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Analysis of Unbalance Harmonic Propagation in a Three-phase Power System

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Abstract

Operation is non-linear in a state of unbalance can cause problems harmonics in the power system. There are two parts over the use of computational time in harmonic load flow, the first in the construction of harmonic admittance matrix and the second is the iteration scheme for solving systems of linear equations. Mechanical completion of the harmonic admittance to the problem can be expressed in this paper, was developed as a harmonic admittance parallel applications, and a direct algorithm to calculate the admittance matrix elements are presented. Here, we show three phase power flow program is broken down into three independent sub problems, namely: network sequence of positive, negative, and zero. Positive sequence network will be solved by using the method of Fast decouple without modifying their formulation. Negative and zero sequence networks solved using nodal voltage equation. All three networks have been modeled by a sequence of three independent circuits and solved simultaneously using multi-core processors in parallel programming.

Keywords: *harmonics admittance, three-phase power, process*

1. Introduction

Harmonics can occur because the component is not linear in the electric power network systems include electric arc furnaces, static konpensator for reactive power control and electronic equipment such as konveter DC and motor speed settings (Variable speed drives) etc. These components cause no sinusoidal currents containing harmonic distortion components. Harmonic distortion is quite influential on the power loss of induction motors, transformers and channels. So that the harmonic analysis has become an important part of the distribution system in line with the rapid increase in the use of increased loads are no liner at various bus distribution system. No load liner usage is increasing with the growing technology in electrical engineering with the use of electronic equipment for controlling and the growing use of computers on electricity consumers.

And the use of non-linear load will be spread in the greater part of the distribution system buses, while the non-linear load is a generator of harmonic waves will cause deviations in the voltage and current wave electrical distribution system, so the harmonic propagation through the system will lead to the addition unfortunate- losses in the distribution system and can reduce the equipment and the possibility of equipment will be damaged due to the overload is generated due to the resonance [1].

While the load flow is a procedure that is in use right to obtain a voltage in a stable condition of the power system at the fundamental frequency. However, the power supply voltage system which does not always provide the right price because of the influence of the presence of harmonic current injected by the nonlinear load and power switching devices on the system energy increased use in the system due to its high efficiency and ease of control. The harmonic currents will cause problems in the performance of the three-phase system.

This problem is increasingly becoming more attention in recent years is due to the increase in harmonics that propagate through the system can result in losses with increasing interference in the communication network and the possibility of reducing the age of the equipment. The procedure for analyzing the harmonic problems can be classified into two methods: the method and time domain frequency domain. Therefore, an interest in the study of harmonic load flow has evolved originally developed by network analysis in steady-state

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conditions are expecting a balanced three-phase voltage at the load terminals to be symmetrical. However, harmonic analysis requires tools that are more accurate and sensitive for the effects of harmonics on the power system. A three-phase power flow program associated with unbalanced electrical system is clearly a solution to this problem, with respect to its ability to consider the asymmetry that is usually ignored by conventional procedures balanced harmonic load flow.

Therefore, an interest in the study of harmonic power flow has evolved which was originally developed by network analysis is stable under conditions that are expecting a balanced three phase voltage at the load terminals to be symmetrical. However, harmonic analysis requires more tools to obtain accurate and sensitive harmonic impact on the power system. A three-phase power flow program related to an unbalanced power systems is clearly a solution to this problem, on its ability to consider the asymmetry that is usually ignored by conventional procedures load balanced harmonious flow. Harmonic penetration is the earliest and most simple method which assumes no influence between the voltage and the non-linear network [2]. So this method is modified prior to penetration iterative harmonic harmonics influence on the behavior of non-linear devices can be considered [3].

It is necessary to analyzing the propagation of harmonics do not balance in three phase power system to be able to overcome the problem of 3-phase power flow system, and also provide the basis of voltage and current as well as the parameters of AC-DC converters. Besides, it also can be to overcome the problem of penetration of harmonics that provide voltage harmonics in three-phase systems.

Analyzing is also possible to calculate losses in the electricity transmission network and developing harmonic load currents are unbalanced. The benefits to be obtained in this study were able to study the development of unbalanced power flow taking into account the effect of non-linear loads that generate harmonic currents injected into the electrical distribution system that will generate a voltage and current deviations that have an impact on power distribution system electricity. By using the development of the proposed models and algorithms are expected to influence the harmonics generated by non-linear loads are unpredictable and unknown magnitude, so it can be measures to eliminate it. Harmonic generation in the operation of the power system can be analyzed accurately and design of optimal techniques can be determined.

This study is also very useful to increase the desire of research in the department, because it uses the facilities and laboratory tools and Distribution Electric Power System (STDE laboratory). The results of this study may be published in accredited journals and can be used to supplement / complement power system analysis tools that exist today. Model systems will be developed program is also very useful in the electrical system in the region of West Sumatra PLN when inserted data exist for the foreign territory of West Sumatra, so that the relationship between the Department of Electrical Engineering and the Faculty of Engineering Unand in general with stakeholders can be nurtured.

2. Three-Phase Power Flow Calculation Method

Three phase harmonic current injection and voltage in various parts of the system and their settlement on symmetrical components that depend on the magnitude and phase sequence of the harmonic injection were met by the harmonic source, and whether their relationship and their three-phase linear load is load balanced or not balanced.

Three-phase harmonic penetration requires a clear understanding of the relationship between the injection symmetric component of harmonics and harmonic voltage source and the current flowing from the harmonic source application for the liner system. Source harmonics are considered a source of injection or treated as a simple harmonic current sources.

The approach uses a dummy node (node fake) and a line of multi-phase system converts into a complete three phase system. Under this approach, the three-phase power flow is not balanced in the form of a network of conceptual order can be completed. The solution of the three-phase power flow using sequence components require construction of a model of three-phase electric power systems in the form of components of their order.

Power flow calculation method based three-phase symmetrical components have been developed to solve the lateral multiphase using virtual node approach and virtual channels. Thus this method has been able to represent almost all of the circumstances that exist in the distribution network such as the unbalanced load, lateral multi-phase and the presence of plants with renewable energy sources. Therefore, a method based on symmetrical components selected in this study.

3. Load and Capacitor Banks

The Loads can be a spot load or load distributed along the channel. They can be connected as a delta or star and can be modeled as the constant power (PQ), constant current (I), or a constant impedance (Z) or a combination of these types Load modeled by current injection at phase components. Then, the injection current in phase coordinates changed men so her partner in sequence components.

Distributed load is modeled by using a model of concentrated Distributed load is modeled by using a model of concentrated loads. This model divides the load distributed between the channel ends using a certain ratio η. This ratio is calculated based on the magnitude of the voltage at node terminal line terminal. It is possible to consider the ratio η becomes 0.5. In this paper, η ratio is calculated per iteration for the power flow solution. Capacitor bank connected to a particular node to compensate reactive power to improve the voltage profile in the power grid or to reduce network losses capacitor bank can be connected as a star or delta. The capacitor is usually determined by the strength of their reactive at nominal operating voltage. Therefore, they are modeled similar to the constant PQ load.

Application of sequence components effectively reduce the magnitude of the problem of three-phase power-flow. In addition, the order of decaying tissue, positive sequence, negative sequence, and zero sequence can also be solved by using parallel processing. Sequence balanced power flow formulation utilizing an established three-phase power-flow method to solve the positive sequence network. Decomposition based on symmetrical components allows the integration of many systems of power studies such as balanced and unbalanced three-phase electric current and-error calculations in a single tool. Three phase power flow program based on symmetrical components independently developed in consists of three sub-problems associated with the network of positive, negative, and zero-sequence, as Figure 1.

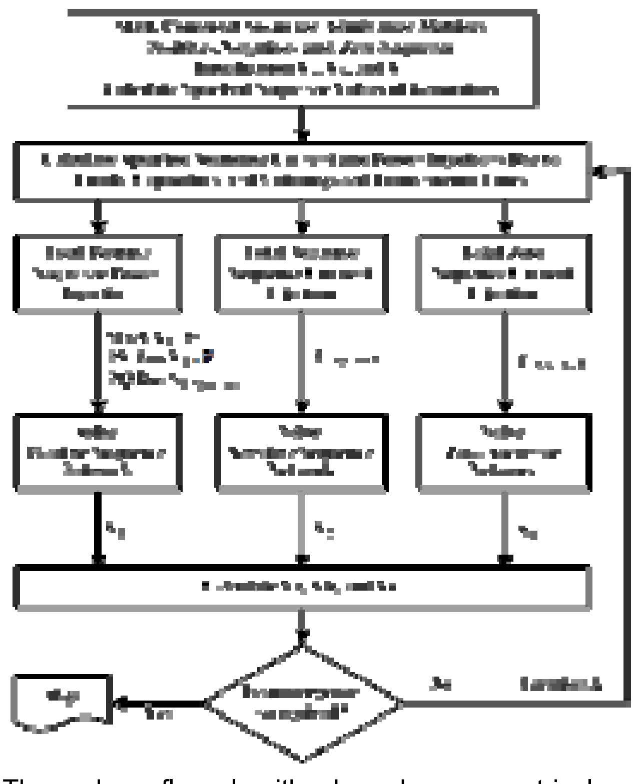

Figure 1. Three-phase flow algorithm based on symmetrical components

As we mentioned earlier that the positive sequence network solved using Newton-Raphson standards without any modification in their formulation since the end of the set value of the order network is still experiencing the same form of negative and zero sequence networks solved using nodal voltage equation. Certain values of the negative and zero sequence network is expressed as an injection current. Therefore, the solution of both negative and zero-sequence networks can be expressed with the usual nodal voltage equation as follows, using matrix notation:

$$\mathbf{Y}_2\mathbf{V}_2 = \mathbf{I}_{2\_\text{Specifie d}} \quad (1)$$

$$\mathbf{Y}_0\mathbf{V}_0 = \mathbf{I}_{0\_\text{Specified}} \quad (2)$$

After solving the sequence networks, phase voltage to the base can be calculated. This process is repeated until the convergence criterion is reached. At this stage of program voltage mismatch, the mismatch sequence of positive voltage and positive sequence power mismatch can be used as a convergence criterion.

The algorithm has been included in the distribution network features much like meshed network or radial, single-phase, two-phase, three-phase line, transformer with load connection, spot and distributed to all types and connections.

The total current harmonic changes can be obtained by the following equation:

$$I_{thd} = \frac{\sqrt{\sum_{h=2}^{\infty} I_h^2}}{I_1} x100\% = \frac{\sqrt{I_2^2 + I_3^2 + I_4^2 .... + I_n^2}}{I_1} x100\% \quad (3)$$

The total of rms current:

$$I_{rms} = \sqrt{I_{fund}^2 + I_{harm}^2} \quad (4)$$

Or,

$$I_{rms} = I_{fund}\sqrt{1 + \left(\frac{I_{thd}}{100}\right)^2} \quad (5)$$

The fundamental current (in fundamental frequency):

$$I_{fund} = \frac{I_{rms}}{\sqrt{1 + I_{thd}^2}} \quad (6)$$

Total change in fundamental current:

$$I_{thd(fund)} = \sqrt{\left(\frac{I_{rms}}{I_{fund}}\right)^2} - 1 \quad (7)$$

Total demand Distortion (TDD):

$$\frac{\sqrt{\sum_{h=2}^{\infty} I_h^2}}{I_{load}} = I_{TDD} = \sqrt{\frac{I_2^2 + I_3^2 + I_4^2 ......I_n^2}{I_{load}}} \quad (8)$$

Where : I_{load} = maximum demand load current (fundamental) pada the PCC
TDD = 'Total demand distortion' of current.

4. Admittance Matrix Base on Harmonic

Three-phase harmonic current injection and voltage in various parts of the system and their settlement on symmetrical components that depend on the magnitude and phase of the injection sequence harmonics are met by the harmonic source, and whether their relationship and their three-phase linear load is a the load balanced or not balanced.

Three-phase harmonic penetration requires a clear understanding of the relationship between the injection of symmetrical components and harmonics source harmonic voltage and current flowing from the source application to harmonic liner system. Sources of harmonics considered or treated as a source of injection simple harmonic current sources [4].

The approach uses a dummy node and many systems convert line phase into a complete three-phase system. Based on this approach, three-phase power flow is not balanced in the form of a conceptual network order can be completed. Solution of the three-phase power flow sequences use these components require the builder of a model of a three-phase electric power systems in the form of their order components.

Power flow calculation method based three-phase symmetrical components have been developed for resolving lateral multi-phase approach using virtual nodes and virtual channels. Thus this method was able to represent almost all of the circumstances that exist in the distribution network as the load is not balanced, and the lateral multi-phase plants with renewable energy sources. Therefore symmetrical component-based method is selected in this study [5-7].

4.1. Decoupled Model Sequence Asymmetrical Lines

Series resistance and inductance of three phase transmission lines between nodes are lumped in the middle. Shunt capacitance of the transmission line is divided into two sections and lumped at the nodes connected to the line. Line series and shunt impedance matrix entry is given by:

$$Z_{ij}^{abc}=\begin{bmatrix} z_{ij}^{aa} & z_{ij}^{ab} & z_{ac}^{ac} \\ z_{ij}^{ba} & z_{ij}^{bb} & z_{ij}^{bc} \\ z_{ij}^{ca} & z_{ij}^{cb} & z_{ij}^{cc} \end{bmatrix} \qquad Y_{ij}^{abc}=\begin{bmatrix} y_{ij}^{aa} & y_{ij}^{ab} & y_{ij}^{ac} \\ y_{ij}^{ba} & y_{ij}^{bb} & y_{ij}^{bc} \\ y_{ij}^{ca} & y_{ij}^{cb} & y_{ij}^{cc} \end{bmatrix} \tag{9}$$

Channel series impedance and shunt impedance matrix of the three-phase line given by (1) be changed in pairs them in sequence component. The resulting series impedance and shunt impedance matrix in the order of the components is given by:

$$Z_{ij}^{012}=\begin{bmatrix} z_{ij}^{00} & z_{ij}^{01} & z_{ij}^{02} \\ z_{ij}^{10} & z_{ij}^{11} & z_{ij}^{12} \\ z_{ij}^{20} & z_{ij}^{21} & z_{ij}^{22} \end{bmatrix} \quad Y_{ij}^{012}=\begin{bmatrix} y_{ij}^{00} & y_{ij}^{01} & y_{ij}^{02} \\ y_{ij}^{10} & y_{ij}^{11} & y_{ij}^{12} \\ y_{ij}^{20} & y_{ij}^{21} & y_{ij}^{22} \end{bmatrix} \tag{10}$$

If the three-phase line is fully transpose, then the impedance and admittance matrices in equation (1) will be symmetrical. Component of its order will be diagonal matrices. However, if the channel is untransposed three-phase, three-component phase component admittance matrix in (1) will be full and symmetrical, but not phase-wise that is balanced. Therefore, the matrix entry sequence will be full and not symmetrical.

Order coupled line model can be decomposed into a sequence of three independent circuits [6-7]. This can be achieved by replacing the clutch, ie the elements off-diagonal in (2), by the equivalent current compensation as follows.

$$\Delta \boldsymbol{I}_i^n=\frac{1}{\boldsymbol{z}_{ij}^{nl}}(\boldsymbol{V}_i^l-\boldsymbol{V}_j^l)+\frac{1}{\boldsymbol{z}_{ij}^{nm}}(\boldsymbol{V}_i^m-\boldsymbol{V}_j^m)+\boldsymbol{y}_{ij}^{nl}\boldsymbol{V}_i^l+\boldsymbol{y}_{ij}^{nm}\boldsymbol{V}_j^m \tag{11}$$

On Figure 1 shows the channel model described in the order of coupling between the components of the order entered by the compensation network flow is computed using (3).

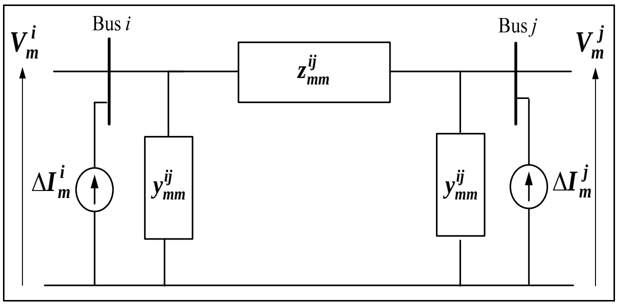

Figure 1. Order of line decoupled models

In the early stages made the bus numbering system to be analyzed. The buses are connected to pre-numbered generator after the bus numbering continued in the load buses, the bus that has the largest generating capacity chosen as the slack bus and was given the number 1 (one), to another bus that is connected to the generator given number 2 (two) as the generator bus and the load bus is numbered 0 (zero).

Compile data on the system to be analyzed which includes data from the resistance, reactance and capacitance between lines, transformer tapping the data, the load the data scheduled, the data generation, assuming initial voltage magnitude and phase angle bus voltage. Calculation begins by forming network impedance $\left(Z_{ij}\right)$ with the formula:

$$Z_{ij} = R_{ij} + jX_{ij} \tag{12}$$

Where

Z_{ij} : Network impedance between bus i and bus j

R_{ij} : Network resistance between bus i and bus j

X_{ij} : Network reactance between bus i and bus j

Then converted Network impedance to Network admittance:

$$Y_{ij} = Yr_{ij} + jYx_{ij} \tag{13}$$

Where,

$$Y_{r_{ij}} = \frac{R_{ij}}{R_{ij}^2 + X_{ij}^2} \tag{14}$$

The next bus admittance matrix Y is formed by the components comprising Network admittance, capacitance and line transformer tapping change. Then the bus admittance matrix Y is formed in a rectangular shape converted into polar form. Where previously the bus admittance matrix Y is separated into components of the matrix G and the matrix B. Scheduled power available on each bus is calculated by the formula:

$$Pi^{jd} = PGi - Pli \tag{15}$$

In the process of iteration, the calculated power sought by Formula:

$$P_i = \sum_{n=1}^{N} \left|Y_{in} V_i V_n\right| \cos(\theta_{in} + \delta_n - \delta_i) \tag{17}$$

$$Q_i = -\sum_{n=1}^{N} \left| Y_{in} V_i V_n \right| \sin(\theta_{in} + \delta_n - \delta_i) \quad (18)$$

Where

P_i : The calculated active power on bus i

Q_i : The calculated reactive power on bus i

V_i, θ_i : Voltage magnitude and phase angle on bus i

V_j, θ_j : Voltage magnitude and phase angle on bus j

Y_{in} , θ_{in} : Magnitude and phase angle of admittance matrx elements Y

The calculated power Mismatch obtained with the equation on this below:

$$\Delta P_i = P_i^{jd} - P_i^{hit} \quad (19)$$

$$\Delta Q_i = Q_i^{jd} - Q_i^{hit} \quad (20)$$

Where

ΔP_i : Active power Mismatch on bus i

ΔQ_i : Reactive power Mismatch on bus i

After Power Mismatch is calculated so is formed Jacobian matrix. Jacobian matrix formation in FastDecouple method has some differences compared with other methods.

This difference arises because:

a) Comparison X/R line of high enough so that the value $G_{ij} \sin \delta_{ij} < B_{ij}$. Difference of each phase voltage bus fairly small so that:

$$\sin \delta_{ij} = \sin(\delta_i - \delta_j) \cong \delta_i - \delta_j \quad (21)$$

$$\cos \delta_{ij} = \cos(\delta_i - \delta_j) \cong 1.00 \quad (22)$$

b) The value of each bus reactive power Qi is always smaller than the value of BiiVi 2 so obtained the following equation:

$$[\Delta P] = [V B^{'} V][\Delta\delta] \quad (23)$$

$$[\Delta Q] = [V B^{''} V] \left[\frac{\Delta |V|}{|V|} \right] \quad (24)$$

Where matrix elements B' and B'' are matrix elements B with the formula as follow:

$$B_{ij}^{'} = -\frac{1}{X_{ij}} \qquad i \neq j \quad (25)$$

$$B_{ij}^{'} = \sum_{j=1}^{n} \frac{1}{X_{ij}} \qquad i = j \quad (26)$$

$$B_{ij}^{'} = -B_{ij} \quad (27)$$

And then the Equation (15) and (16) become:

$$\left[\frac{\Delta P}{V}\right] = \left[B^{'}\right]\left[\Delta\delta\right] \quad (20)$$

$$\left[\frac{\Delta Q}{V}\right] = \left[B^{''}\right]\left[\Delta V\right] \quad (21)$$

So in the next calculation obtained:

$$\left[\Delta\delta\right] = \left[B^{'}\right]^{-1}\left[\frac{\Delta P}{V}\right] \quad (22)$$

$$\left[\Delta V\right] = \left[B^{''}\right]^{-1}\left[\frac{\Delta Q}{V}\right] \quad (23)$$

The Equation (22) or (23) is known as *Fast Decouple Load Flow*. Difference in magnitude and phase angle values of each bus voltage between the old and new then compared with a predetermined value accuracy. If the value of accuracy has not been achieved, the iteration is repeated from the beginning to the accuracy and convergence achieved fulfilled.

Slack Bus power at the next calculated after convergence is reached. The formula used is:

$$P_i = \sum_{n=1}^{N} \left|Y_{in}V_iV_n\right| \cos\left(\theta_{in} + \delta_n - \delta_i\right) \quad (24)$$

$$Q_i = -\sum_{n=1}^{N} \left|Y_{in}V_iV_n\right| \sin\left(\theta_{in} + \delta_n - \delta_i\right) \quad (25)$$

Where

P_i : Active power on Slack bus

Q_i : Reactive power on Slack bus

Besides that reactive power at PV bus (Bus Station) was also calculated after convergence is achieved, while the formula used is the formula (25).

Power flow between buses is calculated using the formula:

$$S_{ij} = V_i\left(V_{ij}^{*}Y_{ij}^{*} + V_i^{*}Y^{*}c_{ij}\right) \quad (26)$$

$$P_{ij} - jQ_{ij} = V_i^{*}\left(V_i - V_j\right)Y_{ij} + V_i^{*}V_iYc_{ij} \quad (27)$$

Where:

S_{ij} : Complex power flow from bus i to bus j

P_{ij} : Active power flow from bus i to bus j

Q_{ij} : Reactive power flow from bus i to bus j

V_i : Voltage vector bus i

V_j : Voltege vector bus j

V_{ij} : Voltage Vector between bus i and bus j

Y_{ij} : Admittance between bus i and bus j

Yc_{ij} : Charging line admittance between bus i and bus j

Power loss between buses is calculated using the formula:

$$S_{ij}\left(losses\right)=S_{ij}+S_{ji} \tag{28}$$

Where

$S_{ij}\left(losses\right)$: Complex power losses from bus i to bus j

S_{ij} : Complex power from bus i to bus j

S_{ji} : Complex power from bus j to bus i

5. Research method

This research was conducted with the following methodology:

5.1. Research Design and Procedures

This study will perform the following steps:

1. Review library and conference surveys taken from journal IIIE / IEE. This phase is to review the literature to determine the state of the art right.
2. The data set is taken from the data network Sumatra, IEEE test systems. Modeling of the transmission system it would use mathematical models to represent accurately the system practically.
3. Conceptual power flow program in the conventional programs that have been modified by clicking change the value of the transmission line on the harmonic order and the use of non-linear loads, then to eliminate tung nonlinear harmonic current of the bus and all bus voltages. And makes the algorithm.
4. This algorithm will be validated by the system test and compare the results with previous results.
5. Overall testing and perfecter of the system model and an algorithm that will be done.

5.2. Operational Framework

Harmonic load flow program will use the unbalanced load of papers ever published. Are being actively carried out by using a small scale and the results obtained will be compared with previous results related.

5.3. Subjects or Data Sources

The main data that will be used in the analysis will be collected from:

a) IEEE Data
b) Data from tutorials / papers published
c) Data from Network PLN region III

5.4. Instrument & Analysis

Instrumentation and data analysis used in this study.

a) Microsoft Visual Studio 2010
b) Using Fluke RPM for the measurement of harmonics

6. Results And Discussion

The purpose of this study is more concerned about the development of solution-harmonic electric current. The results presented here will discuss the issue of reuse (reuse). In addition, a numerical example of the completion of the 32-bus system is not balanced [11] is given when the nonlinear device is on the network.

6.1. Benchmark of Reuse (Reuse)

Reuse is implemented by the class size by calculating that have been made based on inherited, composition, or developed from scratch. The size of the class and re-use of components are summarized in Table 1.

Table 1. Measure for re-usability in the development of harmonic penetration

Reuse	Composition	Inheritance	Scratch	% Reuse
Power system Model (classes)	2	6	-	Composition25%%5% Inherited75%
Solution Algoritm (component)	4	-	1	Composition80% Inherited 20%

First, the model of the electrical system that represents the actual device from the power grid, there are 6 classes which is a derivative form of basic power system libraries where there are two classes reused by composition. In connection with the solution algorithm, there are four components are reused. They are two components to the flow of power is not balanced, one component of the admittance matrix, and a linear component to the settlement. In addition to high reusability, components must be reused without knowing the algorithms that are packed in it. This is because the components are designed with a clear interface based on the data network is already known to electrical engineers. On the other hand the formulation of complex algorithms hidden inside components of privacy or protected from component parts.

4.2. Examples of Numerical Results

Harmonic power flow analysis using CBD application has been tested by using 32 buses, to obtain or calculate perverts an harmonic voltage at all buses are as follows:

Case 1: Harmonic voltage for connection of a nonlinear device.

Case 2: Harmonic voltage due to an unbalanced load demand.

In the first case, there is a nonlinear device which is connected to the 32-bus test systems where Converters Six Pulse no.ID connected on the bus: 32, 41 and 45 on the 32 bus, with 50% of total bus connected to the load, the result there are irregularities pointed it towards total harmonic voltage at all buses in the system.

If only one device is connected to a system of nonlinear 32 bus test system, harmonic distortion is low. This is because when more nonlinear devices connected to the bus network, harmonic voltage deviation will increase at all buses in the network. This is due to the fact that the total or the amount of harmonic current injected into the network have increased and thus will increase the harmonic voltage deviation in the bus network. Voltage THD (%) for the 32 - bus system when Pulse Stories are connected on the bus no.ID 32, 41 and 45 with 50 % of the total load (balanced).

In the second case, the voltage harmonics due to the demand load is not balanced, nonlinear devices connected to the bus are asked loads adapted to increase 20 % for phase A, an increase of 10 % for phase B and a decrease of 5 % for phase C. For example, demand loading on the bus with the ID number 41 for the 32 - bus test system tailored to the individual will increase 20 % for phase A, an increase of 10 % for phase B and a decrease of 5 % for phase C. Adjustment of demand loading is done so that the harmonic voltage deviation in the bus network as the demand is not balanced in the loading obtained and examined.

7. Conclusions and Recommendations

This study has presented the development of object components for the three-phase power flow analysis of unbalanced harmonic Algorithms used harmonic penetration and nodal voltage method for harmonics has been developed as a component object. Harmonic analysis is required as an extension of the basic libraries for the power system nonlinear device models. Components of the nodal voltage method has been integrating the components of three-phase power flow into the existing new component-based applications. Reuse of pre-existing components with a very high frequency suggests that the analysis is very complex power systems can be developed with great flexibility that can not be found in alternative programming approaches. Modeling component for the proposed algorithm can be extended to models of the methods are more comprehensive as the iterative harmonic resolution.

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