Zabol University

Electrical Engineering Department

Thesis title:

Enhancing the Performance of the Interline DC Power Flow Controllers by Modeling the Virtual Capacitor in MMC-based VSC-HVDC Grids

By

Ali Mohammadijoo

Supervisor:

Dr. Mahdi Ghazizadeh Ehsaei

Advisor:

Dr. Saeed Heydari

October, 2024

Abstract

The problem of load distribution is a very critical issue in power networks. The more controllability and flexibility of load distribution (ability to adjust voltages, currents, power factor, etc.), the more optimal the power network will be. High-voltage direct current networks based on voltage source control converters with the same structure as multi-level modular converters that integrate renewable energy sources have been considered due to advantages such as lower power transmission losses, no concern about the existence of reactive power, and controllability of load distribution. In the present study, virtual capacitor modeling was performed to properly use the energy stored in multi-level modular converters and direct it to improve load distribution, and greater flexibility of load distribution was studied and investigated with the concept of defining a new variable of freedom in load distribution control and increasing the steady-state security of high-voltage direct current networks. Finally, it was found that more accurate modeling methods, nonlinear modeling and parameter tuning were very effective for optimizing virtual capacitor modeling, and also predictive control, robust control and decentralized control were effective for improving the control of modular multilevel converters (MMC), and thermal management and switching optimization, along with converter topology optimization, led to reduced energy losses, and reactive power control and power flow optimization were effective in reactive power management. In short, increasing efficiency in these systems requires a comprehensive approach that includes optimizing virtual capacitor modeling, improving control algorithms, reducing losses, reactive power management, using modern technologies and accurate system monitoring. These solutions can help improve the performance and reduce the costs of high-voltage direct current (HVDC) power transmission systems.

Keywords: Interline DC Power Flow Controllers, Virtual Capacitor, MMC-based VSC HVDC Girds, Static