An Improved Power Flow Analysis Technique

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Abstract— Reactive power optimization is important to power system stability and power quality. How to use the reactive power control method to improve the voltage level and decrease system loss is of value both in theory and application. The adjustment of generator voltages, transformer taps, shunt capacitors and inductors will control the reactive power distribution and affect voltage profiles and power losses. The objective is to find proper adjustments of these control variables that would maintain acceptable voltage profiles and minimize power losses. Reactive power optimization has commonly been formulated as a complicated constrained optimization problem with non-differentiable nonlinear objective function Reactive Power consumption increases losses in the system, which reduces the total system real power. Optimizing reactive power in the system can minimize total system real power loss. This can be done by optimally setting the terminal voltage of generating plant, transformer tap settings, output of compensating devices such as capacitor bank and synchronous condensers. Conventional Optimal Reactive Power Dispatch (ORPD) formulations utilize minimization of total system real power loss or voltage deviation as an objective to compute optimal settings of reactive power output or terminal voltage of generating plants, transformer tap settings and output of compensating devices. The present work has considered the setting of Flexible AC Transmission System (FACTS) devices as additional control parameters in the ORPD formulation and studies its impact on system loss minimization. Static models of FACTS devices consisting Static VAR Compensator (SVC) have been included in the present ORPD formulation.

Key words: Optimal Reactive Power Dispatch, (ORPD), Voltage Control, SVC

I. INTRODUCTION

The optimal power flow problem is to minimize the fuel cost, system losses or some other appropriate objective function while maintaining an acceptable system performance in terms of limits on generator real and reactive power output, output in compensating devices, transformer tap settings or bus voltage levels etc.

When only total fuel cost is minimized the optimal power flow problem corresponds to an Economic Load Dispatch (ELD) sub problem. As the system transmission loss depends on reactive power injection, the minimization of loss problem corresponds to the Optimal Reactive Power Dispatch (ORPD) sub problem condenser. To solve this complex problem several methods based on sensitivity relationship are used.

II. OPTIMAL REACTIVE POWER DISPATCH

The main task before utility is to meet the load demand of system most economically while ensuring desired quality of supply to consumers. The quality of supply is judged in terms of constant voltage. Extra reactive power demand from load increases magnitude of current in the system due to which real power loss is increased. Thus voltage drop in the system is increased, which reduces terminal voltage. Reactive power developed in transmission line is proportional to voltage drop in the system. If the extra reactive power demand of load is supplied separately instead of providing it from generator keeps current magnitude constant in the system. Thus maximum real power can be transmitted in a system by reducing the supply of reactive power from generator. This can be achieved by suitably adjusting the following controllable variables:

- Transformer taps
- Generator voltage
- Switchable shunt capacitor and inductor

III. CONVENTIONAL ORPD FORMULATION

The conventional ORPD problem has been formulated as to minimize total system real power loss while satisfying the network performance constraints and the operating limits of control variables. The control variables considered in this formulation include generator terminal voltage and transformer tap settings, which are used to determine the optimal reactive power settings of generator and other VAR sources.

IV. METHOD OF VOLTAGE CONTROL

The following methods are used for voltage control in power system:

- Tap changing transformer
- Shunt reactor
- Synchronous phase modifier
- Shunt capacitor
- Series capacitor
- Static VAR systems

V. ORPD CONSIDERING FACTS DEVICES

Using sensitivity relationship method can solve the complex problem of ORPD. But this is a time consuming method. Also control obtained is not fast due to mechanical switches. In recent years, the fast progress in the field of power electronics and microelectronics has resulted into a new opportunity for more flexible operation of power system. The Flexible AC Transmission System (FACTS) program was launched to develop a number of controllers for this purpose. These new devices have made the present transmission and distribution of electricity more reliable, more controllable and more efficient.

VI. MODELING OF FACTS

A. Static VAR compensator (SVC)

FACTS are a concept promoting the use of thyristor-controlled devices in power system with the objective of optimally utilizing the existing transmission system facilities.