SYNOPSIS

SIMULTANEOUS EHV AC-DC POWER TRANSMISSION

Long EHV ac lines cannot be loaded to their thermal limits in order to keep sufficient margin against transient instability. The transmission angle between sending end and receiving end in long EHV ac lines seldom exceeds 30°. In these conditions ac current in the transmission line conductor is much below its thermal current carrying capacity. But optimum use of transmission lines requires loading of EHV ac lines close to their thermal limits. Flexible AC Transmission System (FACTS) components are used to achieve this. In this thesis it has been shown to achieve the same goal by simultaneous ac-dc power transmission in which the conductors are allowed to carry superimposed dc current along with ac current. Zig-zag connected transformers at both end in simultaneous ac-dc power transmission are used to avoid saturation of core due to dc current injection. Laboratory modelled experimental verification as well as simulation results establish the feasibility of simultaneous ac-dc power transmission.

The present research explores the feasibility of converting a double circuit EHV ac line to simultaneous ac-dc power flow line to get substantial power upgradation of existing transmission line. In the proposed study of conversion of existing EHV ac transmission line to simultaneous ac-dc transmission line, no alterations of conductors, insulator strings and towers structures of the original EHV ac line are required. Substantial gain in the loadability of the line is obtained. Major advantage of the composite ac-dc line is that the transmission angle between two ends of line in steady state may go much beyond 30°-45° values. This is because of inherently fast controllability of dc link embedded in the composite ac-dc line. Such a large transmission angle is impossible to achieve in pure EHV ac transmission line.

HVDC transmission lines in parallel with EHV ac lines are recommended to improve transient and dynamic stability as well as to damp out oscillations in power system. In the present work it has been demonstrated to get advantage of HVDC in parallel with EHV ac
lines by simultaneous ac-dc power transmission. A single machine infinite bus connected by a double circuit ac line, which is converted for simultaneous ac-dc power transmission line has been taken up for, detailed study. For the purpose of comparison, the same double circuit line with pure ac transmission under same disturbances is also studied. Various short circuit faults at number of locations of the transmission line have been created and simulated responses have been studied. A novel approach to solve the first swing stability problem by simultaneous ac-dc power transmission has been presented. It has been demonstrated that the stability of the system can be effectively improved by simultaneous ac-dc power transmission with fast dc power modulation. AC and DC powers flow independently and added dc power flow does not cause any transient instability.

It has also been shown that it is possible to tap small amount of power, (up to 10% of total transfer capability of the simultaneous ac-dc transmission system), to feed remotely located communities, in the same simple way as tapping in case of EHV ac line. It is economical as compared to complicated methods of tapping from HVDC line. The results clearly indicate that the tapping of small amount of ac power from the simultaneous ac-dc transmission line has negligible impact on the performance of composite ac-dc power flow.