

## LOAD FLOW ANALYSIS AND OPTIMAL ALLOCATION OF DISTRIBUTED GENERATION USING PSAT: A REVIEW

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**ABSTRACT:** Load-flow studies are very important aspect intended for planning future expansion of power systems as well as in determining the superlative operation of existing systems. With the help of load-flow study, one can attain the complete voltage angle and magnitude information's about each bus in a power system for identified load, real power and voltage conditions. But due to the increased demand of power other problems associated with load flow also arises such as voltage instability and overloading. So, there should be an optimal way to solve these problems and meet the requirement of Continuation Power Flow regarding improvement of voltage profile and reduction in power losses. This paper describes the optimal use of Distribution Generation for solving the load flow problems which improves voltage magnitude profile and reduces total losses in the line. This proposed approach will be tested on an IEEE 14 Bus test system using MATLAB Toolbox i.e. PSAT.

**KEYWORDS:** Load Flow Analysis, Distribution Generation, CPF, PSAT.

### I. INTRODUCTION

At present time, more than thousands of generating station and load centres is being interconnected through transmission lines to make power system a vast network. So, due to this very reason, the study or analysis of load flow is being required. A Load flow study is an analysis whose aim is to determine the magnitude and phase angles of current and voltage, reactive and real power flow in the transmission line under a normal condition in

an active power system. The aim of this load flow study is to finding out whole voltages magnitude and phase angle information for every bus for a particular load and also voltages criteria and generator power in a power system. Once this data is collected then generator reactive power output as well as power flowing in every branch can easily be determined.

Major tool (practically) is the voltage profile given by load flow. This tool will help to avoid big problems about power loss or failure also problem related to transmission of real and reactive power. With a load flow study reliability of load flow is maintained. Major importance of this study is to plan for future aspects and also find the best operation of present system. The data gathered from this power study is a vector quantity of voltage (phase angle and magnitude) at every buses and power flow in transmitting lines.

Due to the increased demand of power other problems associated with load flow also arises such as voltage instability and overloading. So, there should be an optimal way to solve these problems and meet the requirement of Continuation Power Flow regarding improvement of voltage profile and reduction in power losses.

Load flow analysis are undertaken in the power system for different reasons, some are as follows:

1. The current flows in line.

2. The transport voltages and system voltage profile
3. Influence of variation in arranging and integrating new circuits on system.
4. Loss of transmission capacity and generation on system loading has temporary effect.
5. Operation on Economic system.
6. Minimization of System losses and so on.

Many efficient load flow methods have been presented and practiced for a long time in the power system for solving the load flow problems. The well-known methods that are used are Newton-Raphson Method, Fast Decoupled Method, and Gauss-Seidel Method and so on. Among all these methods, Newton-Raphson Method is the most popular method used for load flow study. This method starts by guessing all variables (voltages magnitude and voltages angles) as unknown. Now, ignore the higher order terms and write a 'Taylor Series' for each or every power equations and gives the final result in linear equation. Until stopping condition met, linear equations are solved to determine the next guess ( $m + 1$ ) of voltage magnitude and voltage angles and, the process continues.

Basically, the use of Newton-Raphson method in the load flow problems is carried out because this is the best suited method for finding the critical bus voltage. For the optimal operation of the power system, improvement in the voltage magnitude profile and reduction in the power losses are very essential. There are so many solvers available in the system for solving the problem associated with the load flows such as FACTS devices, Synchronous generators, Distribution Generation and so on. Among all these methods, Distribution Generation is opted from the point of view of the optimal operation of the load flow analysis.

Distributed generation (or DG) can be defined in many ways but in general it bring up as a moderate (typically 1 kW – 50 MW) electric

power generators which produces electricity next to a location which is nearby to the customers or we can say these are secured as an electric distribution system. Distributed generators comprises of: Synchronous generators, induction generators, reciprocating engines, micro turbines and so on. Distributed generator can be introduced into an electric power system for the improvement of the voltage magnitude profile and also reduces the total transmission losses in the power system. When the Distributed generators are connected to the power system grid, it affects the various profiles of the system such as the voltage regulation, sustained interruptions, harmonics, sags, swells, etc.

In this paper, we propose an optimal Distribution Generation based approach for improving the voltage profile and reducing power losses in the system with the help of MATLAB software i.e. Power System Analysis Toolbox (PSAT) which is an open source MATLAB toolbox used in this paper for the simulation and analysis of an IEEE 14 Bus test system for solving load flow problems. Now days, PSAT is one of the most preferable software among various other software's such as MatEMTP, Matpower, PAT, PST, SPS, VST etc because it gives direct response to the load flow problems regarding critical voltage profile on the software.

## II. POWER SYSTEM ANALYSIS TOOLBOX (PSAT)

Power System Analysis Toolbox (PSAT) project was first began by the Federico Milano in September, 2001. The first public version of this software was out in November, 2002 and after that it has been freely access by any user for its use. PSAT is MATLAB based software used in the electric power system simulation and analysis. The command line version of the PSAT is based on the GNU Octave. The main purpose of the development of the PSAT is that there is a requirement of software for power system education that should be user-friendly,

easy to use, and reliable and also allows users to draw single line diagrams, displaying results and plotting time domain graphs and simulations. PSAT leads as an improved version of the learning process for the students. Firstly, it appears as a user-friendly tool to the power system students as it is based on the MATLAB. Further, the user or student implement the MATLAB algorithms and programs over PSAT and also modify it by adding more features to it.

PSAT offers power flow, continuation power flow, optimal power flow, and small-signal stability analysis and time domain simulation tools. In its simulation, it basically uses Newton Raphson solver having trapezoidal rule as integration method over most critical bus voltage profile.

PSAT comprises of following characteristics of utilities as:

1. One - line framework diagram manager (Simulink library);
2. GUIs for settings framework and normal parameters;
3. Client defined model structure and foundation;
4. Graphical user interface for plotting comes about;
5. Channels for ever-changing over information to and from numerous game plans.

Now a day, PSAT is the mostly acceptable and used software among various software's such as MatEMTP, Matpower, PAT, PST, SPS, and VST etc. because it offers various features rather than the other software's like usual power flow (PF), continuation power flow and/or voltage security examination (CPF-VS), ideal power flow (OPF) , Small signal consistent quality examination (SSSA), time field re-enactment (TDS), graphical UI (GUI) and graphical system building (CAD).

This paper has presented PSAT used for the simulation of the load flow problems on an IEEE 14 Bus test system making use of the PV Generator or without using PV Generator for the graphical simulation over the critical bus. The results obtained from both the simulation are compared and the best results are chosen among them.

### III. DISTRIBUTED GENERATION

Distributed Generation (DG) as any kind of electrical generator or static inverter which generates alternating current and having following features such as: It has the competency for parallel operation with the utility distribution system. It has the capability to function individually from the utility system and also feed a load which can be fed by the utility electrical system. Sometimes it referred as a "generator".

Distributed generator can be introduced into an electric power system for the improvement of the voltage magnitude profile and also reduces the total transmission losses in the power system. When the Distributed generators are connected to the power system grid, it affects the various profiles of the system such as the voltage regulation, sustained interruptions, harmonics, sags, swells, etc. Along with the different features, DG comprises of an often function in which it make use of the surplus heat from the generation method as an further form of energy for space heating, process heating, dehumidification and also for cooling over absorption refrigeration.

There are so many reasons so that a customer possibly will elect to connect a distributed generator. Electricity supply is the main purpose of a power system and here we have a system called DG used to produce a consumer's intact electricity supply; for peak shaving; for reserve or backup generation. It can also be used as a green power source having use of renewable technology and last but not least it can use for increasing reliability and also

having less cost in some areas reducing the constructional cost of transmission and distribution lines.

In this paper, Distribution Generation plays an important role in improving the voltage magnitude profile and reducing the power losses in the system with the help of PV Generator. A PV Generator is a part of Distribution Generation which is connected over the most critical bus on an IEEE 14 Bus test system for improving the voltage magnitude profile and the results are simulated with the help of open source toolbox provided by the MATLAB i.e. PSAT. The simulation of the 14 bus system over critical bus is done with or without using the PV Generator and the obtained results are compared thereafter.

#### IV. CONCLUSION

This paper illustrated the optimal Distribution Generation based approach for the analysis of load flow problems by using Newton-Raphson Solver with the help of MATLAB based software i.e. Power System Analysis Toolbox (PSAT) which is an open source toolbox used for the simulation and analysis of an IEEE 14 Bus test system. A PV Generator is a part of Distribution Generation which is connected over the most critical bus on a 14 Bus test system for improving the voltage magnitude profile and reducing the total losses in the system. The simulation of the 14 bus system over critical bus is done with or without using the PV Generator and the obtained results are compared thereafter. So, basically what we get is? The simulated result that we got by using the PV Generator over the critical bus gives

better results in comparison of the results that we found without using it.

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