Review on Reactive Power Compensation in HVDC Transmission System

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Abstract : The behaviors of HVDC link are taking an ever-larger role in the proper functioning of entire AC-DC power systems. The importance of the interaction between an HVDC link and an AC system is largely determined by the converter bus side AC system's strength. The reactive power compensation is an effective and economical way to control the bus voltage so it naturally has the ability to improve system strength. Therefore, it is important to understand how reactive power compensator (RPC) works and how to optimize its performance in entire AC-DC power systems. Effectively designing and operation of the RPC is necessary in order to achieve and maintain good overall performance of HVDC transmission system. In this paper, the literature on reactive power compensation in a current source converter (CSC) based HVDC transmission system is presented.

IndexTerms **– CSC-HVDC, RPC, FC, SC, SVC, STATCOM**

I. INTRODUCTION

Transmission of electrical energy with HVDC has provided the electric power industry with a dominant way to transmit huge capacity of electricity over very long distances. The HVDC link is naturally non-linear in its function. This basic aspect gives rise to several problems in designing appropriate RPC for HVDC links connected different types of AC systems under various operating conditions. The RPC for an HVDC transmission system is likely to improve the system performance and, subsequently, its reliability. Accordingly, a powerful control of the HVDC transmission system plays a significant role in providing system stability. A short survey of the RPC's used for HVDC transmission system from the available literature is reviewed in the subsequent few paragraphs.

II. THE INTERACTION BETWEEN STRONG AC SYSTEM AND HVDC LINK

A great deal of study has been practiced to recognize the interaction between strong AC system and HVDC link. Zidi et al. [1] investigated the steady state and the dynamic functioning of the HVDC system in Matlab-Simulink environment during DC line fault and single phase to ground fault. Chen et al. [2] analyzed the dynamic operating characteristics of the HVDC in advanced digital power system simulator (ADPSS) during DC line fault and inverter bus fault conditions, but have not been discussed in detail.

III. THE INTERACTION BETWEEN WEAK AC SYSTEM AND HVDC LINK

A lot of work has been done to know the interaction of a weak AC system with an HVDC link. Pilotto et al. [3] described and proposed solutions for eliminating the occurrences accompanying with the voltage stability at HVDC links connected to weak AC system. The Nelson-River HVDC transmission system installed with new synchronous condenser (SC) is analyzed by Thio et al. [4] and also emphasized the planning requirements and the specification of the synchronous compensators to achieve optimal power delivery through the DC links. A performance analysis of the HVDC link connected to a weak AC system is done by Kim et al. [5] for numerous exciter features of synchronous machines associated with the converter bus. Tso et al. explained the direct TSM prediction method [6] based on the extended equal area criterion for the incorporation of HVDC transmission system and the static var compensator (SVC). The need and application of static synchronous compensator (STATCOM) for the conventional HVDC transmission system for the reactive power support at the inverter's end, is reported by Kim et al. [7]. With the help of two different control techniques, the co-ordination in the middle of a STATCOM [8] and classical HVDC connected to a weak AC system is done by Khatir et al. for several fault conditions. Nyati et al. discussed the performance of the HVDC link connected to a weak AC system [9] by considering the fault recovery and suppression of dynamic overvoltage (DOV) criterion with fixed capacitor (FC), SC, thyristor-controlled reactor (TCR), thyristor switched capacitor (TSC), metal oxide varistor (MOV), series capacitor device (SCD).

IV. THE INTERACTION BETWEEN VERY WEAK AC SYSTEM AND HVDC LINK

A lot of work has been done to know the interaction between very weak AC system and HVDC link. Teleke et al. [10] in his paper compared the dynamic performance between a conventional SC, a superconducting SC, and SVC is made in a system set up. Weindl et al. [11] presented the possibility to interconnect AC/DC systems, leading to very weak SCR lower than 1.5 is exposed by considering the STATCOM for RPC. Nayak et al. [12] paper deliberates the performance of dynamic voltage control devices at the inverters of the very weak AC system by considering the RPC's: FC, SC, SVC and a mix of the SC and SVC. The dynamic performances of the various RPC's under AC and DC disturbances were studied. Zhuang's et al. [13] presented the dynamic performance of the innovative static var compensator (STATCON) at the HVDC converter terminal, where the AC system is with very low SCR. The simulation results were compared during various AC and DC disturbances with some other types of RPC's available. Zhang et al. [14][15] investigated the performance of STATCOM as an RPC in an HVDC transmission system, and developed design procedures for reactive power compensation in HVDC transmission systems. The transient performance of STATCOM is compared with the performance of the SC, SVC with their behavior during DC fault recovery, TOV and

commutation failure. In order to quantify the strength of system during RPC's are connected to the converter bus is investigated; a new series of indices apparent short circuit ratio increase (ASCRI) is developed.

V. CONCLUSIONS

In this paper, the literature on reactive power compensation in an HVDC transmission system were presented, which covers major developments in this field from early research to most recent. From the literature review, it is clear that, there is a vital role for RPC in CSC-HVDC transmission system connected to different AC systems such as strong, weak and very weak.

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