Accuracy Load Flow Of Iraqi 400 Kv supper Grid

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Abstract ---The aim of this paper is to develop a mathematical model and a computer program to determine the limits of load flow result deviation for electrical power network. This work basically a comparison consists of load flow method Newton Raphson and fast decoupled .The comparison concerns the voltage magnitude, voltage angle, the generated reactive power of PV –buses and the active and reactive power losses. The accuracy of the fast decoupled method tested compared to the classical N-R considering the operative Iraqi national network (400 KV) power grid as a test case. The programs used in this work are implemented using (MATLAB).

1 INTRODUCTION

T The great importance of load-flow studies is in planning the future expansion of power system as well as in determining the best operation of existing systems. The principal information obtained from a load-flow study is the magnitude and phase angle of the voltage of each bus and the real and reactive power flowing in each line .However much additional information or volume is provided by the printout of the solution from computer programs use by the power companies [1].

Either the bus self-and mutual admittance's which compose the bus admittance matrix Ybus or the driving-point and transfer impedance which compose Zbus may be used in solving the load-flow problem [2]. We shall confine our study to methods using admittance's.

The starting point in obtaining the data, which must be furnished to the computer, is the one-line diagram of the system. Values of series impedance's and shunt admittance's of transmission lines are necessary so that the computer can determine all the Ybus or Zbus elements. Other essential information includes transformer ratings and impedances , shunt capacitor ratings, and transformer tap settings.

Operating loading condition must always be selected for the study. At each bus except one the net real power into the network must be specified .

The power drawn by a load is negative power input to the system. The other power input are from generators and positive or negative power entering over interconnections. In addition at these buses either the net flow of reactive power into the network or the magnitude of the voltage must be specified; that is at each bus a decision is required whether the voltage magnitude or the reactive-

Depending upon which two variables are specified a priori, the buses are classified into three categories:-

(i)PQ bus: At this type of bus, the net powers Pi and Qi are known (PDi and QDi are known from load forecasting and PGi and QGi are specified) . The unknowns are Vi and [5] .

(ii)PV bus: At this type of bus PDi and QDi are known a priori and Vi and Pi (hence Pgi) are specified .The unknowns are Qi (hence QGi) and.

(iii)slack bus: This bus is distinguished from the other two types of buses by the fact that real and reactive power at this bus is not specified. Instead voltage magnitude and phase angle are specified [3].

The main goal in this work is to devise and quantify the accuracy of a certain approximated load flow method compared to a standard classical one. The classical method consideration here is the standard Newton–Raphson in polar form. The approximate method studied here is the fast –decoupled load flow.

The most important mathematical operation in power system analysis is the investigation of load-flows. A load-flow study is concerned with the determination of the state variables (voltage, current, power, and power factor) at the various points of the power network. Load-flow studies are essential for all power system problems, and it is not a simple task. No direct solution can be found, to a load-flow problem because of the nature of the equations and the ever increasing complexity of power systems. Therefore, iterative techniques of solution are conventionally used in this respect [4].

Performance equations for a load-flow study (load-flow methods) are usually derived on the basis of nodal or bus frame of reference. The use of the nodal or bus frame of reference greatly simplifies the preparation of data; and the effects of shunt elements to ground may be easily included.

At each node of the power network, there are four variables; the real power, the reactive power, the voltage magnitude, and the phase shift. The four variables can be combined in a mathematical complex equation which can be resolved into two real equations. It is thus necessary to specify two variables per node to completely solve for the network state.

An early approach to load-flow problem solution was the Gauss-Seidel iterative method using the nodal admittance matrix and this was further improved by using the nodal impedance matrix. The Gauss-Seidel method is basically a straight substitution and correction process. It is used for small systems due to its slow convergence and low computer storage requirements [4].

Newton Raphson's method using the nodal admittance matrix has gained widespread popularity because of its quadratic convergence characteristics in load flow analysis.Its iterative process is summarized as follows: At each stage of the process, a set of nonlinear algebraic equations are linearized about the point representing current values of bus voltages, and a set of linear equations is solved to obtain a better solution of bus voltages. It is basically used for large well-conditioned power systems due to its fast convergence and accurate solution.

Numerical method s are generally at their most efficient use when they take advantage of the physical properties of the system being solved. Hence, for example, the exploitation of network sparsely by ordered elimination and skilful programming has been used in the Newton's method to improve the speed and storage capacity, Recently, attention has been given to the exploitation of the loose physical interaction between MW and Mvar flows in a power system, by mathematically decoupling the MW-θ and Mvar-V calculations [3] .

In a decoupled Newton-method, (a) the convergence of this method is faster than that of the Newton method in the early stages of the solution, (b) the method does not lead to high accurate solution, and (c) It has a high degree of reliability and needs low storage .

There are many powerful methods For load-Flow study, but the fast decoupled load flow method (FDLF) has been accepted in recent years by the utility industry as the best approach to obtain the power flow solutions. The FDLF method is used in system planning, operational planning and operational control this is due to its low memory requirements speed and very good convergence characteristics for practical problems [5].

2 Derivation of Algorithms :

The complex power injected by the source into the ith bus of a power system is :

$$S_i = P_i + jQ_i = V_i I_i^* \quad , \; i = 1,2....,n \; ......(1)$$

Where Vi is the voltage at the ith bus with respect to ground and Ii is the source current injected into the bus.

The load flow problem is handled more conveniently by use of Ii rather than Ii*.

Therefore, taking the complex conjugate of eq : (2) ,we have :

$$P_i - jQ_i = V_i^* I_i \quad , \quad i = 1,2,....,n \quad .....(2)$$

Real and reactive power can now be expressed as :

$$Pi(real\ power) = |Vi| \sum_{k=i}^{n} |Vk||Yik| \cos(\theta ik + \delta k - \delta i) \; ; \; i = 1,2,...,n \quad ....(5)$$

$$Qi(real\ power) = -|Vi| \sum_{k=i}^{n} |V_k||Y_{ik}| \cos(\theta_{ik} + \delta_k - \delta_i);$$

Equations (5) and (6) represent 2n power flow equations at n buses of a power system. For the derivation of algorithms, the power system admittance matrix is taken as a convenient starting point. The bus admittance matrix witch describes the net injected currents as a function of bus voltages can be written as:

[Ibus]=[Ybus][Vbus]…………………..(7)

Injected power at each bus k can be written as:

$$P_k^{cal} = \mathrm{Re}\left(V_k \sum_{i=1}^{n} Y_{ki}^* V_i^* \right)$$

$$= V_k \sum_{i=1}^{n} V_i \left(G_{ki} \cos\theta_{ki} + B_{ki} \sin\theta_{ki} \right) ....(8)$$

ISSN 2229-5518

$$Q_k^{cal} = \operatorname{Im}\left(V_k \sum_{i=1}^{n} Y_{ki}^{*} V_i^{*}\right)$$

$$= V_k \sum_{i=1}^{n} V_i \left(G_{ki} \sin\theta_{ki} - B_{ki} \cos\theta_{ki}\right) \ldots\ldots\ldots\ldots\ldots\ldots (9)$$

Where: Yki=Gki + jBki, $\theta_{ki} = \theta_k - \theta_i$

$$V_i = V_i\left(\cos\theta_i + j\sin\theta_i\right)$$

And superscript "cal" designates the calculated power flowing to bus k from bus i, (i=1,…,n), the variable n is equal to the number of buses.

3 Power- Flow Solution by Newton-Raphson:

The power mismatches at bus k can be written as:

ΔPk=Pksp – Pkcal ………….. (10)

ΔQk=Qksp – Qkcal ..…………. (11)

Where the subscript "sp" designates the net scheduled power at bus k.

The Newton Raphson method is a powerful method of solving non-liner algebraic equations. It is indeed the practical method of load flow solution of large power network.

Its only drawback is the large requirement of computer memory which has been overcome through a compact storage scheme. Convergence can be considerably speeded up by performing the first iteration through the (GS) method and using the values so obtained for starting the NR iterations. Before explaining how the NR method is applied to solve the load flow problem, it is useful to review the method in its general form.

We define the x, y and f vectors for power –flow problem as [5]:

$$x = \begin{bmatrix} \delta \\ V \end{bmatrix} = \begin{bmatrix} \delta_2 \\ \vdots \\ \delta_N \\ V_2 \\ \vdots \\ V_N \end{bmatrix}; y = \begin{bmatrix} P \\ Q \end{bmatrix} = \begin{bmatrix} P_2 \\ \vdots \\ P_N \\ Q_2 \\ \vdots \\ Q_N \end{bmatrix}; f(x) = \begin{bmatrix} p(x) \\ Q(x) \end{bmatrix} = \begin{bmatrix} P_2(x) \\ \vdots \\ P_N(x) \\ Q_2(x) \\ \vdots \\ Q_N(x) \end{bmatrix}$$

………… (12)

Where all v, p and Q terms are in per-unit and terms are in radius.

$$\left.\begin{aligned} P_i &= V_i \sum_{k=1}^{N} Y_{ik} V_k Cos(\delta_i - \delta_k - \theta_{ik}) \\ Q_i &== Q_i(x) = V_i \sum_{k=1}^{N} Y_{ik} V_k Sin(\delta_i - \delta_k - \theta_{ik}) \end{aligned}\right\}$$

$k = 2,3,\ldots N$

…………. (13)

The Jacobian matrix has the form

$$\begin{array}{c} \qquad\qquad J_1 \qquad\qquad\qquad\qquad J_2 \\ J = \left[\begin{array}{ccc|ccc} \frac{\partial p_2}{\partial \delta_2} & \cdots & \frac{\partial p_2}{\partial \delta_N} & \frac{\partial p_2}{\partial V_2} & \cdots & \frac{\partial p_2}{\partial V_N} \\ \vdots & & & \vdots & \vdots & \vdots \\ \frac{\partial p_N}{\partial \delta_2} & \cdots & \frac{\partial p_N}{\partial \delta_N} & \frac{\partial p_N}{\partial V_2} & \cdots & \frac{\partial p_N}{\partial V_N} \\ \hline \frac{\partial Q_2}{\partial \delta_2} & \cdots & \frac{\partial Q_2}{\partial \delta_N} & \frac{\partial Q_2}{\partial V_2} & \cdots & \frac{\partial Q_2}{\partial V_N} \\ \vdots & \vdots & & \vdots & \vdots & \\ \frac{\partial Q_2}{\partial \delta_2} & \cdots & \frac{\partial Q_N}{\partial \delta_N} & \frac{\partial Q_N}{\partial V_2} & \cdots & \frac{\partial Q_N}{\partial V_N} \end{array}\right] \\ \qquad\qquad J_3 \qquad\qquad\qquad\qquad J_4 \end{array}$$

…… (14)

The partial derivatives in each block derived from are given in table (1)

Table (1) Element of Jacobian matrix

$k \neq i$
$J1_{ik} = \frac{\partial p_i}{\partial \delta_k} = V_i Y_{ik} V_k Sin(\delta_i - \delta_k - \theta_{ik})$
$J2_{ik} = \frac{\partial p_i}{\partial V_k} = V_i Y_{ik} Cos(\delta_i - \delta_k - \theta_{ik})$
$J3_{ik} = \frac{\partial Q_i}{\partial \delta_k} = V_i Y_{ik} V_k Cos(\delta_i - \delta_k - \theta_{ik})$
$J4_{ik} = \frac{\partial Q_i}{\partial V_k} = V_i Y_{ik} Sin(\delta_i - \delta_k - \theta_{ik})$
$k=i$
$J1_{ii} = \frac{\partial p_i}{\partial \delta_i} = -V_i \sum_{k=1}^{N} Y_{ik} V_k Sin(\delta_i - \delta_k - \theta_{ik})$
$J2_{ii} = \frac{\partial p_i}{\partial V_i} = Y_{ii} Cos\theta_{ii} + \sum_{k=1}^{N} Y_{ik} V_k Cos(\delta_i - \delta_k - \theta_{ik})$
$J3_{ii} = \frac{\partial Q_i}{\partial \delta_i} = -V_i \sum_{k=1}^{N} Y_{ik} V_k Cos(\delta_i - \delta_k - \theta_{ik})$
$J4_{ii} = \frac{\partial Q_i}{\partial V_i} = -V_i Y_{ii} Sin\theta_{ii} + \sum_{k=1}^{N} Y_{ik} V_k Sin(\delta_i - \delta_k - \theta_{ik}$

ISSN 2229-5518

We now applying to power-flow problem the four Newton-Raphson steps, starting with [7].

$$x^r = \begin{bmatrix} \delta^r \\ V^r \end{bmatrix}$$ at the rth iteration.

Step 1:

Using Eq. (2.19) and Eq. (2.20) to compute

$$\Delta y^r = \begin{bmatrix} \Delta p^r \\ \Delta Q^r \end{bmatrix} = \begin{bmatrix} P - P(x^r) \\ Q - Q(x^r) \end{bmatrix} \qquad (15)$$

Step 2:

Using the equation in table 1 to calculate the Jacobian matrix.

Step 3:

Using Gauss elimination and back substitution to solve

$$\left[\begin{array}{c|c} j_1^r & j_2^r \\ \hline j_3^r & j_4^r \end{array}\right] \begin{bmatrix} \Delta\delta^r \\ \Delta V^r \end{bmatrix} = \begin{bmatrix} \Delta P^r \\ \Delta Q^r \end{bmatrix} \quad \text{.........} (16)$$

Step 4:

Computing

$$x^{r+1} = \begin{bmatrix} \delta^{r+1} \\ V^{r+1} \end{bmatrix} = \begin{bmatrix} \delta^r \\ V^r \end{bmatrix} + \begin{bmatrix} \Delta\delta^r \\ \Delta V^r \end{bmatrix} \quad \text{.......} (17)$$

Starting with initial value V0, the procedure continues until convergence is obtained or until the number of iterations exceeds a specified maximum. Convergence criteria are often based on (Δy^r) called power mismatches.

4 Fast Decoupled Power flow method

The fast decoupled power flow method is a very fast and efficient method of obtaining power flow problem solution. In this method, both, the speeds as well as the sparsity are exploited. This is actually an extension of Newton-Raphson method formulated in polar coordinates with certain approximations which result into a fast algorithm for power flow solution. This method exploits the property of the power system where in MW flow-voltage angle and Mvar flow-voltage magnitude are loosely coupled. In other words a small change in the magnitude of the bus voltage does not affect the real power flow at the bus and similarly a small change in phase angle of the bus voltage has hardly any effect on reactive power flow. Because of this loose physical interaction between MW and Mvar flows in a power system, the MW-δ and Mvar-V calculations can be decoupled .

This decoupling results in a very simple, fast and reliable algorithm. As already said in the preceding article. The sparsity feature of admittance matrix minimizes the computer memory requirements and results in faster computations. The accuracy is comparable to that of the N-R method .

The earlier equation of power flow studies and according to Newton-Raphson method that represented by:

$$\begin{bmatrix} \Delta P \\ \Delta Q \end{bmatrix} = \begin{bmatrix} J_1 & J_2 \\ J_3 & J_4 \end{bmatrix} \begin{bmatrix} \Delta\delta \\ \Delta V \end{bmatrix}$$

$$\begin{bmatrix} \Delta P \\ \Delta Q \end{bmatrix} = \begin{bmatrix} H & N \\ M & L \end{bmatrix} \begin{bmatrix} \Delta\delta \\ \Delta V \end{bmatrix} \text{............} (18)$$

where H, N, M and L are the elements (J1 J2, J3 and J4) of the Jacobian matrix.Since changes in real power (i.e., ΔP) is less sensitive to the changes in voltage magnitude (i.e., ΔV) and changes in reactive power (i.e., ΔQ) is less sensitive to the changes in phase angle of voltage (i.e. Δδ) equation (18) can be reduced to:

$$\begin{bmatrix} \Delta P \\ \Delta Q \end{bmatrix} = \begin{bmatrix} H & 0 \\ 0 & L \end{bmatrix} \begin{bmatrix} \Delta\delta \\ \Delta V \end{bmatrix} \text{............} (19)$$

The equations (19) are decoupled equations and can be expanded as:

$$\Delta P = H * \Delta\delta \quad \text{.........} (20)$$

$$\Delta Q = L * \Delta V \quad \text{.........} (21)$$

ISSN 2229-5518

The next step in deriving the algorithm is to make suitable assumptions in deriving the expressions for H and L.

Off-diagonal element of H is:

$$H_{ik} = \frac{\partial P_i}{\partial \delta_k} = V_i V_k Y_{ik} \sin\left(\theta_{ik} + \delta_i - \delta_k\right)$$
$$= V_i V_k Y_{ik}\left[\sin\theta_{ik}\cos\left(\delta_i - \delta_k\right) + \cos\theta_{ik}\sin\left(\delta_i - \delta_k\right)\right]$$
$$= V_i V_k\left[Y_{ik}\sin\theta_{ik}\cos\left(\delta_i - \delta_k\right) + Y_{ik}\cos\theta_{ik}\sin\left(\delta_i - \delta_k\right)\right]$$
$$= V_i V_k\left[-B_{ik}\cos\left(\delta_i - \delta_k\right) + G_{ik}\sin\left(\delta_i - \delta_k\right)\right] \ldots\ldots\ldots\ldots\ldots(22)$$

Similarly off-diagonal element of L is:

$$L_{ik} = \frac{\partial Q_i}{\partial V_k} = V_i V_k Y_{ik}\sin\left(\theta_{ik} + \delta_i - \delta_k\right)$$
$$= V_i V_k\left[G_{ik}\sin\left(\delta_i - \delta_k\right) - B_{ik}\cos\left(\delta_i - \delta_k\right)\right] \ldots\ldots\ldots\ldots\ldots(27)$$

From equations (22) and (23), we have

$$H_{ik} = L_{ik} = V_i V_k\left[G_{ik}\sin\left(\delta_i - \delta_k\right) - B_{ik}\cos\left(\delta_i - \delta_k\right)\right]\ldots$$

The diagonal elements of H are given as:

$$H_{ii} = \frac{\partial P_i}{\partial \delta_i} = -\sum_{\substack{k=1 \\ k\neq i}}^{n} V_i V_k Y_{ik}\left[\sin\left(\theta_{ik} + \delta_i - \delta_k\right)\right]$$
$$= -Q_i + V_i V_k Y_{ii}\sin\theta_{ii} = -Q_i - V_i^2 B_{ii} \ldots\ldots\ldots\ldots\ldots(24)$$

Similarly diagonal elements for the matrix are given as

$$L_{ii} = \frac{\partial Q_i}{\partial V_i} = 2V_i^2 Y_{ii}\sin\theta_{ii} + \sum_{\substack{k=1 \\ k\neq i}}^{n} V_i V_k Y_{ik}\sin\left(\theta_{ik} + \delta_i - \delta_k\right)$$
$$= 2V_i^2 Y_{ii}\sin\theta_{ii} + Q_i - V_i^2 Y_{ii}\sin\theta_{ii}$$
$$= Q_i + V_i^2 Y_{ii}\sin\theta_{ii} = Q_i - V_i^2 B_{ii} \ldots\ldots\ldots\ldots(25)$$

In the case of fast decoupled power flow method of power flow studies the following approximations are made for evaluating Jacobian elements.

$$\left.\begin{array}{l} \text{Cos}(\delta i\text{-}\delta k)\approx 1 \\ \text{Giksin}(\delta i\text{-}\delta k) <= \text{Bik} \\ \text{Qi} << \text{BiiVi2} \end{array}\right\} \ldots\ldots(26)$$

With the above assumptions the Jacobian elements become

$$\left.\begin{array}{l} \text{Hik=Lik=-ViVkBik for } k \neq i \\ \text{And Hii=Lii=-Vi2 Bii} \end{array}\right\} \ldots\ldots (27)$$

With these Jacobian elements equations become

ΔPi=H Δδ =ViVk Bik' Δδk ……….. (28)

And ΔQi =L ΔV= ViVk Bik"ΔVk ……….. (29)

Where Bik' and Bik" are elements of –Bik matrix. Further decoupling and final algorithm for the fast-decoupled power-flow studies are obtained by.

(i) Omitting from B', the representation of those network elements that affect Mvar flows, i.e., shunt reactances and off-nominal in phase transformer taps.

(ii) Omitting from B", the angle shifting affects of phase shifters.

(iii) Dividing equations (28) and (29) by Vi and assuming Vk = 1.0 p.u and also neglecting series resistance in calculating the elements of B'.

With the above assumptions, equations (30) and (31) for the power flow studies become:
ΔPi/Vi=B' Δδ …………..(30)

And

ΔQi/Vi=B" ΔV …………..(31)

In the above equations B' and B" are real and sparse and have similar structures as those of H and L respectively. Since, they contain only network admittances, they are constant and do not change during successive iterations for solution of power flow problem, they need to be evaluated only once and inverted once during the first iteration and then used in all successive iterations. It is due to the nature of Jacobian matrices B' and B" and the sparsity of these matrices that the method is Fast. In this method of power flow studies, each cycle of iteration consists of one solution for Δδ to update δ and one solution for ΔV to update V. The iterations are continued till ΔP and ΔQ at all load buses and ΔP at all generation buses are within prescribed (or assumed) tolerances.

5 General

The software package used in this work includes the program (load flow project) which computes voltage magnitude and angle at each bus in a power system balanced three-phase steady –state operation.

To give an indication that the main program used in this study is proper, the computed bus voltages are then used by another program to compute generator, line, and transformer loading .

The bus admittance matrix is calculated from the input data using the following equalities.

For the first iteration , starting values of bus voltage magnitudes and angles are set equal to those of slack bus, except for voltage- controlled busses, whose voltage magnitudes are known. For subsequent,iteration with input data changes, the final values of run are used as starting values for the next run.

The Newton –Raphson procedure is terminated when the magnitudes of all power mismatches $\Delta P(r)$ and $\Delta Q(r)$ are less than a tolerance level (typically 0.0001 per unit) or when the number of iterations exceeds a maximum (typically 10). Both the tolerance level and maximum number of iterations are selected by the user.

In the fast Decoupled, the selection of maximum iteration depends on the size of the system.

Bus out data include voltage, real and reactive power of each generator and load, and identification of buses with voltage magnitude more than 5% above or below that of slack bus. Line out data include real and reactive power flows entering the terminals and identification of lines with MVA flows above their maximum ratings. Other useful out put include generation, load, and line loss totals, number of iterations to converge, and total mismatches ΔP and ΔQ after convergence. If desired, reactive power delivered by line capacitances or other shunt reactive elements can also be obtained.

The main calculation procedure folloed through that this work using the ready provided Matlab subprograms is generally shown in fig. 1

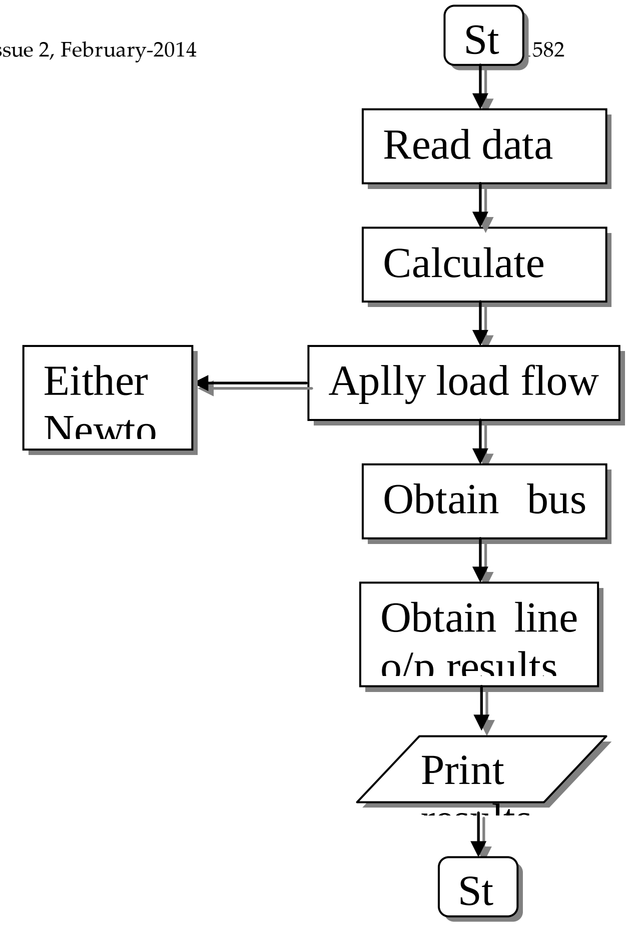

Fig. (1) General procedure Flow chart

6 Result and Discussion

The transmission level in the Iraqi electrical network consists of the 400kV network, (the super grid network) and 132 kV network connected to it. The aim of this work is limited to the 400kV network with all its bus-bars and transmission lines.

The network under consideration consists of 24 bus-bars and 37 transmission lines; with total length at 3711 km. Figure (2) shows a configuration of this network [16].

The model and program which are developed in the previous chapters are applied on the Iraqi super grid network (400kV).

The loads are represented by a static admittance and the lines by the nominal π sections. All network data expressed in per-unit referred to a common base power of 100MVA and common base voltage of 400kV. The results of the network load flow calculations are given in table (1). In the load flow solution, the Baijip.s. station is selected as reference.

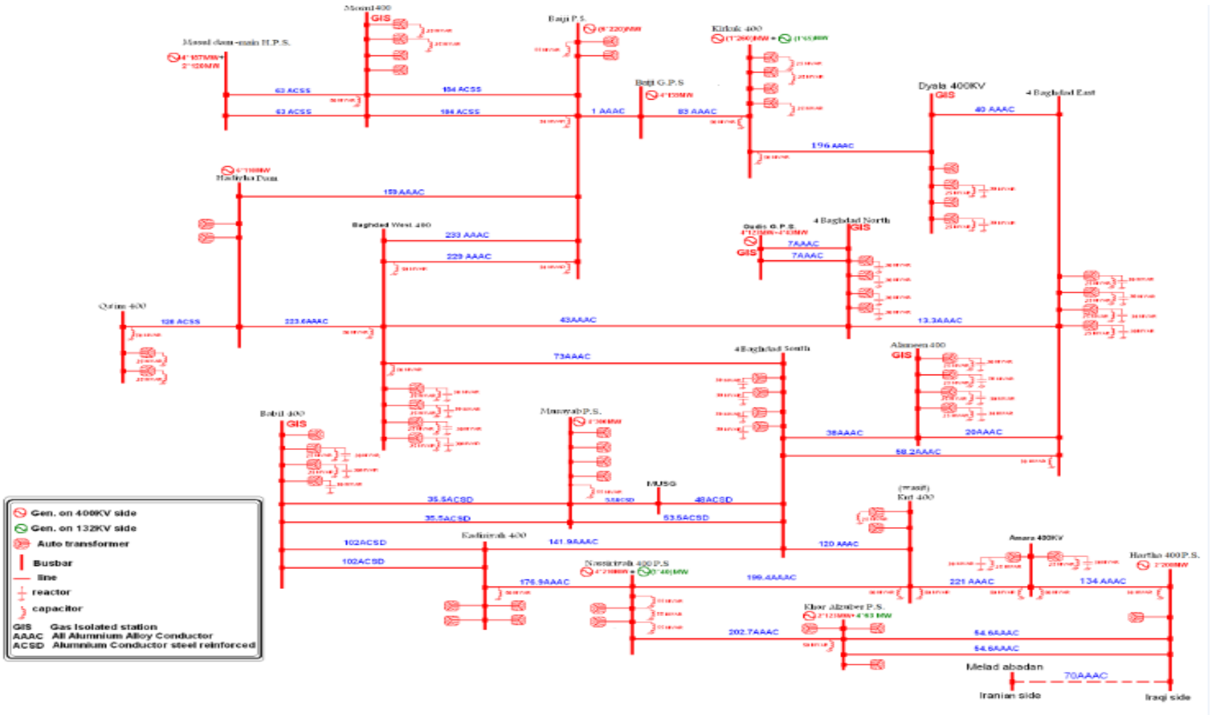

Fig.(2) Iraqi national supper grid (400kV).

6.1 METHOD ITERATION COUNT RELATION:

To quantify the effect of the power mismatches on the method performance,

theBase case load flow is only adopted.A mismatch of(0.1-1*10^-7) for both active and reactive powers is used in a study.Table(2) shows the results for the iteration count against the mismatch.If is clear for table(1)that N-R load flow iteration number is not much dependent on the mismatch range considered.Alternatively, the fast decoupled load flow iteration count is very much dependent on the mismatch ,i.e ,the lower mismatch the iteration number.

Table (2) iteration number against mismatch

Fast Decoupled load flow		Newton Raphson load flow	
mismatch	Iteration count	mismatch	Iteration count
0.1	4	0.1	3
0.01	5	0.01	3
0.001	7	0.001	3
0.0001	9	0.0001	4
0.00001	11	0.00001	4
0.000001	12	0.000001	4
0.0000001	14	0.0000001	4

6.2 THE METHOD OUTPUT ACCURACY

In order to realize the method accuracy with respect to a reference flow method, the following procedure followed:

i) A classical Newton Raphson algorithm is considered for the reference method.

ii) The fast decupled method is used as the method for an accuracy study.

iii) A system generation and load increase above the base case (considered here is 100% state)of 125% , 150% and 175% are considered .

iv) A system generation and the load decrease below the base case of 75%,50% and 25% are considered.

v) The accuracy is measured as the difference of a system physical variable for the same system operating condition when calculated in both the reference method and the method under study.

vi)The system variable considered here for the comparison are:

$|V_i|$:The bus voltage magnitude for all system buses.

δ_i :The bus voltage angle for all system buses.

ISSN 2229-5518

Qgi :The generated reactive power in all PV buses

Ploses: The system power active loses. And Qloses : The system power reactive loses.

6.3 ACCURACY RESULTS

Table(2)show the deviation (accuracy)of the system bus voltage magnitude for the difference system operating condition .if is interesting to net that the|Vi |is the same under the base condition for both the N-R, and fast decupled load flow. Also it is noted that the two methods almost meet in |Vi| the values the closer the operating condition to the base case and depart as the loadingincrease.The same observation is noted loading decrease. Figure (3) shows the deviation in plotted form for the result) Accuracy of |V| | for Iraqi power grid. Fig (4) shows variation in the voltage angular displacement for the twenty four Iraqi system buses. The method accuracy is sum what differs from that of|Vi|as there are deviations in the base case result too.

Fig.(5) gives the accuracy of the fast decupled method compared to the newton Raphson output the PV buses Q generated the results shows a wide range of variation fig.(5) present the Q generated results.

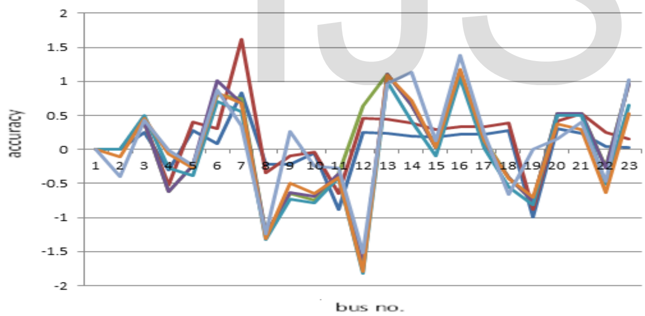

Fig.(3) Accuracy of |V| | for Iraqi power grid

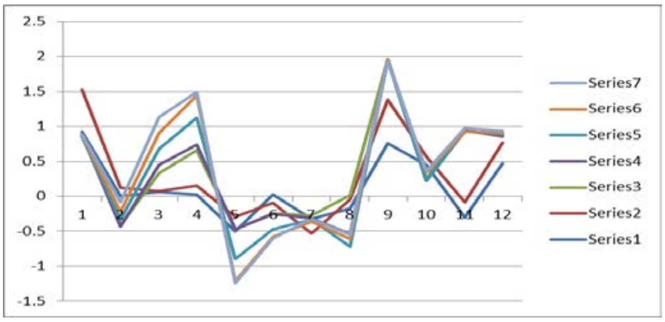

Fig.(4) Accuracy of δ for Iraqi power grid

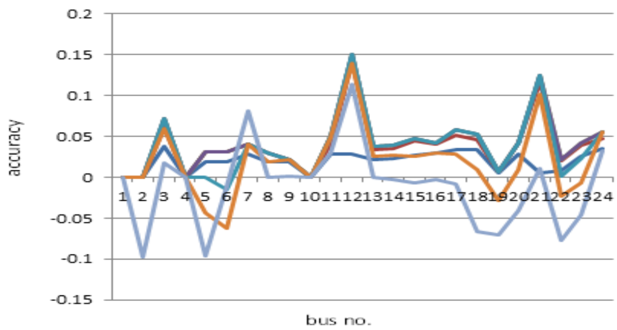

Fig. (5) Accuracy of Q for Iraqi power grid

7 CONCLUSIONS

a.The fast decoupled power flow solution required more iterations than the Newton-Raphson method, but required less time per iteration, and a power flow solution is obtained very rapidly. This technique is very useful in contingency analysis where numerous outages are to be simulated or a power flow solution is required for on-line control.

b.For fixed number of iterations the fast decoupled algorithm is not as accurate as the exact Newton-Raphson algorithm. But the saving in computer time is considered more important.

c.A very important limitation for Newton's method is that it dose not generally converge to solution from arbitrary starting point.

d.For large power systems the Newton-Raphson method is found to be more efficient and practical. The number of iterations required to obtain a solution is independent of the system size, but more functional evaluations are required at each iteration. In fast decoupled, the number of iterations is a function of system size.

e. Because of its quadratic convergence, Newton's method is mathematically superior to the Fast – Decoupled method, i.e. the number of iteration are less in Newton-Raphson.

f. The Newton-Raphson and Fast – Decoupled methods using the bus admittance matrix has the advantage that the tolerances are specified for the net real and reactive powers at a bus. The tolerances, therefore, are given directly in quantities that are meaningful to the engineer who specifies the desired accuracy.

REFERENCES

[1].W.D. Humpage, "Power system load flow analysis", 1967.

[2].J.B Gupta, "A course in power system" by s.k.kataria and sons, 2004.

ISSN 2229-5518

[3].W.F. Tinney and C.E. Hart, “Power flow solution by Newton’s method”, IEEE. Trans., PAS-89, PP.1449-1460, 1967.

[4]Notes on Power System Load Flow Analysis using an Excel Workbook

[5].B. Stott, “decoupled Newton load flow”, IEEE. Trans. PAS-91, PP.1972.

[6]S. elangovan and C.kanniyappan,”New contributions to load flow studies by the method of Reduction and Restoration”, Proc. IEEE, 217, 223, 1983.

[7].Brian Stott, “Review of load flow calculation methods”, proc.IEEE, vol.62, PP.916, July 1974.

[8].Stott B. Alsaco, “Fast decoupled load flow”, IEEE, trans. App, PAS-93, 859-869, Step.1974.

[9].Ali Abdul, “A study of some problems on the Iraqi National Grid and establishing a modified algorithm for load flow study”, M. Sc. Thesis, university of Baghdad, 1994.

[[10].hadi Saadat, “Power system analysis”, McGraw-Hill, 1999.

[11].Stagg, G.W and El-Abiad A.H., “Computer methods in power system analysis”, McGraw-Hill, 1968.

[12].A.E Guile and W. Paterson, “Electrical power systems vol. 2 ”, Oliver and Boyd. Edinburgh, 1972.

[13].K. Prabhashankar and Wasyt Janisehewyj, “Digital simulation of multi-machine power system for stability studies”, IEEE. Trans. Vol. PAS-87, No.1 Jan 1968.

[14].L.P. Singhe, “ Advanced power system analysis and Dynamics”, 1983.

[15]. J. Duncan Glover and Mulukutal, “Power system analysis and design”, Pws Publishing company, Boston USA, 1994.

[16].National Dispatch Centre (NDC), Baghdad, Iraq, 2006.

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