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Reactive Power Compensation Using Statcom

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Abstract
As technology advances, the demand for electrical energy also increases. Electricity demand has become a measure for the country's development. Since the operating lines must operate close to their thermal stability limits, the electrical equipment must use the available transmission capacity to meet the demand and large power. Lines operating near or above the thermal stability limit will cause system malfunction or even system failure. One way to increase the transmission capacity without operating the casing to the limit of its thermal stability is to provide reactive power compensation at different locations. Reactive power compensation can improve the power distribution of the system, increase power transmission in the line and reduce losses. This article attempts to use a statcom for power compensation. To examine the effects, an electrical study was performed on the standard ieee (institute of electrical and electronics engineering) ieee 30 bus with and without statcom, and the results were then compared to demonstrate the presence of statcom placing statcom in the system. Newton-raphson method is used to study the load flow.the simulation was performed using matlab (matrixlaboratories).

Keywords:- *statcom,facts devices,svc,ieee bus,newton-raphson*

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I. INTRODUCTION

The term "power flow" refers to the active and reactive power flows occurring under steady-state conditions in the power system. These power measurements are important for continuous monitoring and verification of power systems to meet increasing demand.

In fact, these loadflow energy studies are often used for energy planning and security assessment and sustainable performance evaluation. Use renewable energy to reduce transmission loss. Reactive power compensation is also used to control transmission capacity and control electrical equipment. Control of line impedance in transmission lines is called series compensation. Changing the line impedance means that capacitive or inductive compensation is taken, thus the active power is controlled. TCSCs (Thyristor Controlled Series Capacitors) are connected in series to improve power transfer.

Balance is used to improve the efficiency of energy conversion and control energy distribution. STATCOM (Static Compensator) is a shunt compensator belonging to the FACTS devices category for use on power lines. They are used to control power systems. Applications such as scheduling power, reducing symmetric line components, reducing power oscillations and improving stability.

Large connections cause more power and more stress. Voltage sag frequently occurs in such high-load power systems. The main reason for this situation is that the electrical power cannot meet the reactive power demand of the load. The main reason for this is that the production and transmission of reactive power is limited . Traditionally the reactive power flow is controlled by compensation and other devices such as shunt reactors, shunt capacitors and rotary synchronization capacitors. The introduction of high-speed devices such as Flexible AC Transmission System (FACTS) controllers has proven to be an effective solution for reactive power management. These controllers are widely used in digital applications. Increase power transmission capacity, increase the capacity of the transmission line, improve voltage stability, reduce loss in the system, reduce power swing,

Among various FACTS controllers, STATCOM is one of the important controllers. It is a frequently used connecting device to improve power management and increase the ability to increase power.

II. THE STATCOM- STRUCTURE AND OPERATION

STATCOM is one of the most widely used and versatile FACTS device. With the emergence of a new generation of electronic devices – high power-gate thyristors and transistor components (GTO, IGBT ...) are widely used in electronic systems. Voltage Source Converter (VSC) is a simple electronic component of STATCOM that converts DC voltage into three-phase output voltage with desired amplitude, frequency and phase. Show a simple diagram o f a VSC-based STATCOM. It consists o f shunt transformer , VSC, DC capacitor, magnetic circuit an d controller. STATCOM can generate or absorb reactive power by controlling the output voltage amplitude of the VSC relative to the bus voltage. STATCOM generates reactive power when the VSC voltage leads the bus voltage; STATCOM absorbs reactive power when the VSC voltage lags behind the bus voltage.

A device that absorbs or injects power to control the voltage to matain the line stability. STATCOM is connected in parallel to the line and creates a controlled voltage to source or reduce impact of reactive power. They are used in many applications such as voltage control, power correction and grid support in fault or transient situations.

The STATCOM uses power electronics and it is a shunt connected device connected through the coupling transformer at the mid-point of the transmission line.

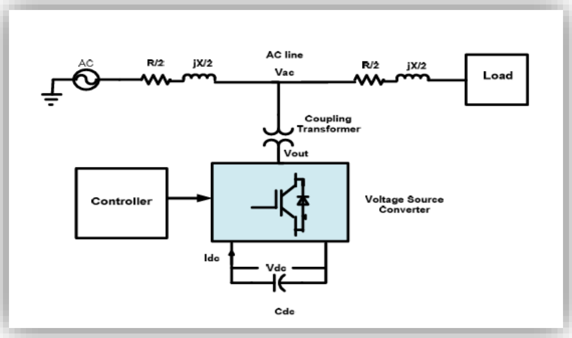


Fig.1 VSC-based STATCOM

The STATCOM includes a coupling transformer, a converter/inverter circuit, and a DC capacitor as shown in Figure 1 above. The ideal case analysis for this arrangement assumes that the active power exchange between the AC system and the STATCOM is negligible and only reactive power can be exchanged between them. When the magnitude of the output voltage increases more than the system voltage, current flows from the inverter to the AC system through reactance and the inverter produces the capacitive energy used in the AC. number plate. On the other hand, if the amplitude of the output voltage is lower than the amplitude of the AC grid, the reactive current flows from the AC system to the inverter, which absorbs the inductive energy. Moreover, when the amplitude of the output voltage is equal to the AC mains voltage, the reactive power flow becomes zero. The output of the reactive current depends on the Thyristor firing angle Î± range derived from the phase change of the STATCOM voltage E and the bus voltage V. According to the firing angle Î±, the state of the thyristor value DC capacitor changes and hence the amplitude of the STATCOM bus voltage E changes. STATCOM. The difference between the amplitude of the busbar voltage and the reactance XT of the power grid and transformer determines the size of the reactive current injected into power system, as shown in Equation .

$$I = \frac{V-E}{X_{rr}} \quad (1)$$

III. MODELING OF POWER SYSTEMS WITH FACTS CONTROLLERS

Calculation of electric power flow is necessary to study problems in the operation and control of energy. These calculations can ensure continuous operation. Regarding the study of power flow of the STATCOM, specific objectives are

-- to determine the proper location and measurement of the STATCOM.
- Provides information on the effects ofl active and reactive power flow under normal and abnormal conditions.
- Provide initial conditions for stability research.
-Identify critical, emergency and res electrical transmissions.

The symbolic representation of a power system consisting of multiple generators, multiple loads, and a STATCOM is shown in the block diagram in figure. The connection between different elements communication network can be modeled by their recognition (Y matrix). It should be noted that the power capability model of the system expresses the net active/reactive energy of each busbar injected into all other busbar voltages (magnitude and angle). In addition, such a model can be easily integrated into a power flow algorithm, especially the Newton-Raphsonflow algorithm. FACTS controllerless power system The power flow balance equation between buses (bus i) without flexible ac transmission system can be represented as:

$$P_{in} = P_{Gini} - P_{Loi} = \sum_{j=1}^{N} |V_i||V_k||Y_{ik}|(\cos\delta_i - \delta_j - \theta_{ik})$$

$$Q_{in} = Q_{Gini} - Q_{Loi} = \sum_{j=1}^{N} |V_i||V_k||Y_{ik}|(\cos\delta_i - \delta_j - \theta_{ik})$$

(2)

Among the buses i = 1,2, 3…..N, bus 1 is used as slack bus and N are all buses. Please refer to Figure 2 , there are FACTS devices say k and m respectively,

$$P_{ik} = P_{Genk} - P_{Loadk} + P_{kpowerinj} = \sum_{j=1}^{N} |V_i||V_k||Y_{ik}|(\cos\delta_i - \delta_j - \theta_{ik})$$

$$Q_{ik} = Q_{Genk} - Q_{Loadk} + Q_{kpowerinj} = \sum_{j=1}^{N} |V_i||V_k||Y_{ik}|(\cos\delta_i - \delta_j - \theta_{ik})$$

(3)

$$P_{im} = P_{Genm} - P_{Loadm} + P_{mpowerinj} = \sum_{j=1}^{N} |V_i||V_k||Y_{ik}|(\cos\delta_i - \delta_j - \theta_{ik})$$

$$Q_{im} = Q_{Genm} - Q_{Loadm} + Q_{mpowerinj} = \sum_{j=1}^{N} |V_i||V_k||Y_{ik}|(\cos\delta_i - \delta_j - \theta_{ik})$$

(4)

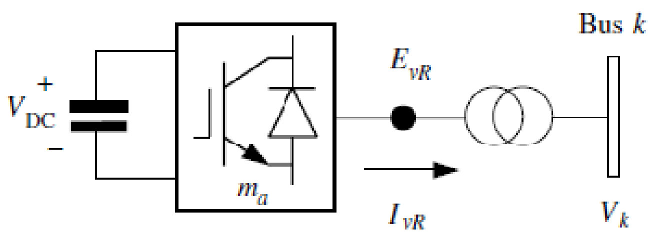
Buses t and k can be designated as PV or PQ buses, like other buses in the network. The energy flow equation shown in (1) is solved iteratively using the linearized Jacobian equation given . This equation is as follows:

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

Where,

$$J1 = \partial P/\partial\hat{\partial}, J2 = \partial P/\partial|V|, J3 = \partial Q/\partial\hat{\delta}$$
$$J4 = \partial Q/\partial|V|$$

The main purpose of this is to solve the problem of power flow in the system with FACTS controller - STATCOM in more severe loaded conditions .The existence of the FACTS controller is satisfied in (2) and (3). Jacobian equation (4) detailed and/or modify accordingly



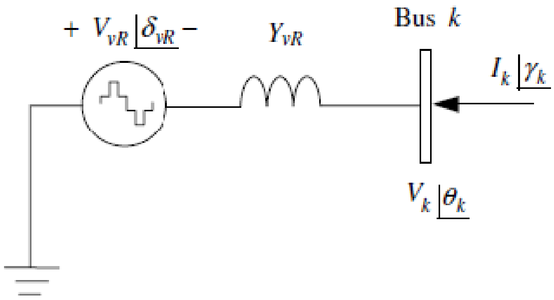


Fig. 2 Equivalent circuit of STATCOM

A, Power Flow Model of STATCOM

To realize the advantages of STATCOM in improving power distribution and transmission capacity, the STATCOM power flow model needs to be examined. This should have an accurate representation of steady-state STATCOM. The schematic diagram of STATCOM and its equivalent circuit is shown in figures . 2 (a) and (b) accordingly.

The bus connected to STATCOM is represented as a PV bus and can be converted to a PQ bus in case of any limitations. In this case, the generated or absorbed reactive power will correspond to the fault limit . According to the equivalent circuit of STATCOM shown in Figure 3, the power balance for the converter and bus k can be deduced as shown

$$P_{vR} = -V_{vR}^2 G_{vR} + V_{vR}V_k[G_{vR}\cos(\delta_{vR} - \theta_k) - B_{vR}\cos(\delta_{vR} - \theta_k)] \quad (5)$$

$$Q_{vR} = -V_{vR}^2 B_{vR} + V_{vR}V_k[G_{vR}\sin(\delta_{vR} - \theta_k) - B_{vR}\cos(\delta_{vR} - \theta_k)] \quad (6)$$

$$P_k = V_k^2 G_{vR} + V_k V_{vR}[G_{vR}\cos(\theta_k - \delta_{vR}) + B_{vR}\sin(\theta_k - \delta_{vR})] \quad (7)$$

$$Q_k = -V_k^2 B_{vR} + V_k V_{vR}[G_{vR}\sin(\theta_k - \delta_{vR}) - B_{vR}\cos(\theta_k - \delta_{vR})] \quad (8)$$

B.STATCOM constrains
:

$$P_{Shunt} + jQ_{Shunt} = V_{Shunt}\angle\theta_{Shunt}\left(\frac{V_i\angle\theta_i - V_{Shunt}\angle\theta_{Shunt}}{Z_{Shunt}}\right)$$

(9)

where ,
Vsh – It is the STATCOM controllable voltage source .
It is used to control the bus voltage.

The limitation for operation of the STATCOM is active power exchange through the DC link

$$PE_X = R_{REA}(V_{Shunt} I_{Shunt} *) = 0$$

(10)

$$V_I - V_I^{Spec} = 0$$

(11)

where
Vi∠θi – It is the ith bus complex voltage
Vsh∠θsh - STATCOM complex voltage
Zsh - impedance of the shunt transformer
Psh+Qsh – It is the apparent power
Vi spec - bus voltage control

C. Implementation of STATCOM in Newton-Raphson
Power Flow Solution.

Since the power exchange with the DC bus must always be zero, the STATCOM has only one degree of control freedom. The compact Newton-Raphson power flow algorithm using STATCOM is given as follows:

$$F(Y) = J\ (\Delta Y)$$

(12)

Where

X - is the solution vector,

J- is the partial derivative matrix of F(Y) with respect to Y (i.e. the Jacobian matrix), which can be calculated as:

$$\mathrm{F(Y)} = \begin{bmatrix} \Delta \mathrm{P_k} \\ \Delta \mathrm{Q_k} \\ \Delta \mathrm{P_{vR}} \\ \Delta \mathrm{Q_{vR}} \end{bmatrix}, \quad (13) \qquad \Delta \mathrm{Y} = \begin{bmatrix} \Delta \theta_\mathrm{k} \\ \frac{\Delta \mathrm{V_k}}{\mathrm{V_k}} \\ \Delta \delta_\mathrm{vR} \\ \frac{\Delta \mathrm{V_{vR}}}{\mathrm{V_{vR}}} \end{bmatrix} \quad (14)$$

$$\mathrm{J} = \begin{bmatrix} \frac{\partial \mathrm{P_k}}{\partial \theta_\mathrm{k}} & \frac{\partial \mathrm{P_k}}{\partial \mathrm{V_k}} \mathrm{V_k} & \frac{\partial \mathrm{P_k}}{\partial \delta_\mathrm{vR}} & \frac{\partial \mathrm{P_k}}{\partial \mathrm{V_{VR}}} \mathrm{V_{vR}} \\ \frac{\partial \mathrm{Q_k}}{\partial \theta_\mathrm{k}} & \frac{\partial \mathrm{Q_k}}{\partial \mathrm{V_k}} \mathrm{V_k} & \frac{\partial \mathrm{Q_k}}{\partial \delta_\mathrm{vR}} & \frac{\partial \mathrm{Q_k}}{\partial \mathrm{V_{vR}}} \mathrm{V_{vR}} \\ \frac{\partial \mathrm{P_{vR}}}{\partial \theta_\mathrm{k}} & \frac{\partial \mathrm{P_{vR}}}{\partial \mathrm{V_k}} \mathrm{V_k} & \frac{\partial \mathrm{P_{vR}}}{\partial \delta_\mathrm{vR}} & \frac{\partial \mathrm{P_{vR}}}{\partial \delta_\mathrm{vR}} \mathrm{V_{vR}} \\ \frac{\partial \mathrm{Q_{vR}}}{\partial \theta_\mathrm{k}} & \frac{\partial \mathrm{Q_{vR}}}{\partial \mathrm{V_k}} \mathrm{V_k} & \frac{\partial \mathrm{Q_{vR}}}{\partial \delta_\mathrm{vR}} & \frac{\partial \mathrm{Q_{vR}}}{\partial \delta_\mathrm{vR}} \mathrm{V_{vR}} \end{bmatrix} \quad (15)$$

Where,

the active and reactive power mismatches at the bus K and converter ΔPk, ΔQk, ΔPvR, and ΔQvR .

The sum of active and reactive powerflows leaving the bus K and the converter, respectively are Pk, Qk, PvR and QvR.

The modified Jacobian matrix here gets compared in the presence of STATCOM and therefore it is called as "augmentedJacobian matrix". Size of the matrix depends on t controllers. The matrix dimensions are given as :

$$\mathrm{J1}\left(\mathrm{n_{pq}} + \mathrm{n_{pv}} + \mathrm{n_c}\right) \text{ by } \left(\mathrm{n_{pq}} + \mathrm{n_{pv}} + \mathrm{n_c}\right)$$
$$\mathrm{J2}\left(\mathrm{n_{pq}} + \mathrm{n_{pv}} + \mathrm{n_c}\right) \text{ by } \left(\mathrm{n_{pq}}\right)$$
$$\mathrm{J3}\left(\mathrm{n_{pq}}\right) \text{ by } \left(\mathrm{n_{pq}} + \mathrm{n_{pv}} + \mathrm{n_c}\right)$$
$$\mathrm{J4}\left(\mathrm{n_{pq}}\right) \text{ by } \left(\mathrm{n_{pq}}\right)$$

(15)

Where,

Nc- number of STATCOM's

IV. FLOWCHART

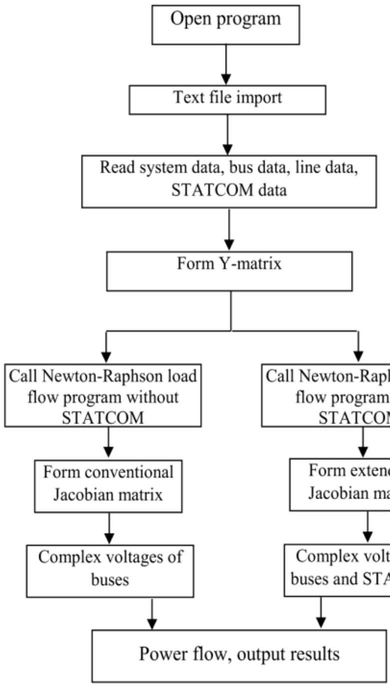


Fig.4 Flowchart

V. STRUCTURE OF PROGRAM ALGORITHM

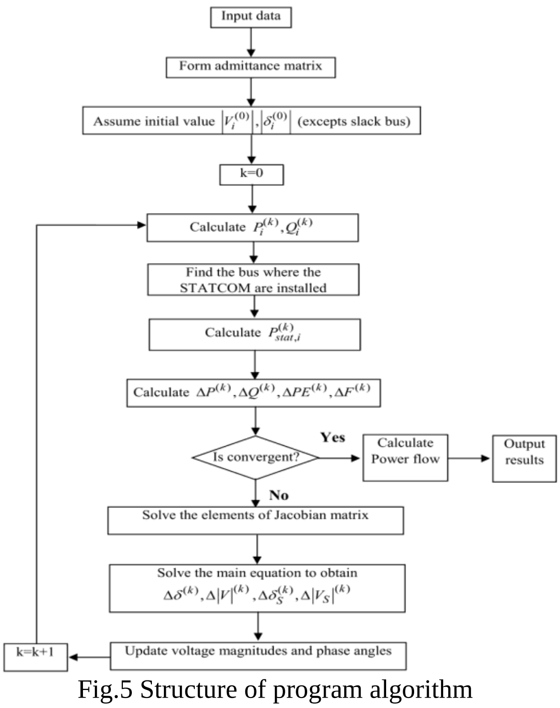


Fig.5 Structure of program algorithm

VI. IMPLEMENTATION AND RESULTS

Bus data (Display from MATLAB)

```
function busdata = busdata30()
%          |Bus | Type | Vsp | theta | PGi | QGi | PLi | QLi |  Qmin | Qmax |
busdata = [ 1     1    1.06    0       0     0     0     0     0       0;
            2     2    1.043   0      40   50.0  21.7  12.7   -40     50;
            3     3    1.0     0       0     0    2.4   1.2    0       0;
            4     3    1.0     0       0     0    7.6   1.6    0       0;
            5     2    1.01    0       0   37.0  94.2  19.0   -40     40;
            6     3    1.0     0       0     0    0.0   0.0    0       0;
            7     3    1.0     0       0     0   22.8  10.9    0       0;
            8     2    1.01    0       0   37.3  30.0  30.0   -10     40;
            9     3    1.0     0       0     0    0.0   0.0    0       0;
           10     3    1.0     0       0     0    5.8   2.0    0       0;
           11     2    1.082   0       0   16.2   0.0   0.0   -6      24;
           12     3    1.0     0       0     0   11.2   7.5    0       0;
           13     2    1.071   0       0   10.6   0.0   0.0   -6      24;
           14     3    1.0     0       0     0    6.2   1.6    0       0;
           15     3    1.0     0       0     0    8.2   2.5    0       0;
           16     3    1.0     0       0     0    3.5   1.8    0       0;
           17     3    1.0     0       0     0    9.0   5.8    0       0;
           18     3    1.0     0       0     0    3.2   0.9    0       0;
           19     3    1.0     0       0     0    9.5   3.4    0       0;
           20     3    1.0     0       0     0    2.2   0.7    0       0;
           21     3    1.0     0       0     0   17.5  11.2    0       0;
           22     3    1.0     0       0     0    0.0   0.0    0       0;
           23     3    1.0     0       0     0    3.2   1.6    0       0;
           24     3    1.0     0       0     0    8.7   6.7    0       0;
           25     3    1.0     0       0     0    0.0   0.0    0       0;
           26     3    1.0     0       0     0    3.5   2.3    0       0;
           27     3    1.0     0       0     0    0.0   0.0    0       0;
           28     3    1.0     0       0     0    0.0   0.0    0       0;
           29     3    1.0     0       0     0    2.4   0.9    0       0;
           30     3    1.0     0       0     0   10.6   1.9    0       0 ];
```

Case 1: Under steady state condition

After executing the program the results are as follows

```
>> nrlfppg
-----------------------------
|  Bus   |    V     |  Angle   |
|  No    |    pu    |  Degree  |
-----------------------------
    1       1.0600      0.0000
    2       1.0430     -5.3543
    3       1.0196     -7.5308
    4       1.0104     -9.2840
    5       1.0100    -14.1738
    6       1.0096    -11.0581
    7       1.0020    -12.8649
    8       1.0100    -11.8193
    9       1.0392    -14.0644
   10       1.0215    -15.6706
   11       1.0820    -14.0644
   12       1.0496    -15.1245
   13       1.0710    -15.1245
   14       1.0320    -16.0018
   15       1.0251    -16.0084
   16       1.0304    -15.6251
   17       1.0188    -15.8687
   18       1.0114    -16.6067
   19       1.0066    -16.7658
   20       1.0095    -16.5502
   21       1.0082    -16.2178
   22       1.0120    -15.9811
   23       1.0085    -16.2294
   24       0.9991    -16.3007
   25       1.0032    -16.0720
   26       0.9852    -16.5038
   27       1.0145    -15.6559
   28       1.0078    -11.7163
   29       0.9944    -16.9077
   30       0.9828    -17.8067
-----------------------------
```

Under the steady state condition all the bus voltages are near to 1 pu.

Case 2: When load is increased to 90% (Without STATCOM)

Now by using inspection method increasing the load to 90% at bus 26 and 30.

Bus data

```
function busdata = busdata30()
%          |Bus | Type | Vsp | theta | PGi | QGi | PLi | QLi |  Qmin | Qmax |
busdata = [ 1     1    1.06    0       0     0     0      0      0       0;
            2     2    1.043   0      40    50.0  21.7   12.7   -40     50;
            3     3    1.0     0       0     0     2.4    1.2    0       0;
            4     3    1.0     0       0     0     7.6    1.6    0       0;
            5     2    1.01    0       0    37.0  94.2   19.0   -40     40;
            6     3    1.0     0       0     0     0.0    0.0    0       0;
            7     3    1.0     0       0     0    22.8   10.9    0       0;
            8     2    1.01    0       0    37.3  30.0   30.0   -10     40;
            9     3    1.0     0       0     0     0.0    0.0    0       0;
            10    3    1.0     0       0     0     5.8    2.0    0       0;
            11    2    1.082   0       0    16.2   0.0    0.0   -6      24;
            12    3    1.0     0       0     0    11.2    7.5    0       0;
            13    2    1.071   0       0    10.6   0.0    0.0   -6      24;
            14    3    1.0     0       0     0     6.2    1.6    0       0;
            15    3    1.0     0       0     0     8.2    2.5    0       0;
            16    3    1.0     0       0     0     3.5    1.8    0       0;
            17    3    1.0     0       0     0     9.0    5.8    0       0;
            18    3    1.0     0       0     0     3.2    0.9    0       0;
            19    3    1.0     0       0     0     9.5    3.4    0       0;
            20    3    1.0     0       0     0     2.2    0.7    0       0;
            21    3    1.0     0       0     0    17.5   11.2    0       0;
            22    3    1.0     0       0     0     0.0    0.0    0       0;
            23    3    1.0     0       0     0     3.2    1.6    0       0;
            24    3    1.0     0       0     0     8.7    6.7    0       0;
            25    3    1.0     0       0     0     0.0    0.0    0       0;
            26    3    1.0     0       0     0     4.55   23    0       0;
            27    3    1.0     0       0     0     0.0    0.0    0       0;
            28    3    1.0     0       0     0     0.0    0.0    0       0;
            29    3    1.0     0       0     0     2.4    0.9    0       0;
            30    3    1.0     0       0     0     13.78    23   0       0 ];
```

After executing the program with 90% increase of load the results are as follows:

Bus No	V pu	Angle Degree
1	1.0600	0.0000
2	1.0330	-5.6381
3	0.9996	-7.9501
4	0.9859	-9.8332
5	1.0100	-15.1003
6	0.9812	-11.7028
7	0.9850	-13.6412
8	0.9900	-12.6663
9	0.9907	-15.5093
10	0.9588	-17.6145
11	1.0420	-15.5093
12	1.0082	-16.9607
13	1.0410	-16.9607
14	0.9843	-17.9825
15	0.9714	-17.9289
16	0.9796	-17.5182
17	0.9593	-17.8184
18	0.9538	-18.6233
19	0.9468	-18.8176
20	0.9490	-18.5814
21	0.9377	-18.2122
22	0.9233	-18.0118
23	0.9359	-18.2134
24	0.8773	-18.2096
25	0.7658	-17.2145

26	0.5969	-12.0401
27	0.7872	-18.0328
28	0.9592	-12.1306
29	0.6922	-18.9485
30	0.6028	-19.0563

From the results we can observe that when the load is increased to 90% the voltage pu near the bus 26 and 30 have decreased to 0.5969 near bus 26 and 0.6028 near bus 30.

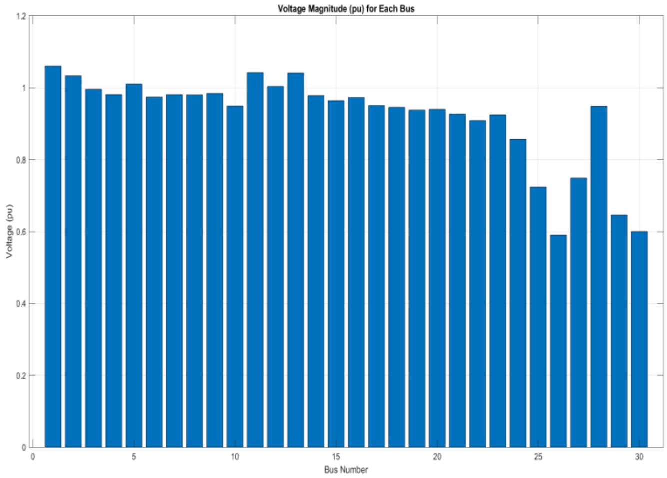


Fig.6 Voltage magnitude without statcom

Case 3: After placing STATCOM at the buses (26&30) that are impacted.
Now by using inspection method the reactive power is injected using statcom near bus 26 and 30.

Bus data

```
function busdata = busdata30()
%          |Bus | Type | Vsp | theta | PGi | QGi | PLi | QLi |  Qmin | Qmax |
busdata = [ 1     1    1.06    0      0     0     0     0      0      0;
            2     2    1.043   0     40   50.0  21.7  12.7   -40     50;
            3     3    1.0     0      0     0    2.4   1.2     0      0;
            4     3    1.0     0      0     0    7.6   1.6     0      0;
            5     2    1.01    0      0   37.0  94.2  19.0   -40     40;
            6     3    1.0     0      0     0    0.0   0.0     0      0;
            7     3    1.0     0      0     0   22.8  10.9     0      0;
            8     2    1.01    0      0   37.3  30.0  30.0   -10     40;
            9     3    1.0     0      0     0    0.0   0.0     0      0;
           10     3    1.0     0      0     0    5.8   2.0     0      0;
           11     2    1.082   0      0   16.2   0.0   0.0    -6     24;
           12     3    1.0     0      0     0   11.2   7.5     0      0;
           13     2    1.071   0      0   10.6   0.0   0.0    -6     24;
           14     3    1.0     0      0     0    6.2   1.6     0      0;
           15     3    1.0     0      0     0    8.2   2.5     0      0;
           16     3    1.0     0      0     0    3.5   1.8     0      0;
           17     3    1.0     0      0     0    9.0   5.8     0      0;
           18     3    1.0     0      0     0    3.2   0.9     0      0;
           19     3    1.0     0      0     0    9.5   3.4     0      0;
           20     3    1.0     0      0     0    2.2   0.7     0      0;
           21     3    1.0     0      0     0   17.5  11.2     0      0;
           22     3    1.0     0      0     0    0.0   0.0     0      0;
           23     3    1.0     0      0     0    3.2   1.6     0      0;
           24     3    1.0     0      0     0    8.7   6.7     0      0;
           25     3    1.0     0      0     0    0.0   0.0     0      0;
           26     3    1.0     0      0   15.3   4.55  23      0      0;
           27     3    1.0     0      0     0    0.0   0.0     0      0;
           28     3    1.0     0      0     0    0.0   0.0     0      0;
           29     3    1.0     0      0     0    2.4   0.9     0      0;
           30     3    1.0     0      0   16.5  13.78  23      0      0 ];
```

After executing the program with implementation of STATCOM near bus 26 and 30 ,the results are as follows:

Bus No	V pu	Angle Degree
1	1.0600	0.0000
2	1.0430	-5.4750
3	1.0177	-7.6965
4	1.0081	-9.4925
5	1.0100	-14.3858
6	1.0070	-11.3030
7	1.0004	-13.0976
8	1.0100	-12.1211
9	1.0318	-14.4429
10	1.0129	-16.1302
11	1.0720	-14.4429
12	1.0461	-15.5693
13	1.0710	-15.5693
14	1.0273	-16.4692
15	1.0191	-16.4656
16	1.0247	-16.0753
17	1.0110	-16.3274
18	1.0044	-17.0746
19	0.9990	-17.2378
20	1.0017	-17.0197
21	0.9986	-16.6945
22	0.9992	-16.4864
23	0.9987	-16.7083
24	0.9810	-16.8315
25	0.9659	-16.6712
26	0.9216	-16.5233
27	0.9792	-16.5203
28	1.0019	-11.9698
29	0.9462	-17.9626
30	0.9211	-19.0630

From the results we can observe that when the STATCOM is incorporated near the effected buses the voltage pu near the bus 26 and 30 have increased to 0.9216 near bus 26 and 0.6211 near bus 30.

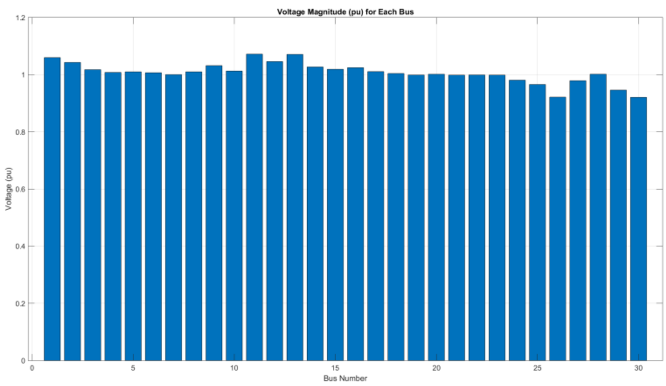


Fig.7 Voltage magnitude witht statcom

Comparison

TABLE 1

Comparision of voltage magnitudes with and without statcom

S.no	Bus no.	Before placing STATCOM Vpu	After placing STATCOM Vpu
1	26	0.5969	0.9216
2	30	0.6028	0.9211

The voltage profile of the network is hence improved with the incorporation of STATCOM in the network

VI. Conclusion

In this paper reactive power compensation using STATCOM is presented using MATLAB program by taking Newton-Raphson method into consideration for load flow analysis in power system. The MATLAB program is developed for the Newton-Raphson load flow algorithm incorporating STATCOM and the program implemented for IEEE 30 bus system. The results before and after implementation of STATCOM are simulated and are shown and compared. The voltage profile of the network is hence improved with the incorporation of STATCOM in the network

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