学 位 論 文 内 容 の 要 旨

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学 位 論 文 題 名

Study of modern reconfiguration on distribution system based on flow algorithms
（フローアルゴリズムに基づいた配電系統の新しい構成変更決定手法に関する研究）

The conventional electrical distribution power system is facing with several new challenges, as the requirement of online management, the interconnection of the distributed generators (DG) and time-varying nature of load files. As a result, the efficiency of distribution system management is required to be improved. This thesis mainly focuses on modern reconfiguration techniques, and highly efficient reconfiguration method is proposed respectively to cope with the above mentioned challenges.

This thesis firstly focuses on online reconfiguration of distribution network for loss minimization. The relationship between line loss and voltage profile is investigated on the distribution network model. Based on the observed properties, a new reconfiguration algorithm, named intelligent flow algorithm (IFA), is proposed. The proposed IFA finds the optimal network configuration in a short computation time based on the monitored load distribution. The proposed algorithm is validated by simulations with 33-bus and 43-bus test distribution systems. Simulation results show that the proposed IFA is accurate, fast, stable and robust.

Interconnection of the DGs to the power system would cause the efficiency degradation of distribution system management. Minimization of voltage deviation by network reconfiguration is one of the important solutions of this problem. The authors accordingly proposes an extension of IFA, named extended flow algorithm (EFA), which can more effectively find the optimal network configuration for the distribution system with massive DG installation. The EFA is a two-stage method, where the configuration uniformly supplying loads, named balanced configuration, is generated firstly, and the optimal configuration is searched based on the balanced configuration by an improved branch-exchange approach. Accordingly, more simplifications are given to the EFA to improve its computation speed on large scale system. The performance of the proposed methods is tested through case studies with four test distribution systems on the MATLAB environment. The enhanced performance of the EFA to cope with DG installation and large scale system is clearly established.

Network reconfiguration has also been involved in voltage deviations by considering the time-varying nature of loads. With the integration of renewable energies to the power grid, optimal configuration should be determined corresponding to the variations in loads and DGs. Based on the previous studies, a long-term reconfiguration method named long-term expanded flow algorithm (LTEFA), which improves timeliness of configuration behaving on time-varying load, is proposed to substitute for the past short term ones. Moreover, optimal reconfiguration instants are achieved by a novel approach of optimal daily schedule named accumulation of unbalanced load distribution (AULD) based on the trade-off of switching operations costs and voltage deviations reduction. The proposed methods were tested by case studies of two test distribution systems under real-time measured data with interconnection of

photovoltaic (PV) generators in the MATLAB environment. By applying the proposed methods, the total operating cost of the network is reduced significantly within reasonable computation time, and its efficiency was also compared with fixed configuration, online reconfiguration policies and daily schedule proposed on other publications.

As a brief conclusion, the reconfiguration techniques proposed in this research are proved to be successful, applicable and also in high efficiency, which is expected to bring reconfiguration issue of distribution system into the next generation.

Keywords: distribution system reconfiguration, power distribution planning, distributed generation, large scale power system, minimization of voltage deviation, daily optimal schedule of reconfiguration.