On the convergence of the power flow methods for DC networks with mesh and radial structures

Abstract

The convergence analysis of the power flow methodologies for direct current (dc) electrical networks is addressed in this paper. The Banach fixed-point theorem is employed to prove the convergence and uniqueness in the power flow solution for two different alternatives based on graph theory named successive approximations and triangular-based power flow. The successive approximation method works with radial and mesh grids, including multiple voltage-controlled sources. The triangular-based method only deals with radial structures and one slack node. A six-nodes high-voltage dc system is used to illustrate the convergence of the graph-based methods under study. Three test feeders composed of 33, 35, and 69 nodes are used to validate the effectiveness of the proposed approaches when compared with classical methods such as Newton-Raphson and Gauss-Seidel. In addition, large-scale radial distribution networks are generated randomly with 50 to 200 nodes to demonstrate the scalability of studied power flow methods regarding processing time and the number of iterations. All the simulations have been conducted in MATLAB software.