# Load Flow Analysis of 10-Bus Test System

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**Abstract:- The importance of power flow analysis can't be overstated. In the field of electrical power engineering, it is critical for both the utility and the consumer to understand a variety of electrical variables such as voltages and power flows inside power systems. This paper effectively applies Power World Simulator software to perform load flow analysis on a typical power system. The results may be applied to a much more complicated system with many loads and a range of power supply sources.**

***Keywords:-*** *Power Flow Analysis, Power Systems, Voltages, Power World Simulator.*

## I. INTRODUCTION

Power flow analysis is an essential part of power systems. Without it, a comprehensive description of power systems impossible.It may be used to monitor voltages, active and re active power flows at various points in the power system, in cluding bus bars.Furthermore, active, and reactive losses itra nsmission lines can be identified.In summary,we may assess the system's overall status to determine if it is in good worki ng order or not.Load flow studies and simulations maybe co nducted using wide range of commercial computer software. This paper has used Power World Simulator because of its c lear and appealing characteristics.From a theoretical standpo int, load flow calculations are often performed using several methods such as GaussSeidel, Newton Raphson, and the De coupled iteration approach. In this Paper, load flow calculations are performed utilizing the Newton-Raphson power flow iteration method, which is far more efficient and accurate than previous approaches. Furthermore, its calculation time is significantly lower and is completelyindependent of the size of the power network [1].

## II. LITERATURE REVIEW

Simulator can represent generators as having no cost model or as having a cubic cost model or a piecewise linear model.The cost model type you select influences the content of therest of this dialog.

➢ *Load Flow or Power Flow Analysis*

It is the computational technique (numerical algorithms) used to calculate the steadystate operational [2] characteristics of a power system network based on the line and bus data.

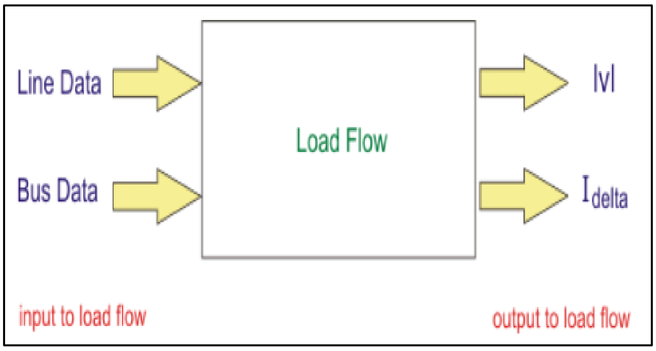


Fig 1 Load Flow or Power Flow Analysis

➢ *Things you Need to know about Load flow:*

- Load flow study involves analyzing the steady state of a power system network.
- Load flow studies determine the system's operational condition for specific loads.
- Load flow solves simultaneous nonlinear algebraic power equations for two unknown variables (|V| and ∠δ) at each node in a system.
- To solve non-linear algebraic equations, numerical techniques must be quick, efficient, and precise.
- Load flow analysis yields voltage, phase angle, real and reactive power, line losses, and slack bus power[3].

➢ *Load Flow Steps*

The research of load flow entails three steps:

- Modeling power system components andnetworks.
- Developing load flow equations.
- Solving load flow equations with numericalmethods.

➢ *Modeling of Power System Components*

- *Generator*

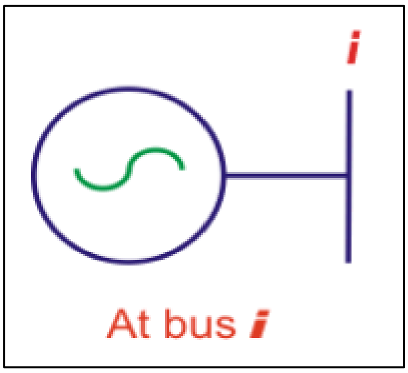


Fig 2 Generator

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$$S_{Gi} = P_{Gi} + jQ_{Gi} \ \ (total\ generation\ at\ bus\ i)$$

- *Load*

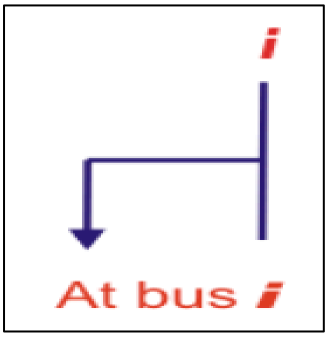


Fig 3 Load

$$S_{Di} = P_{Di} + jQ_{Di} \ \ (total\ demand\ at\ bus\ i)$$

- *Transmission Line*

A Transmission line is represented as a nominal $\pi$ model.

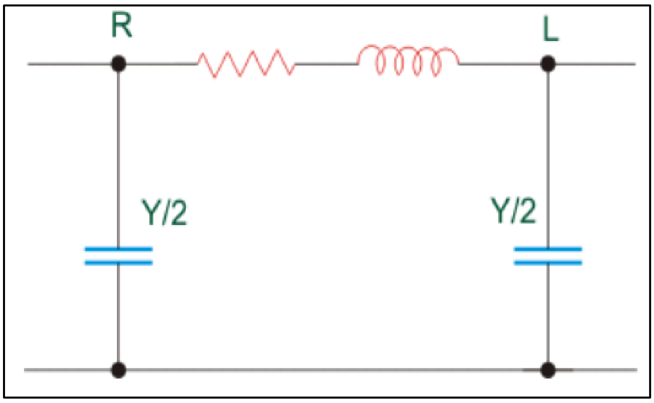


Fig 4 Transmission Line

Where, R + jX is the line impedance and Y/2 is called thehalf line charge impedance.

Off Nominal Tap Changing Transformer

For a nominal transformer the relation

$$\frac{N_1}{N_2} = \frac{E_1}{E_2}\ holds\ true.$$

But for an off nominal transformer

$$\frac{N_1}{N_2} \neq \frac{E_1}{E_2}$$

Thus, for an off- nominal transformer we define the transformation ratio (a) as follows.

$$Transformation\ ratio\ (a) = Tap\ ratio/Nominal\ ratio$$

## III. POWER SYSTEM UNDER STUDY

The test system used in this paper consists of ten buses. The load flow study will be carried out using a 10-bus test system [5]. It should be emphasized, however, that we can modify the number of buses depending on the kind and scale of the power system being analyzed [6].

- *Generator Data*

Table 1 Generator Data

| Generotor | | | | | |
|---|---|---|---|---|---|
| Name of Bus | Number of Bus | ID | status | Gen.MW | Gen.Mvar |
| 6 | 6 | 1 | Close | 123.7 | 36.67 |
| 8 | 8 | 1 | Close | 100 | 14.79 |

- *Branch Data*

Table 2 Branch Data

| Line and transformer Data | | | |
|---|---|---|---|
| Bus Bars | | R | X |
| 1 | 2 | 0.00696 | 0.0351 |
| 3 | 4 | 0.0175 | 0.00343 |
| 4 | 5 | 0.0865 | 0.0123 |
| 5 | 6 | 0.0076 | 0.023 |
| 5 | 7 | 0.00545 | 0.015 |
| 2 | 5 | 0.00831 | 0.074 |
| 2 | 10 | 0.00665 | 0.035 |
| 3 | 9 | 0.00777 | 0.0787 |
| 1 | 8 | 0.001664 | 0.0311 |

- *Bus Data*

Table 3 Bus Data

| Bus | | | | |
|---|---|---|---|---|
| Number | Name | Area Name | Nom kV | ZBR Bus Primary |
| 1 | 1 | 1 | 13.65 | 1 |
| 2 | 2 | 1 | 112.64 | 2 |
| 3 | 3 | 1 | 3.38 | 3 |
| 4 | 4 | 1 | 3.38 | 4 |
| 5 | 5 | 1 | 109.25 | 5 |
| 6 | 6 | 1 | 13.8 | 6 |
| 7 | 7 | 1 | 12.48 | 7 |
| 8 | 8 | 1 | 13.8 | 8 |
| 9 | 9 | 1 | 3.47 | 9 |
| 10 | 10 | 1 | 12.87 | 10 |

➢ *Electrical Model*

- *Single Line Diagram*

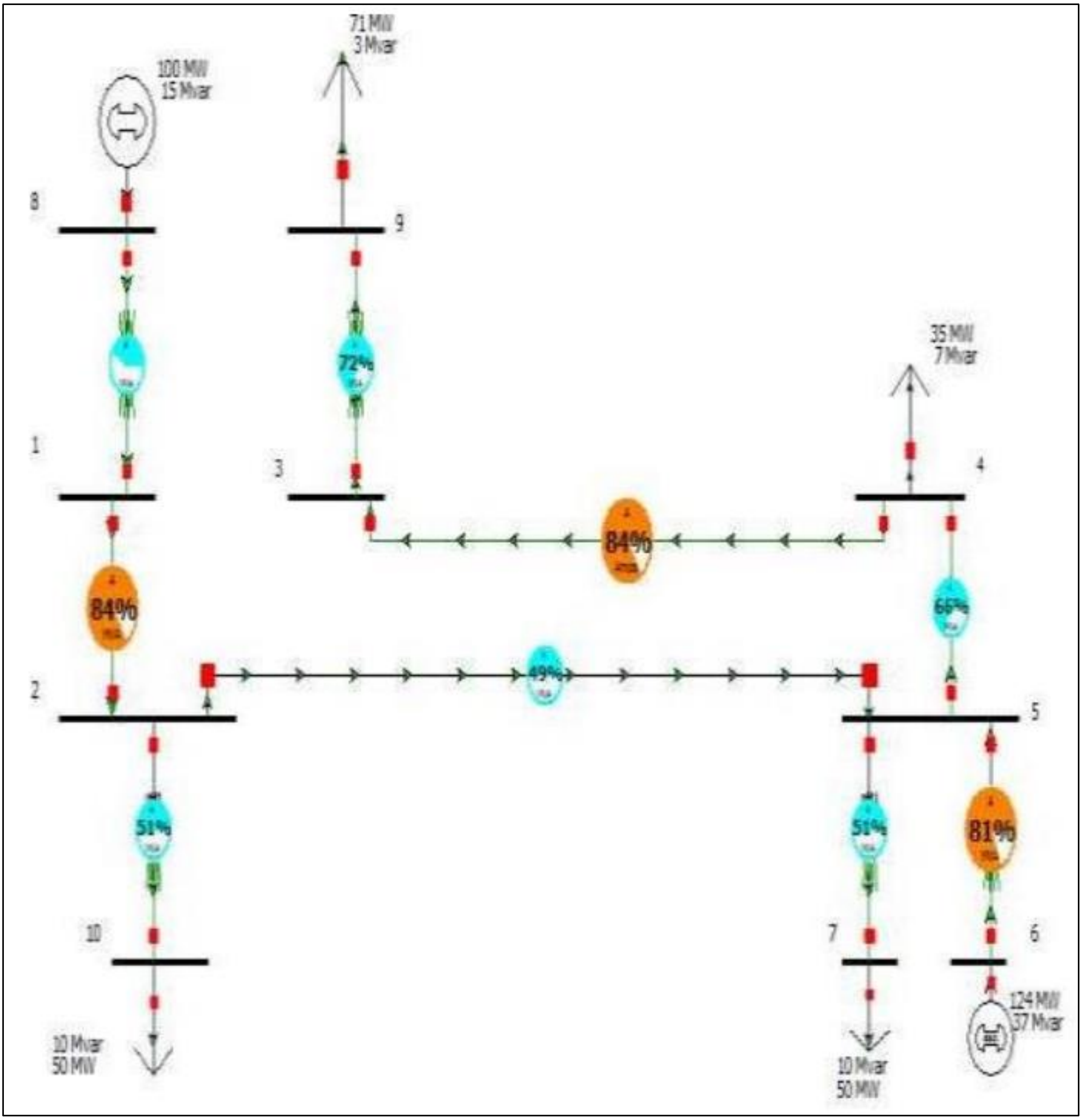


Fig 5 Single Line Diagram for Taste Data

## IV. SIMULATION AND ANALYSIS

Since the symmetrical components technique involves multiple matrix operations, computers may be used to do fault analysis in a well-organized, effective [7], quicker, and logical manner. The purpose of presenting this section is to corroborate the hand calculations discovered before. Furthermore, the algorithm may be utilized to complete this work in cases when manual computations cannot handle a bigger system and analysis becomes problematic. Power World Simulator was chosen as the simulation tool in this study for a variety of reasons [8]. Our history in Power World Simulator was the primary basis behind this decision. Furthermore, the command edit window allows for the easy editing and modification of any code to handle future scenarios. Authors and affiliations [9]

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➢ *Load Flow Analysis Results.*

The network was simulated using the data in Figures. Bus voltages and angles (after completing the power flow) are shown beside each bus [10].Line loading may also be shown; for example, the Transmutation line between Bus 6 and 5 is at 81% of its MVA capacity, and the transmission line between Bus 3 and 4 is loaded at 81% of its present rating. The simulation results are shown in tabular form below.

Table 4 Load Flow Analysis Results

| | Number | Name | Area Name | Nom kV | PU Volt | Volt (kV) | Angle (Deg) | Load MW | Load Mvar | Gen MW | Gen Mvar |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 1 | 1 | 13.65 | 0.99422 | 13.571 | 2.67 | | | | |
| 2 | 2 | 2 | 1 | 112.64 | 0.98373 | 110.807 | 0.66 | | | | |
| 3 | 3 | 3 | 1 | 3.38 | 0.85886 | 2.903 | -1.54 | | | | |
| 4 | 4 | 4 | 1 | 3.38 | 0.87374 | 2.953 | -1.47 | 35.00 | 7.00 | | |
| 5 | 5 | 5 | 1 | 109.25 | 0.98250 | 107.338 | -1.50 | | | | |
| 6 | 6 | 6 | 1 | 13.80 | 1.00000 | 13.800 | 0.00 | | | 123.70 | 36.67 |
| 7 | 7 | 7 | 1 | 12.48 | 0.97816 | 12.207 | -1.91 | 50.00 | 10.00 | | |
| 8 | 8 | 8 | 1 | 13.80 | 1.00000 | 13.800 | 4.45 | | | 100.00 | 14.79 |
| 9 | 9 | 9 | 1 | 3.47 | 0.84707 | 2.939 | -5.92 | 70.85 | 3.00 | | |
| 10 | 10 | 10 | 1 | 12.87 | 0.97659 | 12.569 | -0.34 | 50.00 | 10.00 | | |

## V. CONCLUSION

This Paper used Power World Simulator software to evaluate load flow parameters like bus and load voltages. A power system consisting of 10 buses was simulated to realize the importance of load flow issues. The most important piece of information obtained from the load flow calculation analysis is the voltage profile of the power system. If voltage varies greatly over the system, large reactive power flows (MVARs) will take place in the system This, in effect, will cause augmented active power losses and, in extreme cases, an increased prospect of system voltage collapse. When a specific bus has an inadmissibly low voltage, the normal practice is to mount capacitor banks to provide reactive compensation to the load. In short, load flow studies are used to find out how much reactive power reimbursement should be applied at a particular bus, to bring its voltage up or down to its rated value level. If new power transmission lines or additional distribution transformers are to be appended to the power system, a load flow study will establish how it will terminate overloads on any two adjacent lines.

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