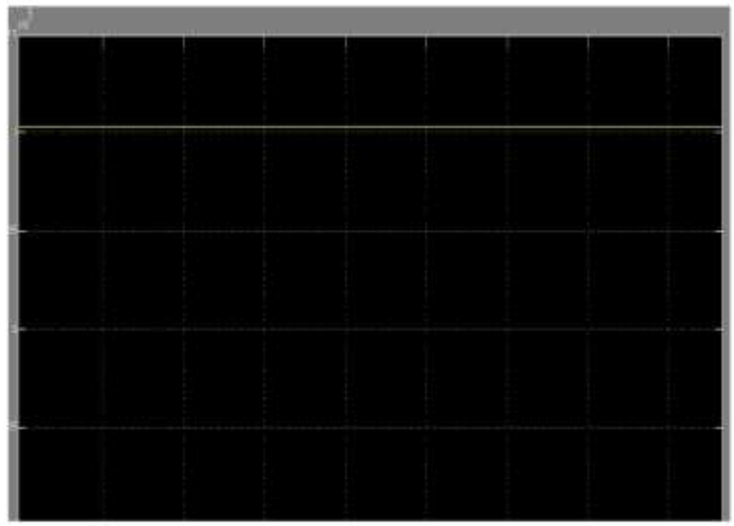

Fig 10: Inverter Input

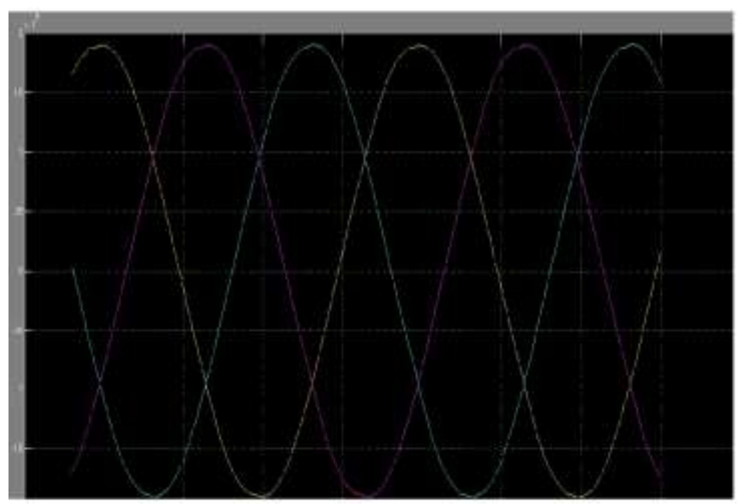

Fig 11: Final output or load input

## X. CONCLUSIONS

From the simulation we have observed that the transmission losses and reactive power required for the flow of active power through transmission line reduces.

Two varied network having different frequency can be operated together using HVDC transmission link.

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