Ain Shams University, Faculty of Engineering,
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Allocation of FACTS Devices Using New Optimization Techniques

By

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Table of content

List of Figures

List of Tables

List of Abbreviations

- AI : Artificial intelligence
- BSA : Bacterial swarming algorithm
- FACTS : Flexible AC transmission systems
- GA : Genetic algorithm
- HVDC : High voltage direct current
- IP : Interior point
- LP : Linear programming
- Max : maximum
- Min : minimum
- NLP : Nonlinear programming
- NR : Newton Raphson
- OPF : Optimal power flow
- PSO : Partical swarm optimization
- QP : Quadratic programming
- STATCOM : Static Synchronous compensator
- SVC : Static VAr compensator
- TCPST :Thyristor controlled phase shifting transformer
- TCVR : Thyristor controlled voltage regulator
- TCSC : Thyristor-controlled series compensators
- TTC : Total transfer capability
- UPFC : Unified power flow controller

List of Symbols

- θ_p : phase shifting angle
- Delta : power angle
- P : power flow
- P_d : power demand
- P_g : generated power
- P_{loss} : power loss
- %p : power flow from line rated power
- Q : reactive power flow
- Q_d : reactive power demand
- Q_g : generated reactive power
- Q_{loss} : reactive power loss
- Q_s : reactive power injected or absorbed by svc
- S : complex power
- T_v : Tab change transformer turns ratio
- V : voltage
- X_{added} : TCSC reactance added to line
- X_{old} : line reactance without FACTs
- X_l : line reactance

Abstract

The deregulated power systems suffer from congestion management problems. Also they cannot fully utilize transmission lines due to excessive power loss that it could cause. FACTS devices such as thyristor-controlled series compensators (TCSC) can, by controlling the power flows in the network, help reducing the flows in heavily loaded lines. Also they can minimize the power loss of the systems. However, because of the considerable costs of FACTS devices, it is important to minimize their number and obtain their optimal locations in the system.

Several research works are carried out to solve the optimal location problem of the TCSC. Optimization techniques applied in most of these works can not be accepted as general optimization techniques as they used a fixed pre-specified number of FACTS devices, but it is better to include number of devices in optimization strategy. Some other works did not select the proper type or the proper working range of FACTS devices used in the optimization problem.

This research is carried out to find the optimal location of thyristor-controlled series compensators (TCSC) in the power system to improve the loadability of the lines and minimize the total loss. Also this research aims to find the optimal number of devices and their optimal ratings by using genetic algorithm with taking into consideration the thermal and voltage limits. Examination of the proposed approch is carried out in healthy IEEE 9-bus system and in modified IEEE 30-bus system with one line outage and loading of one bus increased by 50%.

Results show that TCSC optimal location can minimize the total losses with thermal and voltage constraints not violated. Also optimal location of TCSC can increase system stability margin by increasing minimum voltage of the system. Optimal location can also return system to the constraints limit after it gets out of constraints due to lines outage. Finally proper selection of FACTS values and accurate selection of the available locations are the main important factors of using FACTS to improve system stability.

Statement

This thesis is submitted to Ain Shams University for the degree of Master of Science in Electrical Engineering.

The work included in this thesis was carried out by the author. No part of this thesis has been submitted for a degree or a qualification at any other university or institution.

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