LOAD FLOW ANALYSIS FOR A 220KV LINE – CASE STUDY

Sadanand A. Salgar
Department of Electrical Engineering
Fabtech College of Engineering and Research,
Sangola, INDIA

Prof. CH. Mallareddy
Department of Electrical Engineering
Fabtech College of Engineering and Research,
Sangola, INDIA

ABSTRACT

In power engineering the power flow analysis (also known as load flow study) is an important tool involving numerical analysis applied to a power system. This project deals with a model of existing power system using the actual data taking care of all parameters required for the simulation and analysis. With the help of Maharashtra State Electricity Transmission co. Ltd., a model of 220KV lines, of Solapur District grid using MATLAB software will be modeled. In this project, an algorithm will be used for power flow study and data collection and coding required for modeling. Load flow studies will be carried out using Newton Raphson method and voltage profile of buses will be analyzed. New method for the improvement of voltage profile will be suggested and analyze using the developed model. The optimization techniques include power factor compensation, tap changing, up gradation of substation, up gradation of line and load shifting will be analyzed. Importance of power flow or Load flow studies is in planning future expansion of power system as well as determining the best operation of existing systems. From results of simulation buses with low voltage profile will be identified and possible solutions can be suggested.

KEYWORDS— Power flow analysis, active and reactive power flow, tie line flow, voltage variations

INTRODUCTION

Power flow analysis is the backbone of power system analysis and design[1]. They are necessary for planning, operation, economics scheduling and exchange of power between utilize. Power flow analysis is required for many other analyses such as transient stability, optimal power flow and contingency studies. The principal information of power flow analysis is to find the magnitude and phase angle of voltage at each bus and the real and reactive power flowing in each transmission lines. Power flow analysis is an importance to involving numerical analysis applied to a power system. In this analysis iterative technique can be used due to there no known analytical method to solve the problem. This resulted nonlinear set of questions or called power flow equations are generate. To finish this analysis there is methods of mathematical calculations which consist plenty of step depends on the size of system. This process is difficult and takes much time to perform by hand. By develop a toolbox for power flow analysis surely will help the analysis become easier. High speed, low storage, and reliability for ill-conditioned problem are the characteristics requirements of superior power flow method. For regular power flow studies, newton raphson method is versatile, reliable and accurate to commonly use[2]. Newton Raphson method based power flow simulations are performed for different operations schemes of a big industrial petrochemical complex and finally best operation configuration of the system is indicate[4].

A comparison of load flow analysis using DistFlow, Gauss-Seidel, and optimal load flow algorithms:

The state of a power system and the methods of calculating this state are extremely important in evaluating the operation of the power system, the control of this system, and the determination of future expansion for the power system. The state of the power system is determined through load flow analysis that calculates the power flowing in the lines of the system. There are several different methods to determine the load flow of a given system. For the purposes of this paper, only three methods of load flow algorithms are evaluated: Gauss-Seidel, optimal load flow, and the DistFlow method[5]

Load Flow Analysis with Voltage-Sensitive Loads

This paper conducts load-flow analysis of a five-bus test system containing voltage sensitive loads. Generalized equations that are suitable for the voltage sensitive loads and applicable to the Newton-Raphson method are developed. Three load flow studies are carried out. In the first study, all loads are assumed as constant power loads. In the other two studies, all loads are assumed as constant current or constant impedance loads respectively [7].

Load flow analysis of 132 / 11 kV distribution substation using static var compensator for voltage enhancement — A case study

In a power system, load varies from one hour to another; reactive power varies accordingly which results into unacceptable voltage variation. This affects the performance of load and other parameters like power loss and power factor. This paper deals with Simulation of 132/11 kV Distribution Sub Station using SVC for voltage enhancement. Load Flow is carried out, considering balanced system during peak load condition, with the voltage enhancement is the main objective. Other objectives of the paper are the reduction in power loss and improvement in power factor[8]. Simulation is developed in Electrical Transient Analyzer Program (ETAP) environment and recorded parameters are compared with Simulation results[9].

MATPOWER: Steady-State Operations, Planning, and Analysis Tools for Power Systems Research and Education

MATPOWER is an open-source Matlab-based power system simulation package that provides a high-level set of power flow, optimal power flow (OPF)[11], and other tools targeted toward researchers, educators, and students. The OPF architecture is designed to be extensible, making it easy to add user-defined variables, costs, and constraints to the standard OPF problem. This paper presents the details of the network modeling and problem formulations used by MATPOWER, including its extensible OPF architecture. This structure is used internally to implement several extensions to the standard OPF problem, including piece-wise linear cost functions, dispatch able loads, generator capability curves, and branch angle difference limits. Simulation results are presented for a number of test cases comparing the performance of several available OPF solvers and demonstrating MATPOWER's ability to solve large-scale AC and DC OPF problems. MATPOWER is an open-source Matlab-based power system simulation package that provides a high-level set of power flow, optimal power flow (OPF), and other tools targeted toward researchers, educators, and students. The OPF architecture is designed to be extensible, making it easy to add user-defined variables, costs, and constraints to the standard OPF problem. This paper presents the details of the network modeling and problem formulations used by MATPOWER, including its extensible OPF architecture. This structure is used internally to implement several extensions to the standard OPF problem, including piece-wise linear cost functions, dispatch able loads, generator capability curves, and branch angle difference limits. Simulation results are presented for a number of test cases comparing the performance of several available OPF solvers and demonstrating MATPOWER's ability to solve large-scale AC and DC OPF problems [10].

Distributed Fast Decoupled Load Flow Analysis

This paper presents an implementable distributed load flow calculation method for online analysis, for power systems having multiple, geographically separated areas. The system is partitioned into multiple areas, with each area having its own control centre. Adjacent areas share a tie-line and the power flowing in these tie-lines are expected to be known to the control centers concerned before the analysis is started. Since each area may be governed by different companies, it is justified to expect that the power that is traded through a tie-line would be known to the control centers sharing the line. The proposed method uses the fast decoupled load flow approach and it suitably adds elements to the B' and B" matrix to find out the state variables of the boundary buses. Results on the IEEE 14 and 30 bus systems show that the distributed analysis converges as fast as the centralized ones[11].

Modified Newton-Raphson load flow analysis for integrated AC/DC power systems

The significant increase in planned offshore wind parks and the tendency towards large parks in considerable distances offshore, make the well-established HVDC technology a favorable solution for the connection of these large & distant offshore wind parks to the main power grid onshore. It is therefore necessary to adequately model the HVDC transmission links and integrate them in the load flow analysis of the complete AC-DC system. In this paper, the well-known Newton-Raphson method for the load flow analysis is modified to achieve compatibility for AC-DC systems with integrated DC links in the AC network. The elements of the residual vector and the Jacobian matrix for the AC network are kept unchanged and are merely complemented by a new vector and a new matrix, which represent the modifications due to the DC link. The modified Jacobian equation includes the DC real and reactive power at the AC-DC buses, and their dependency on the AC system variables. The modified Newton-Raphson method is evaluated on an AC-DC test system with a load flow computation in Matlab and the results are presented [12].

Distribution system power flow analysis-a rigid approach

This approach is oriented toward applications in three phase distribution system operational analysis rather than planning analysis. The solution method is the optimally ordered triangular factorization Y_{BUS} method (implicit Z_{BUS} Gauss method) which not only takes advantage of the scarcity of system equations but also has very good convergence characteristics on distribution problems. Detailed component models are needed for all system components in the simulation. Utilizing the phase frame representation for all network elements, a program called Generalized Distribution Analysis Systems, with a number of features and capabilities not found in existing packages, has been developed for large-scale distribution system simulations. The system being analyzed can be balanced or unbalanced and can be a radial, network, or mixed-type distribution system. Furthermore, because the individual phase representation is employed for system and component models, the system can comprise single, double, and three-phase systems simultaneously

Complex-Variable Newton-Raphson Load-Flow Analysis with FACTS Devices

Based on complex voltage variables, the paper develops a Newton-Raphson (NR) load-flow analysis formulation which includes FACTS devices. Detailed analysis of the formulation confirms that significant reduction in memory access is achieved by the complex-variable NR formulation in comparison with the traditional formulation based on the real form. The significant reduction in memory access achieved will lead to the advantage of substantial reduction in computing time when load-flow analysis is implemented in parallel-computing environment. This advantage is also applicable in the case of single-processor computing environment, depending on memory cycle time. The formulation removes the approximation used in the previously-published NR load-flow analysis in complex form. The new method preserves fully the powerful convergence property of the NR algorithm. In addition, complex-variables offer a flexible and direct approach for modeling FACTS devices. The formulation is tested by simulation with representative power systems, including that with FACTS devices

Load Flow Analysis Framework for Active Distribution Networks Based on Smart Meter Reading System

With the expansion of distributed generation systems and demand response programs, the need to fully utilize distribution system capacity has increased. In addition, the potential bidirectional flow of power on distribution networks demands voltage visibility and control at all voltage levels. Distribution system state estimations, however, have traditionally been less prioritized due to the lack of enough measurement points while being the major role player in knowing the real-time system states of active distribution networks. The advent of smart meters at LV loads, on the other hand, is giving relief to this shortcoming. This study explores the potential of bottom up load flow analysis based on customer level Automatic Meter Reading (AMRs) to compute short time forecasts of demands and distribution network system states. A state estimation framework, which makes use of available AMR data, is proposed and discussed.

Numerical methods for on-line power system load flow analysis

Newton-Raphson method is the most widely accepted load flow solution algorithm. However LU factorization remains a computationally challenging task to meet the real-time needs of the power system. This paper proposes the application of very fast multifrontal direct linear solvers for solving the linear system sub-problem of power system real-time load flow analysis by utilizing the state-of-the-art algorithms for ordering and preprocessing. Additionally the unsymmetrical multifrontal method for LU factorization and highly optimized Intel® Math Kernel Library BLAS has been used. Two state-of-the-art multifrontal algorithms for unsymmetrical matrices namely UMFPACK V5.2.0 and sequential MUMPS 4.8.3 ("Multifrontal Massively Parallel Solver") are customized for the AC power system Newton-Raphson based load flow analysis. The multifrontal solvers are compared against the state-of-the-art sparse Gaussian Elimination based HSL sparse solver MA48. This study evaluates the performance of above multifrontal solvers in terms of number of factors, computational time, number of floating-point operations and memory, in the context of load flow solution on nine systems including very large real power systems. The results of the performance evaluation are reported. The proposed method achieves significant reduction in computational time.

A Fast Continuation Load Flow Analysis for an Interconnected Power System

The paper provides an algorithm for a fast continuation load flow to determining critical load for a bus with respect to its voltage collapse limit of an inter connected multi-bus power system using the criteria of singularity of load flow Jacobian matrix. For this purpose, load flow Jacobian matrix of an interconnected multi-bus power system is transformed into a two by two elements Jacobian matrix with respect to a target/selected bus by incorporating the effect of all the other buses of the system on the target bus. The validity of the proposed method has been investigated for the IEEE 30 and IEEE 118 bus system [12].

Load Flow Analysis: An Overview

The load flow study in a power system constitutes a study of paramount importance. The study reveals the electrical performance and power flows (real and reactive) for specified condition when the system is operating under steady state. This paper gives an overview of different techniques used for load flow study under different specified conditions.

A Simple and Reliable Algorithm for Computing Boundaries of Power Flow Solutions due to System Uncertainties

Power flow studies are typically used to determine the steady state or operating conditions of power systems for specified sets of load and generation values, and is one of the most intensely used tools in power engineering. When the input conditions are uncertain, numerous scenarios need to be analyzed to cover the required range of uncertainty, and hence reliable solution algorithms that incorporate the effect of data uncertainty into the power flow analysis are needed. To address this problem, this paper proposes a new solution methodology based on the use of optimization techniques and worst-case scenario analysis. The application of these techniques to the power flow problem with uncertainties is explained in detail, and several numerical results are presented and discussed, demonstrating the effectiveness of the proposed methodology [13].

Load Flow Analysis on IEEE 30 bus System-

Power flow analysis is the backbone of power system analysis and design. They are necessary for planning, operation, economic scheduling and exchange of power between utilities. The principal information of power flow analysis is to find the Magnitude and phase angle of voltage at each bus and the real and reactive power flowing in each transmission lines. Power flow analysis is an importance tool involving numerical analysis applied to a power system. In this analysis [14], iterative techniques are used due to there no known analytical method to solve the problem. To finish this analysis there are methods of mathematical calculations which consist plenty of step depend on the size of system. This process is difficult and takes a lot of times to perform by hand. The objective of this project is to develop a toolbox for power flow analysis that will help the analysis become easier. Power flow analysis software package develops by the author use MATLAB programming the economic load dispatch plays an important role in the operation of power system, and several models by using different techniques have been used to solve these problems [15]. Several traditional approaches, like lambda iteration and gradient method are utilized to find out the optimal solution of nonlinear problem. More recently, the soft computing techniques have received more attention and were used in a number of successful and practical applications [16].

Novel Load Flow Algorithm for Multi-Phase Balanced/ Unbalanced Radial Distribution Systems :

In this work, distribution system load flow analysis is formulated and tested for fundamental steady-state and harmonics power flow. For the steady-state analysis, a novel power flow formulation method for the general multiphase balanced and/or unbalanced radial distribution systems is presented. The special topology of the power distribution system has been fully exploited to facilitate obtaining a direct solution using the graph theory. Only one developed matrix used in conjunction with simple standard formulation is enough to obtain the power flow solution[17]. This matrix is the branch-path incident matrix. A feature of using this method is that it significantly reduces the number of power flow equations, as compared to conventional methods, hence very low computation time and memory storage[18]. The presence of nonlinear loads in the power system causes the circulation of harmonics currents in the system, leading to harmonics voltage drops. The harmonics flow analysis in this paper, uses the
network techniques in conjunction with graph theory resulting in a powerful algorithm for nonlinear load flow analysis. Six pulse converters model were used to represent the nonlinear load. Two MATLAB programs have been built and used to solve for the load flow solution of standard test systems in both steady-state and harmonics cases. The results of the distribution system cases studies are presented and shows a very good resemblance with a standard results[20].

POWER FLOW ANALYSIS OF A CONTINUOUS PROCESS PLANT: (A CASE STUDY):

For the continuous evaluation of the performance of the power system, power flow solutions are essential for exhibiting suitable control actions in case of requirement. This case study presents analysis of the electrical power system of continuous process plant having its own captive generation along with the provision of the Grid connectivity. The different power system elements are modeled as per the manufacturer's data sheet. To evaluate the steady state performance, power flow simulations and analysis of the complex power system for various invasive operating conditions are carried out[21].

Voltage stability assessment using continuation power flow:

This Paper presents voltage stability assessment through P-V curve and bus voltage sensitivity factor. It addresses a measure of how close the system is to voltage instability? Active power margin is used to measure the distance to instability. Continuation power flow is used to obtain P-V curve of power system. Continuation power flow starting with initial operating point and increasing load to the maximum loading point. Voltage stability index and weakest bus is found from the result. A power system analysis tool is used to run continuation power flow[22].

Coordinated power flow control by multiple FACTS devices:

This work describes a development of a control system and control strategies capable of governing multiple flexible AC transmission system (FACTS) devices[23]. The main purposes of the presented coordinated control system are to remove overloads and to achieve specified power flows in transmission lines of a power system in the normal and N-1 steady-state operational modes. Proposed control strategies are based on heuristic rules; therefore they do not require intensive computations. A prototype of a control system has been designed as a real time tool constantly monitoring power flows and generating appropriate control signals to each FACTS device in order to maintain acceptable power flow levels. It has been interfaced with load flow software to test its effectiveness through non-linear simulations using the 380/220 kV Swiss power system as the study case. The results obtained are presented[24].

Calculation of transmission losses from a planning viewpoint

An analytical technique based on statistical methods is developed to evaluate the expected difference in the transmission losses, in a defined study area, between two overall systems that use two different 500 kV line configurations that are technically and environmentally acceptable. A study area is carefully chosen so that essentially all the difference in IR loss between any two alternatives occurs in that study area[25]. The annual load duration curve of the entire system is used to define the annual generation schedule pattern of the study area. AC load flows are performed on a reduced system that has all of the study area represented. Using power conservation equation and Maclaurin series, the interface flow is eliminated from the study area loss function. The load-duration curve, which is a reliability function, is expressed as a continuous function of the study area load demand. This function is used to derive the probability density function of the study area load demand. The annual expected value of the difference in the study area losses between two alternatives is evaluated using the above probability density function and the derived loss function. Calculated values show very good agreement with those obtained with load flow studies[27].

Convergence regions of Newton method in power flow studies: Numerical studies

Power flow study is a fundamental task of power system operation and planning. Of the several methods developed in commercial package for power flow study, the Newton-Raphson method is the most successful one. It is however well recognized that the NR method may diverge in power flow study[28]. In this paper, we numerically study the convergence regions of power flow solutions using Newton-Raphson(NR) method. This study of convergence region is motivated by the need to determine an initial guess which converges to one of the power flow solution. It will be numerically shown that the convergence region of NR method, if exist, has a fractal boundary and is hence sensitive to initial conditions. Several fractal features will be investigated considering the convergence regions of power flow at the base case and at various loading conditions, and with different load models. An IEEE 14-bus system will be used to illustrate the fractal boundary via numerical results[29].

Inclusion of slack bus in Newton Raphson load flow study

Load flow solution is an inevitable tool for power system planning and operation. Among various methods of load flow solution techniques Newton Raphson (N-R) and its derivatives are the most popular and widely used ones. In Newton Raphson method one of the generator buses is treated as slack bus which is kept out of calculation during iterations. This is because of the fact that the slack bus is to carry entire loss of the system and total loss cannot be calculated before the end of iterations[29]. The exclusion of slack bus from the load flow iteration restricts many analyses to make. Consideration of distributed slack bus, load flow for Micro grids, study on minimization of system losses etc. cannot be performed when the slack bus is excluded from the iterations. This paper reports the development of a method of including slack bus into the Jacobians for N-R load flow study. The method involves formulating the loss equation and then devising the formula for the terms to be included with the elements of the Jacobian matrix. The modified N-R method is applied to all of the buses and the losses are calculated in each iteration and included with the slack bus[30]. The results obtained using the modified method is compared with those using conventional method. The agreement of the results confirms the accuracy of the developments.

Newton-Raphson method in complex form [power system load flow analysis]

A new algorithm that may be used for the solution of three-phase (or unsymmetrical) power flow analyses of both power transmission or distribution systems under unsymmetrical operating conditions and power quality problems, is presented. This technique is both new and robust, and is developed on the basis of the extension of the Newton-Raphson method and its Jacobian in a complex form, that gives the solutions in a whole phasor format. A comparative example is presented to illustrate the convergence characteristics of the proposed numerical method[32].

Load Flow Analysis with Voltage-Sensitive Loads

This paper conducts load-flow analysis of a five-bus test system containing voltage sensitive loads. Generalized equations that are suitable for the voltage sensitive loads and applicable to the Newton-Raphson method are developed[33]. Three load flow studies are carried out. In the first study, all loads are assumed as constant power loads. In the other two studies, all loads are assumed as constant current or constant impedance loads respectively[34].

AI technique for load flow planning and contingency analysis

An outline is presented of the development process of the intelligent load flow engine. Building the engine proceeds from simple to hard tasks by incrementally improving the organization and the representation of the knowledge base. Interface programs are designed to provide the communication from the engine to a load flow and contingency analysis program[37].

Load flow analyzes of power system of PETKİM Petrochemical Aliaga complex

This study presents load flow simulations of a big petrochemical plant having both external and internal supplying facilities. First its power system is modeled and modeling accuracy is verified by comparison the simulation results with the actual measurements for two different loading conditions[38]. Then, load flow simulations are performed for four different operation schemes and the results are compared with each other from several points of view. Finally, best operation configuration and expansion possibilities of the system are discussed[39].

CONCLUSION:

Load flow studies are important for planning future expansion of power system as well as determining the best operation of existing system. The principal information obtained from the power flow study is the magnitude and phase angle of the voltage at each bus and the rael and reactive power flowing in each line. Load flow analysis will be conducted on 220KV & 132KV Lines in the Maharashtra State Electricity Transmission Company Ltd., Solapur District Power system Network using MATLAB. Overloaded bus will be identified and suitable measures for reducing the overloading can be suggested. Up gradation of substation, tap changing of transformer, Static capacitor banks for reactive power compensation, Capacitor bank shifting techniques, replacing single circuit’s lines by double circuit’s lines are found to be effective in improving the voltage.

REFERENCES

[1] Stott, B., "*Review of load-flow calculation methods", Proceedings of the IEEE, 62,* 1974.

[2] Ray. D Zimmerman and Hsiao-Dong. H, "Fast decoupled power flow for unbalanced radial distribution systems," IEEE-PES Winter Meeting,paper no. 95, New York, 1995

[3] Stagg, G. W. and A. H. EL-Abiad, *Computer methods in power system analysis, McGrow-Hill Book Co.1968.*

[4]A. Oudalov, R. Cherkaoui, A.J. Germond, "*Application of fuzzy logic techniques for the coordinated power flow control by multiple series FACTS devices", Proceedings of the 22nd IEEE Power Engineering Society International Power Industry Computer Applications Conference (PICA'01), Sydney, Australia, pp. 74-80*

[5] J. M. Vanderleck "*Instrumentation for Power Loss and Meteorological measurements at Ontario hydro\'s Cold water Project", AIEE Transactions on Power Apparatus and Systems, pp.388 -396 1961*

[6] L. K. Kirchmayer *Economic Operation of Power Systems, pp.48 -110 1958 :John Wiley & Sons*

[7] J. D. Kalbfleish and R. L. Prentice *The Statistical Analysis of Failure Time Data, pp.5 -9 1980 :John Wiley & Sons*

[8] P. L. Meyer *Introductory Probability and Statistical Applications, pp.62 -76 1965 :Mass: Addison Wesley*

[9] T. Halpin *"Analysis of Automatic Contingency Selection Algorithms", IEEE Trans. on Power Apparatus and Systems, vol. PAS-103, no. 5, pp.938 -945 1984*

[10] Matthew Varghese; James S. Thorp; Hsiao-Dong Chiang. *"Fractally deformed basin boundaries of pendulum systems: New approaches in the study of swing dynamics ". Proceedings of the 26th IEEE Conference on Decision and Control, 1987.*

[11] Thorp, J.S.; Varghese, *M."Truncated fractal basin boundaries in three machine power systems ". ISCAS, 1988.*

[12] Varghese, N.; Thorp, J.S. "*An analysis of truncated fractal growths in the stability boundaries of three-node swing equations ". IEEE Transactions on Circuits and Systems, 1988.*

[13] D. Shirmohammadi, H. W. Hong, A. Semlyen, and G. X. Luo, "*A Compensation-based power flow Method for weakly Meshed Distribution and Transmission Networks", IEEE Transactions on Power System, Vol. 3, No. 2, May 1988, pp. 753-762.*

[14] Tamby, J. P. and John, V. I, "*Q' Harm-A Harmonic Power Flow Program for Small Power Systems", IEEE Transaction on power systems, Vol. 3, No. 3, August 1988.*

[15] Thorp, J.S.; Naqavi, S.A. "*Load flow fractals". Proceedings of the 28th IEEE Conference on Decision and Control, 1989.*

[16] HEYDT, G.T, "*The Present Status of Harmonic Power Flow Studies", Electric Energy Conversion in Power System-CAPRI, May, 1989.*

[17] Thorp, J.S.; Naqavi, S.A.; Chiang, H.-D. "*More load flow fractals". Proceedings of the 29th IEEE Conference on Decision and Control, 1990*.

[18] N.H. Hingorany, "*Flexible AC Transmission System", IEEE Spectrum, April 1993, pp.40-*

[19] M. Noroozian, G. Anderson, "*Power Flow Control by Use of Controllable Series Components", IEEE Trans. Power Delivery, Vol.8, No.3, pp.1420-1429, July 1993*

[20] M. Iravani, "*Application of Static Phase Shifters in Power Systems", IEEE Trans. Power Delivery, Vol.9, No.3, pp.1600-1608, July 1994*

[21] IEEE Special Stability Controls Working Group, "*Static VAR Compensator Models for Power Flow and Dynamic Performance Simulation" IEEE Trans. Power Systems, Vol.9, No.1, pp.229-240, February 1994*

[22] J. Paserba, N. Miller, E. Larsen, R. Piwko, 1994, "*A TCSC Model for Power System Stability Analysis" IEEE Transactions on Power Delivery, Vol.10, No.3, July 1995, p.1471-1478*

[23] J.A. Momoh, X.W. Ma, K. Tomsovic, "*Overview and literature survey of fuzzy set theory in power systems", IEEE Trans. Power Systems, vol. 10, no. 3, August 1995, pp.1676-1690*

[24] L. Gyugyi, CD. Schauder, S.L. Williams, T.R. Reitman, DR. Torgenson, A. Edris, "*The Unified Power Flow Controller: A New Approach to Power Transmission Control", IEEE Trans. Power Delivery, Vol.10, No.2, pp.1085-1097, April 1995*

[25] *IEEE Task Force on Harmonics Modeling and Simulation, "Modelling and Simulation of the Propagation of Harmonics in Electric Power Networks. Part II: Sample systems and examples", IEEE Transaction on power delivery, Vol. 11, No. 1, January 1996.*

[26] Thorp, J.S.; Naqavi, S.A. "*Load-flow fractals draw clues to erratic behaviour ". IEEE Computer Applications in Power, 1997.*

[27] IEEE 399-1997, "*IEEE Recommended Practice for Industrial and Commercial Power Systems Analysis", The Institute of Electrical and Electronics Engineers, Inc., 1998.*

[28]] A. Oudalov, R. Cherkaoui, A.J. Germond, "*Coordinated control of multiple series FACTS devices", Proceedings of the 1999 Power System Automation and Control Conference (PSAC'99), Bled, Slovenia, ISBN 961-6210-68-8, pp. 71-77;*

[29] S. K. Goswami and S. K. Basu, "*Direct solution of distribution systems," IEE Proc., pt. C, vol. 188, no. 1, pp. 78-88, 1999.*

[30] D. Thukaram, H. M. Wijekoon Banda, and J. Jerome, "*A Robust three phase power flow algorithm for radial distribution systems," Electric Power System Research, vol. 50, no. 3, pp. 227-236, Jun. 1999.*

[31] W. M. Lin, Y. S. Su, H. C. Chin, and J. H. Teng, "*Three-Phase unbalanced distribution power flow solutions with minimum data preparation,"IEEE Trans. on Power Systems, vol. 14, no. 3, pp. 1178-1183, Aug. 1999.*

[32] *AN ARES 2000 Simulator, Users Manua*l, ESI, Irkutsk, Russia, anares@isem.sei.irk.ru, 2000.

[33] P. A. N. Garcia, J. L. R. Pereira, S. Carnerio, V. M. da Costa, and N. Martins, "*Three-Phase power flow calculations using the current injection method," IEEE Trans. on Power Systems ,vol. 15, no. 2, pp. 508-514, May 2000.*

[34] W. M. Lin and J. H. Teng, "*Three-Phase distribution networks fast decoupled power flow solutions," Electric Power and Energy Systems, vol.22, no. 5, pp. 375-380, Jun. 2000.*

[35] P. Aravindhababu, "*A new fast decoupled power flow method fordistribution systems," Electric Power Components and Systems ,vol. 31, no. 9,pp. 869-878, Sept. 2003.*

[36] K. Ramalingam and C. S. Indulkar, "*Transmission Line Performance With Voltage Sensitive Loads," Int. J Elect. Eng. Educ., vol. 41, pp.64-70, Jan. 2004. Energy Systems, vol. 17, no. 5, pp. 335-346, Oct. 1995.*

[37] P. Kundur, "*Power System Stability and Control", Tata McGraw-Hill Publishers, 2008.*

[38]Serrican A., Ozdemir A., Ihan s., "*Load flow analyzes of power system of PETKİM Petrochemical Aliaga complex, EUROCON 2009, IEEE, Conference Publications, May 2009 , Page(s): 470 – 474*

[39] D P Kothari and I J Nagrath., "*Modern Power System Analysis", Third Edition, Chapter No.6, Tata McGraw-Hill Publishers, 2010*