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Load Flow Analysis Using Facts Device

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***Abstract*: -- Electrical power systems is a large interconnected network that requires a careful design to maintain the system with continuous power flow operation without any limitations and for the steady state operation of the power system. To achieve this requirement, new technology such as FACTS device is used in load flow analysis. Flexible Alternating Current Transmission System (FACTS) is an application of a power electronics device to control the power flow and to improve the system stability of a power system. STATCOM is a versatile device in the FACTS family of controllers which has the ability to simultaneously control all the transmission parameters of power systems i.e. voltage, impedance, and phase angle which determines the power flow of a transmission line. This said research work is mainly focused on implementation of the steady-state model of STATCOM in Newton Raphson method. The Standard IEEE bus system will be used to verify the effectiveness and performance of the model. The simulations are carried out on standard IEEE bus test system like 30 bus system under the MATLAB environment.**

***Keywords*— Load Flow Analysis, FACTS, STATCOM, NRLF.**

I. INTRODUCTION

The power flow problem is formulated as a set of nonlinear equations. Many calculation methods have been proposed to solve this problem. Among them, Newton-Raphson power-flow technique adopted for industry applications. Newton-Raphson method is faster than any other power-flow method due to its quadratic rate of convergence. To meet the load demand in a power system and for satisfying the stability and reliability criteria, either the existing transmission lines must be utilized more efficiently or new transmission lines should be added to the system. Therefore, power electronics based controllers based on FACTS technology are used to optimize the power flow on existing lines. These are known as FACTS Controllers. Among all controllers, STATCOM are the ones that are currently installed in maximum numbers by the utilities. For maximum utilization of STATCOM in power system planning, operation and control, the power flow solution of the network containing them is a fundamental requirement. The STATCOM is represented as a voltage source for the full range of operation. Incorporating STATCOM into an existing Newton-Raphson load flow (NRLF) algorithm helps to decide whether the system performance is improving or not. In this paper, a case study will be carried out on standard IEEE 30 bus system. The power flow equations derived for the network solved using the Newton-Raphson (NR) method and the simulation is carried out in MATLAB.

II. LITERATURE REVIEW

LOAD-FLOW analysis has a central role in transmission and distribution systems planning, design, operation and control including security assessment. In many applications, particularly online ones, computing time required is a critical issue.[1]. H.Saadat suggest the basic concept of load flow analysis.[2] A faster solution is obtained using the Newton-Raphson method and is suitable for large-scale problems. In this approach, the partial derivatives are used to construct the Jacobian matrix solution. The Newton-Raphson solution approach is much faster than the other approaches.[3]
Recent development of power electronics has introduced the use of Flexible Alternating Current Transmission Systems (FACTS) devices in electric power systems, FACTS devices are capable of controlling the network conditions in a very fast manner and are recognized as viable solution for controlling transmission voltage, power flow. [4]. The STATCOM is the one of most powerful Facts device, introduced by K.R.Padiyar [5].The concept of FACTS very well discuss in references[6]. The static compensator (STATCOM) is one of the most prominent members in the family of flexible AC transmission system (FACTS) devices, which is connected in shunt to the transmission grid. Its main function is to provide voltage support to the transmission/distribution grid through controlled reactive power injection. However, apart from the voltage support, it is also used to provide damping to the transmission grid for enhancing the stability of the system [7]. Y. Zhang, B. Wu and J. Zhou, provides detail description related Newton Raphson power flow algorithm [8]. Enrique Acha presents an approach for FACTS Modelling [9]. References [10,11,12] discuss about the concept of STATCOM

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modeling. The output voltage of a STATCOM is controlled such that it provides the requisite amount of reactive power compensation to any system bus to which it is connected [13]. Suman Bhowmick, Biswarup Das and Narendra kumar, present an approach for STATCOM model for power flow analysis as well power flow equations in proposed STATCOM model [14]. The performance of 30 bus system with and without STATCOM discuss in reference [15]. References [16,17] discuss about the concept of power flow model, controllers etc. An effective placement strategy of STATCOM very well discuss in reference[18].

III. IEEE 30 BUS SYSTEM

It is proposed to consider IEEE 30 bus system to perform Newton raphson load flow analysis Single line diagram for IEEE 30 bus system is shown in figure(1). First of all Normal Newton raphson load flow (NRLF) operation will be perform. From this different result for load flow analysis will be obtained like bus voltages, phase angle, active and reactive power etc. Next step is to identify weak bus from the overall 30 buses. It can be identify from the results of bus voltages which will obtained from NRLF.

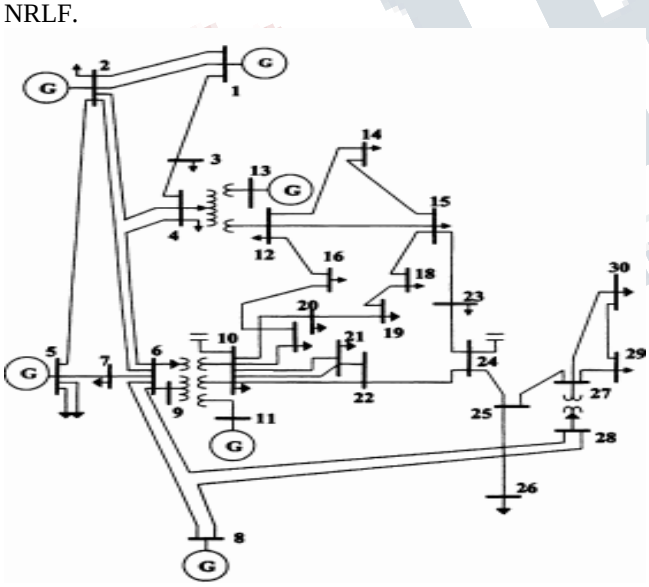

Figure 3: Single line diagram of IEEE 30 bus system

IV. EQUIVALENT CIRCUIT OF STATCOM

After performing load flow analysis, the optimal location of STATCOM will be decided. STATCOM is considered to control the voltage of a bus by shunt reactive power compensation. A STATCOM mainly consists of a coupling transformer, inverter and a DC capacitor. Figure (2) shows a STATCOM connected to any bus 'i' of an existing power system network through a coupling transformer.

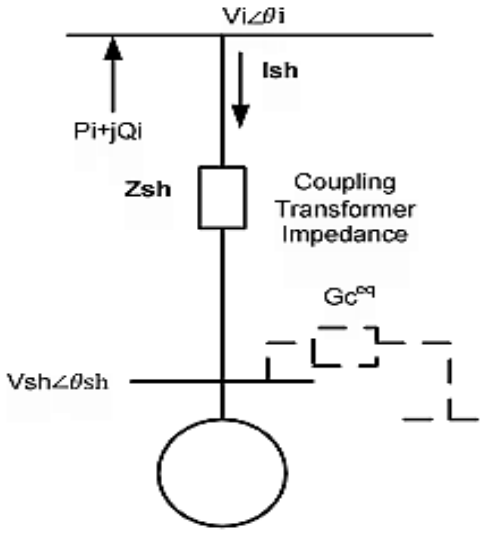

Figure 2: Equivalent circuit diagram of STATCOM

V. CONCLUSION

FACTS is the technology of power electronics device which provides ability to increase controllability and transmission system operation in terms of power flow,control etc. STATCOM are incorporated in a bus system which helps for improving the power flow, system stability, reliability with existing power system. And the number of iterations require to perform Newton raphson load flow analysis are less than Gauss Siedal method.

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