A SOFTWARE APPROACH AND ANALYSIS IN VOLTAGE STABILITY AND IMPROVEMENT OF A POWER NETWORK

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ABSTRACT-Power demand increases steadily while the expansion of power generation, transmission has been severely limited due to inadequate resource and environmental forces. As demand is increasing day by day, the generation cannot be increased with matching of demands because fossil fuel is restricted and cost factors are there. The load area are far away from generation side so only one possibility to give the power to load area by minimizing the losses of transmission lines by proper analyzing of transient stability. The voltage stability is not match standard values for all period of times when the line is heavily loaded severe transient oscillations will occurs. In peak hour period, at that period if fault is also occurred due to unbalance current flow through the transmission network as a result a severe voltage oscillation occurred in transmission lines. As we are not get enough tariff from distribution section, then loss will become more costly. So it is very much necessary to analyses transient stability, voltage stability and power flow through power network systems. There are several methods for analyzing voltage and transient stability like FACTS devices etc. But all these methods create extra cost for transmission and Generation Company which will be bear by them only. So here we analyses simulation method i.e. capacitor improvement method for voltage stability.

Keywords:-Voltage Stability, line Compensation, load compensation, Series capacitor, Dynamic stability, Stability Analysis, Load Analysis.

INTRODUCTION

Voltage control and stability problems are very much familiar to the electric utility industry but are now receiving special attention by every power system analyst and researcher. With growing size along with economic and environmental pressures, the possible threat of voltage instability is becoming increasingly pronounced in power system networks. In recent years, voltage instability has been responsible for several major networks collapses in New York, France, Florida, Belgium, Sweden and Japan, even in India also. Research workers, R and D organizations and utilities throughout the world, are busy in understanding, analyzing and developing newer and newer strategies to cope up with the menace of voltage instability/collapse.

As in all power systems, the larger machines are of the synchronous type; these include substantially all the generators and condensers, and a considerable part of motors. On such systems it is necessary to maintain synchronism will not be achieved. The transient disturbances are caused by the changes in loads, switching operations and, particularly, faults and loss of excitations. Thus, maintenance of synchronism during steady state conditions and regaining of synchronism or equilibrium after a disturbance are of prime importance to the electrical utilities. The term ‘stability’ can be interpreted as ‘maintenance of synchronism.

At any point of time, a power system operating condition should be stable, meeting various operational criteria, and it should also be secure in the event of any credible contingency. Present day power systems are being operated closer to their stability limits due to economic and environmental constraints. Maintaining a stable and secure operation of a power system is therefore a very important and challenging issue.

Voltage stability implies that to maintain a steady acceptable voltages at all buses in the system. A system enters a state of voltage instability when a disturbance, increase in load demand inability of a power system to meet the demand for reactive power. A criterion for voltage stability is that, bus voltage magnitude increase as reactive power injection at the same bus increase.

The present trend is towards interconnection of the power systems; resulting into increased lengths and increased reactance’s of the system, this presents an acute problem of maintenance of stability of the system. The term ‘Power limit’ is also sometimes interpreted as ‘Stability’ because to have the maximum utility of the system it should be capable of supplying maximum power without causing instability. Power system stability, in general terms, and may be defined as it’s to respond to a disturbance from its normal operation by returning to a condition where the operation is again normal.

ADVANTAGES OF POWER COMPENSATIONS IN POWER NETWORKS

For reduction of cost and improved reliability, most of the world's electric power systems continue to be interconnected. Interconnections take advantages of diversity of loads, availability of sources and fuel price for supplying power to loads at minimum cost and pollution with a required reliability. In a deregulated electric service environment, an effective electric grid is essential to the competitive environment of reliable electric service.

Now a day, greater demands have been placed on the transmission network, and these demands will continue to rise because of the increasing numbers of non utility generators and greater competition among utilities themselves. It is not easy to acquire new rights of way. Increased demands on transmission, albescence of long term planning and the need to provide open access to generating companies and customers have resulted in less security and reduced quality of supply.

Compensation in power systems is, therefore, essential to alleviate some these problems, series/shunt compensations has been use for past many years to achieve this objective. In power system, the insignificant electrical storage, power generation and load must be balanced at all times. In some extent, we can say that, the electrical system is self regulating, when transient oscillations occurred in any transmission lines, system has ability to overcome the oscillation, but if it is not possible to overcome oscillations then voltage instability occurs. Another reasons of instability occurs in power system is if the generation is less than load, voltage and frequency drop will occurred. To overcome from these problems used to reduce load levels or increases generation by manuals or automatic controlling of load frequency and automatic voltage controller, by controlling the inputs of boilers and excitations, then only the instability can be improved. If voltage is propped up with reactive power support, then load increase with consequent drop in frequency may result in system collapse or inadequate reactive power, the system voltage collapse. So here we have used series compensations for improved the voltage stability.

LOADING CAPABILITY

There are three kinds of limitations for loading capacity of transmission system

i)Thermal

ii)Dielectric

iii)Stability

Thermal Capability of an overhead line is a function of the ambient temperature, wind conditions, conditions of the conductor and ground clearance. There is a possibility of converting a single circuit to a double –circuit line to increase the loading capability.

Dielectric limitations:-From insulation point of view, many lines are designed very conservatively. For a given nominal voltage rating it is often possible to increase normal operating voltages by 10% (400 KV-440 KV).So one should however, ensure that dynamic and transient over voltages are within limits.

Stability issues:- There are certain stability issues that limit the transmission capability. These include steady-state –stability, transient stability, dynamic stability, frequency collapse, voltage collapse and sub synchronous resonance.

The load and Line compensations are mainly used in stability analysis.

Load Compensations

Load compensation is the management of reactive power to improve power quality i.e, V profile and P.F. Here the reactive power to improve power quality i.e. V profile and P.F.Here the reactive power flow is controlled by installing shunt compensating devices(capacitors/reactors)at the load end bringing about proper balance between generated and consumed reactive power. This is most effective in improving the power transfer capability of the system and its voltage stability. It is desirable both economically and technically to operate the system near unity power factor. This is why some utilities impose a penalty on low pf loads.

Yet another way of improving the system performance is to operate it underwear balanced conditions so as to reduce the flow of negative sequence currents thereby increasing the system's load capability and reducing power loss.

Line Compensations

Ideal voltage profile for a transmission line is flat, which can only be achieved by loading the line with its surge impedance loading while this may not be achievable, the characteristics of the line can be modified by line compensators so that

1. Ferranti effect is minimized

2. Under excited operation of synchronous generators is not required

3. Power transfer capability of the line is enhanced. Modifying the characteristics of a lines is known as line compensations.

Various compensating devices are

1. Capacitors

2. Capacitors and inductors

3. Active voltage source

When a number of capacitors are connected in parallel to get the desired capacitance ,it is known as a bank of capacitors, similarly, a bank of capacitors and inductors can be adjusted in steps by switching(Mechanical).capacitors and inductors are passive line compensators.

Shunt compensation is more or less like load compensation with all advantages associated with load compensation. It needs to be shunt Capacitors/inductors cannot be distributed uniformly along the line. These are normally connected at the end of the line and or at midpoint of line.

Shunt capacitors raised the load pf which greatly increases the power transmitted over the line as it is not required to carry the reactive power. There is a limit to which transmitted over the line as it is not required to carry the reactive power. There is a limit to which transmitted power can be increased by shunt compensation as it would require very large size capacitor bank, which would be impractical. So for increasing power transmitted over the line, other and better means can be adopted. When switched capacitors are employed for compensation, these should be disconnected immediately under light load conditions to avoid excessive voltage rise and Ferro resonance in presence of transformer.

The purpose of series compensation is to cancel part of series inductive reactance of the line using series capacitors. This helps in 1) increase of maximum power transfer ii) reduction in power angle for given amount of power transfer iii) increased loading.

From practical point of view, it is desirable not to exceed series compensation beyond 80%.If the line is 100% compensated, it will behave as a purely resistive element and would cause series resonance even fundamental frequency. The location of series capacitors is deicide by economical factors and severity of fault currents. Series capacitor reduces line reactance thereby level of fault currents.

Compensation

Compensation controls the power flow in transmission lines.

i) Controlling the sending and receiving end voltages Vs and Vr (through voltage regulations at the respective buses)

ii) Controlling the angle between Vs and Vr (maximum angle is selected depending upon the stability margins)

iii) Controlling the series reactance (series connected capacitors increase the maximum power transfer capacity).These 3 parameter is controlled by connecting series shunt compensation in the transmission system.

STABILITY ANALYSIS

A power system stability improvement is very important for large scale system. The AC power transmission system has diverse limits, classified as static limits and dynamic limits[2 ,3].Traditionally, fixed or mechanically switched shunt and series capacitors, reactors and synchronous generators were being used to enhance same types of stability augmentation[2]. For many reasons desired performance was being unable to achieve effectively.
For the purpose of analysis there are three stability conditions that must be considered.

The development of the modern power system has led to an increasing complexity in the study of power systems, and also presents new challenges to power system stability, and in particular, to the aspects of transient stability and small-signal stability. Transient stability control plays a significant role in ensuring the stable operation of power systems in the event of large disturbances and faults, and is thus a significant area of research. The classification of stability

- Steady State Stability.
- Transient Stability.
- Dynamic Stability.

1. STEADY STATE STABILITY.

It may be defined as the capability of an electric power system to maintain synchronism between machines within the system and external lie lines following a small slow disturbance(normal load fluctuations, the action of automatic voltage regulators and turbine governors).In case the maximum power transfer exceeds under this condition, individual machines or groups of machines will cease to operate in synchronism, violent fluctuations of the voltage will occur and the steady state limit for the system as a whole would have been reached. The Steady state stability limit refers to the maximum power which can be transferred through the system without loss of stability.

2. TRANSIENT STABILITY

Transient stability is the ability of the system to remain in synchronism during the period following a disturbance and prior to the time that the governors can act. Ordinarily the first swing of machine rotors will take place within about one second following the disturbance, but the exact time depends on the characteristics of the machines and the transmission system. Following this period, governors begin to take effect, and dynamic stability conditions are effective.

3. DYNAMIC STABILITY

It is the ability of a power system to remain in synchronism after the 'initial swing' (transient stability period) until the system has settled down to the new steady state equilibrium condition. When sufficient time has elapsed after a disturbance, the governors of the prime movers will react to increase or decrease energy input, as may require re-establishing a balance between energy input and the existing electrical load. This usually occurs in about 1-1.5 seconds after the disturbance. The period between the time governors begin to react and the time that steady state equilibrium is re-established is the period when dynamic stability characteristics of a system are effective. It is possible to have transient stable but dynamically unstable conditions. Immediately after a disturbance, the machine rotors will go through the first swing (before governor action) successfully, and then after governor control is initiated, the oscillations will start increasing until the machine falls out of synchronism. Such action can occur if the time delays of the governor control are such that, following the sensing of necessity for increasing or reducing energy input, action is delayed sufficiently in time to augment rather than diminish the next swing. If such a condition exists, the oscillations of the machine rotor can continue to build up until the machine falls out of synchronism

RESEARCH ANALYSIS

The many papers are to present an analysis of reactive power control and voltage stability in power systems. The steady state voltage and reactive power control in distribution systems can be properly controlled by coordinating the available voltage and reactive power control equipment, such as on-load tap-changers, series capacitors, substation shunt capacitors and feeder shunt capacitors. It began with an overview of reactive power and voltage stability in transmission, distribution and load, and the importance of providing reactive power locally.

PROBLEM IDENTIFICATIONS AND ANALYSIS

The main problem that has been encountered in a load area network is transient current. Due transient current, the voltage drop of the transmission lines reduces as a result the losses increases which contribute to reduced supply .Since the tariff is a fixed constraint so it is increases a burden for the additional inadequate supply. And customers need to face economic crisis

AIM OF THE PAPER

The aim of this paper is the clear idea of instability. Now a day's loads are increasing gradually but we will not increasing our generation due to economical, financial and political reasons. Today's power world has main aim to supply uninterrupted and reliable power to our authorized loads centers'. But same time our unauthorized loads are also increasingly rapidly due to financial and political reasons. So it is very difficult to maintained reliable supply to our load area. Due to unauthorized and uncertain load demand but we cannot stop to supply reliable power to load area. For that reason we adopt many other ways to maintained reliable supply to load area.

With increasing demand of power in load area(authorized/unauthorized) will affect the stability of the transmission lines by increasing (producing) reactive powers in transmission network, as transmission power through lines are almost fixed(as demands) so increasing loads creates a unbalanced in transmission lines because as demands (un authorized, due to power theft)are increasing, so active power demands are also increases but it is not possible to supply extra active power demands by transmission lines always .But loads draw the required active powers from transmission lines as a results generators are affected due to meet the demands by increasing the speed of generators to supply that active power and generators runs as a super synchronous speed and generators are run as synchronous motors that generators are not supply the powers to transmission lines, they draws the power from transmission lines, and reverse power flow occurred. In the generating station reverse power flow relay is used to give protections for such cases but reverse power flow is very dangerous fault in transmission lines and generators also. Due to reverse power flow, generators may be damaged. In our power networks most costly device is generators, So we cannot do this, not only for that reasons, if generators are getting fault then whole system will be black outs. So reverse power flow protection is only depends upon reverse power flow relay only. If it is failure due to mal operation of relay, it is very dangerous to power networks.

So, it is not the good sign always for this type of faults that we should always depends upon this relay. We should think about other ways also. We should analysis the causes of this fault and find out the ways to overcome from this situation.

As load is increasing and generation is fixed then extra burden occurred in generators and transmission lines, to maintained transmission line voltage stability ,generators will run as synchronous speed not in super synchronous speed ,We can prevent that by two ways i)to compensated reactive powers by compensation devices or ii)supply extra powers from other sources. Then only stability can improve.

The aim of our project is to find out how to overcome from this problem.

PROBLEM IDENTIFICATIONS

As power system stability is burning problems always, many scientist and researchers are work out in this problems. Voltage control and stability problems are not new to the electric utility industry but are now receiving special attention in many systems. Once associated primarily with weak systems and long lines, voltage problems are now also a source of concern in highly developed networks as a result of heavier loadings. In recent years, voltage instability has been responsible for several major network collapses.

So we have taken a voltage stability problem and analysis it by mat lab simulink and verify and compare outputs with desired results. We are tried to give a clear idea of voltage in stability through this demo power network. Hope that it will help to further researchers.

Here we have take a power network with heavily loaded (35 MW) line with power supply (MW) and analysis of stability. We have see that the system will go through instability region due to reactive power generations of the line. After that we can improved the stability of that system by analysing of several cases.

These analyses are give us clear idea of instability and stability of a system.

PROBLEM STATEMENT

1ST step:-

At first we have taken a 100 MW generator with 11 KV, The voltage has been step up in KV voltage to supply the load 30 MW by a transmission network. And analysis the voltage stability of load area, where we see that voltage level is sharply fall down and system will go through the instability region.

2ND step:-

As output voltage is sharply fall down due to insufficient of supply or increasing reactive vars .So in sconed case we give another extra supply from grid network or by other parallel operation. Then we see that the voltage has improved with positive value but is totally transient or oscillatory of exponential with lower magnitude. So we can conclude that only increasing of power the voltage stability will not improved completely.

3RD step:-

So in third step we compensated the transmission lines by connecting a series Capacitors (super Capacitors) through the transmission lines. We see that the voltage stability of the transmission lines has been improved tremendously.

4^{TH} step:-

After improving the stability of the voltage again we connected extra load to the transmission lines to check out the stability degree. We see that stability has not fall down and power network maintained its stability.

Thus we have analysis stability and instability of a power network.

Research Analysis and Scope

Stability analysis is the burning problems for researchers, scholars. Many papers are published regarding this. Maximum cases stability analysis and improve by compensation network designs by FACTS controllers etc. Our research work is starting cases of stability analysis by series capacitors, this analysis will be continuing by analyzing other facts devices in networks.

ANALYSIS OF PROBLEMS (Software approach)

Different Case Study:

In this paper we have studied different cases of stability in a loaded network.

Software approach

CASE 1: PROBLEM ANALYSIS:

230 Mw generation is supplied the load area by step-up voltage levels by two winding transformer .Generator has supplied 30 MW load. And AGC is connected through the generator. So when we run the simulation we see that output voltage is not maintaining stability before and after the transformer but the generator is controlled by AGC unit. As AGC is controlled the voltage fluctuation by load changing and give the stable output. Here we will not get stable output. So we concluded that in power network to maintain voltage stability others things also required that is compensations.

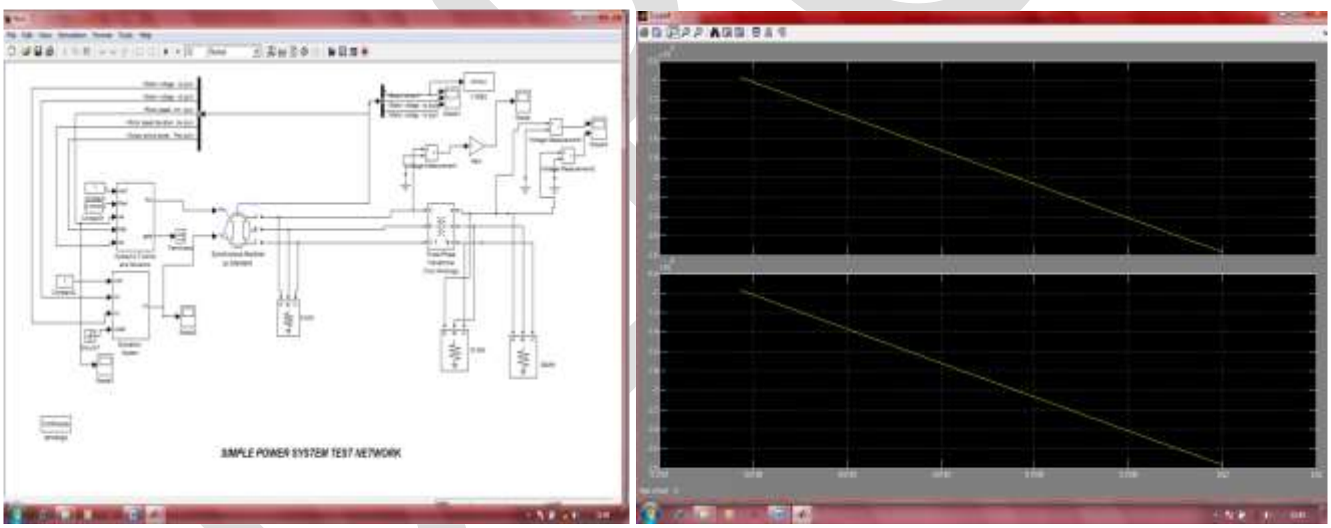


figure 1&figure2-it is the voltage measured across the 10 as well as 20 mw load.

RESULT: Output voltage has sharply fall down, So system has not maintaining stability The dynamic stability falls due to lack of source; as a result the voltage stability of the system is reduced. In the second case a Three Phase Supply is added in order to compensate the loss of voltage due to transient currents which would lead to improvement of voltage stability. This supply has denoted from infinite source or grid.

We can observe that now output (voltage) is rising but transient oscillation there because the curve is ramp nature. So there is required further improvement.

CASE 2:

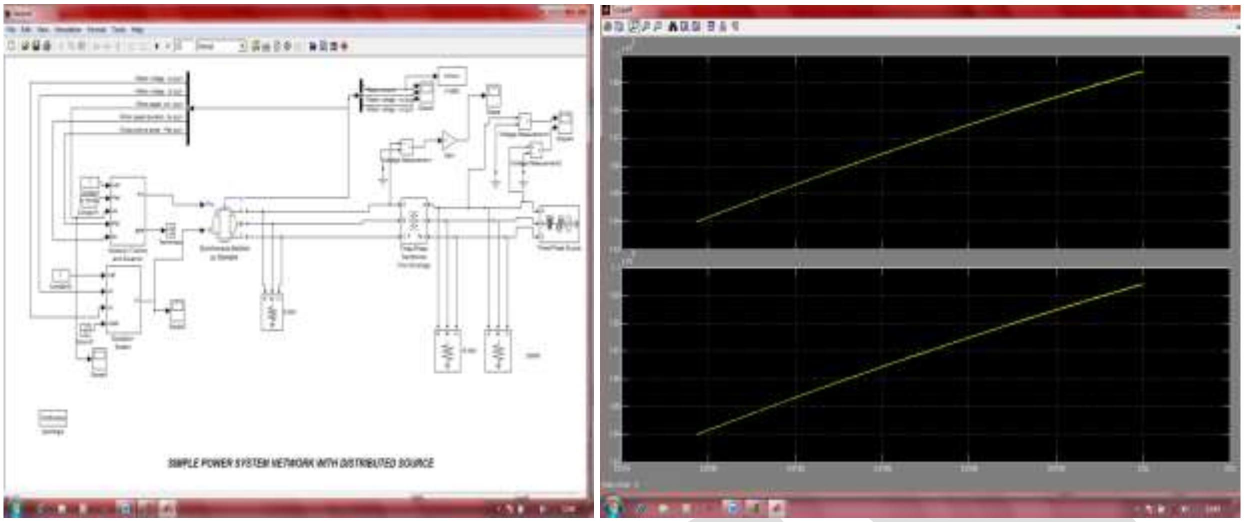


figure 1 & figure2-it is the voltage measured across the 10 and 20mw load with the three phase supply connected across the far end of the total 30mw load.

RESULT: Voltage level is increasing but it is now ramp function, so we concluded that some oscillations are still present and need to improvement.

Case3:-Problem analysis:

Voltage stability have been improved in case 2 but due to transients the losses are more hence it is required to future improvement. So here we have introduces the series capacitors in the transmission lines that reactive power will consume by capacitor vars

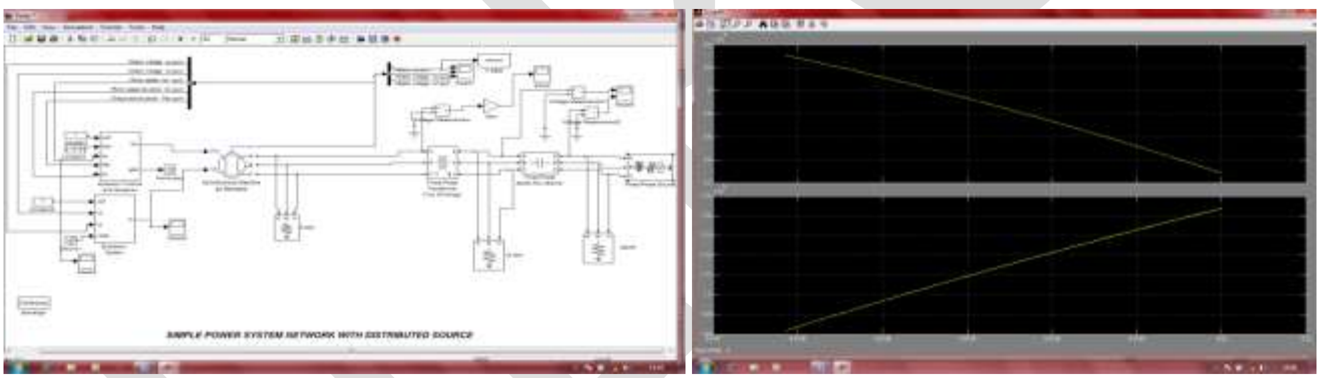


Figure 1 & 2- output response of transmission line voltage. Here we see that after applying capacitors and voltage stability is improved

Case4 :-Problem analysis:

Although a capacitor has been incorporated in the system but it has been observed that in case3 that voltage has not compensated ,So here given extra sources from grid network.We observe that the voltage stability has been improved with oscillations.

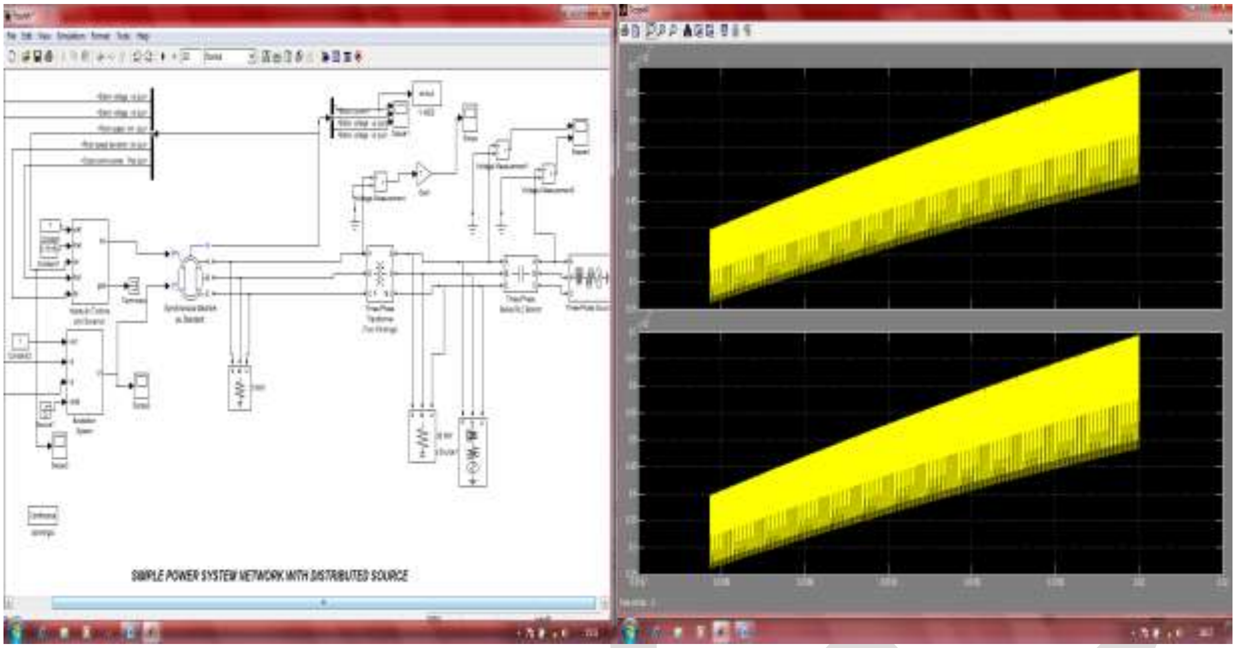


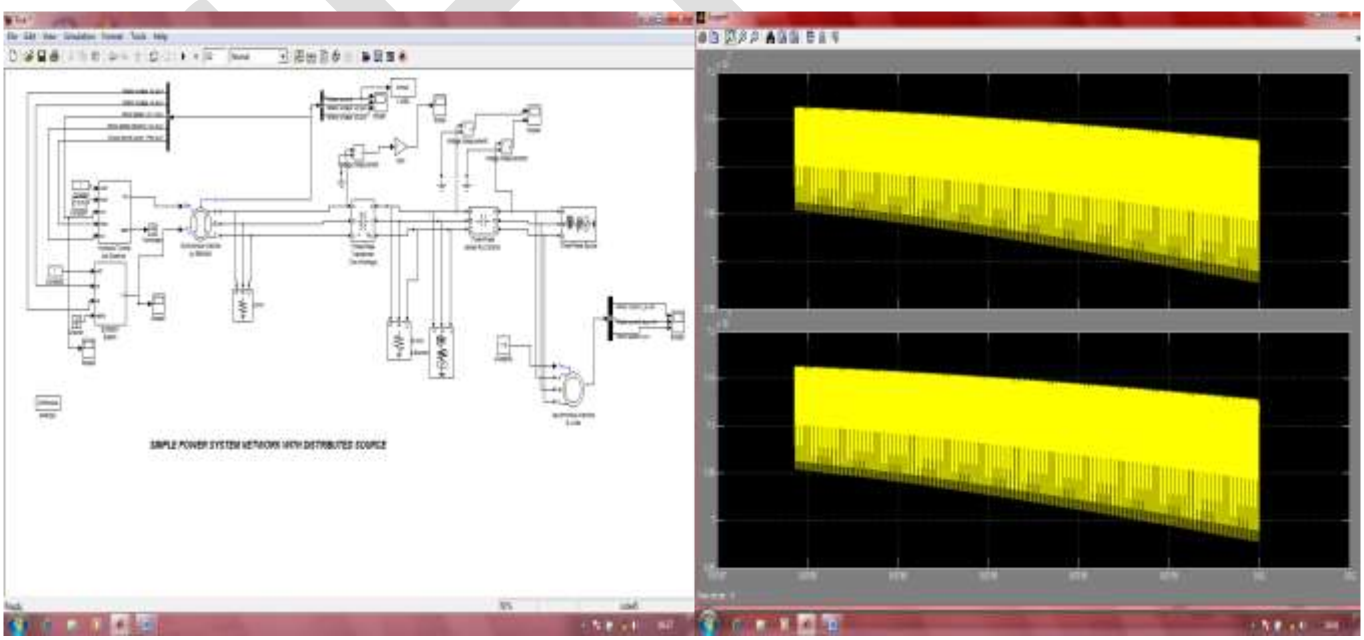
Fig1 & fig2-the voltage is measured across the capacitor which is employed as well as a three phase source is connected to prevent disruption of voltage stability.

CASE5

PROBLEM ANALYSIS:

The voltage stability has improved .so we make the system in real demo system by supplying motor loads in the same network and analysis the output

CASE 5:

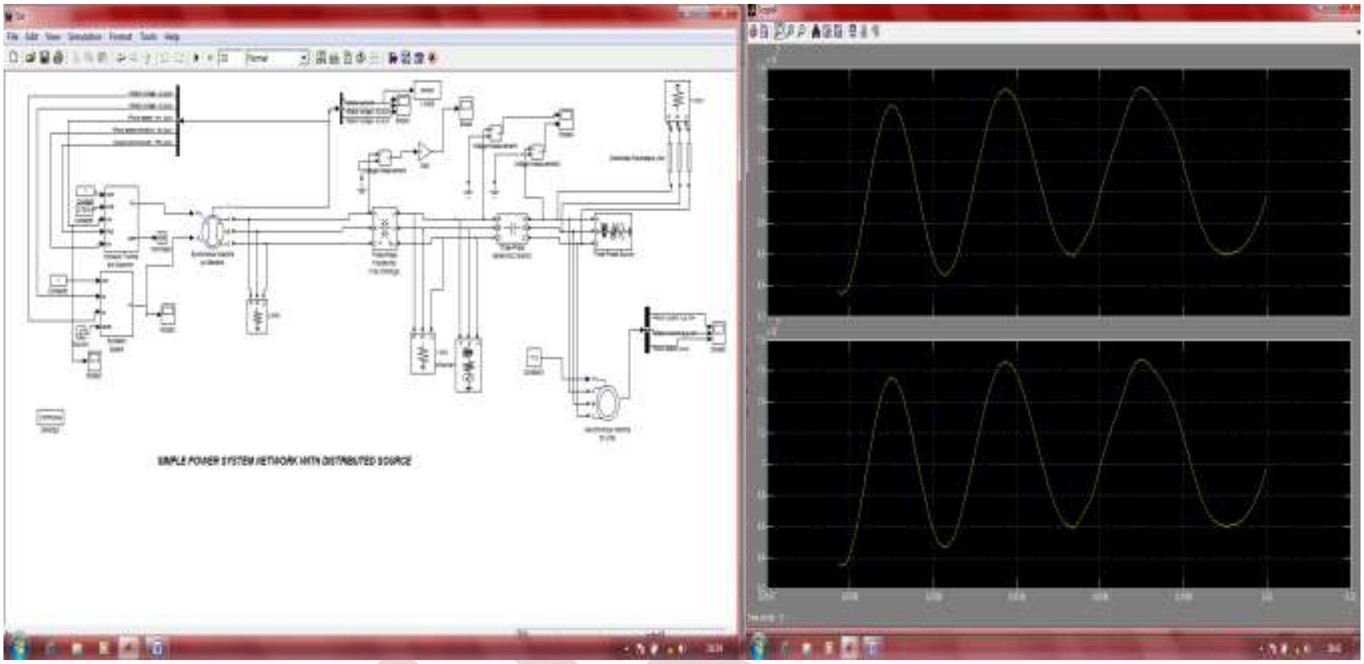


RESULT:

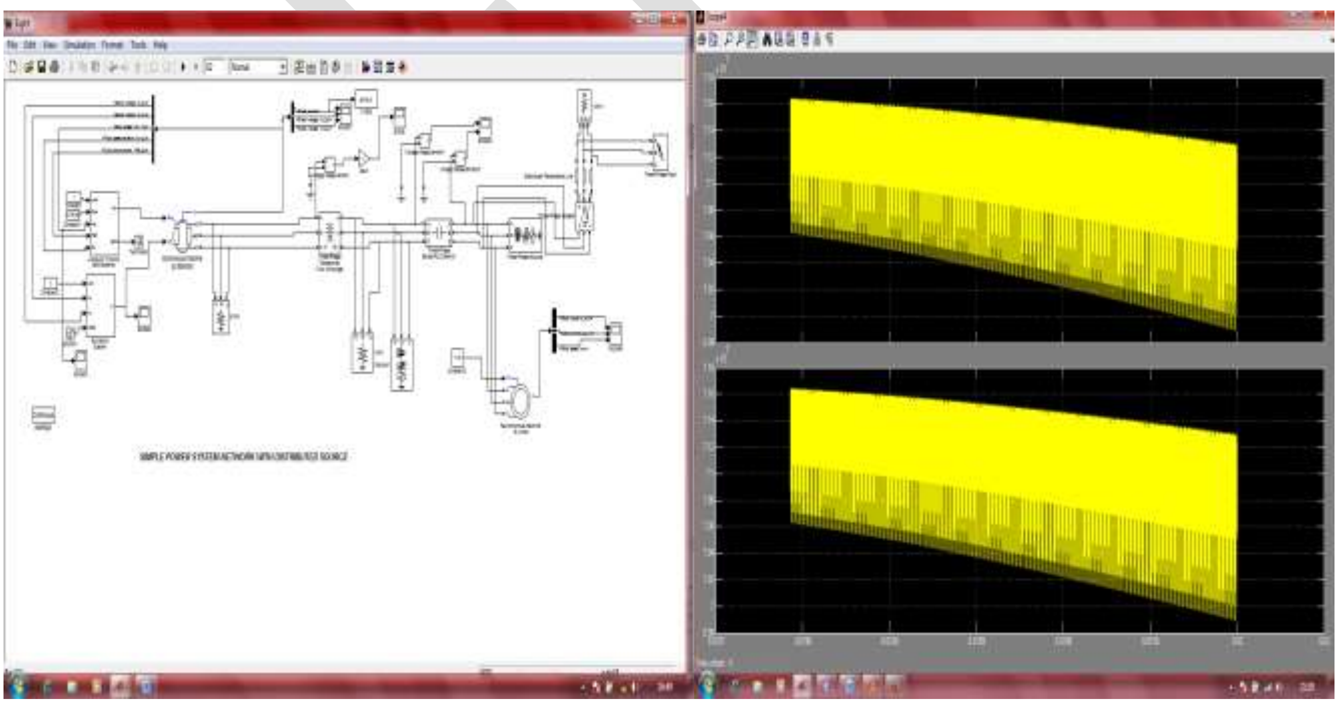
We observed that after supplying motor load the voltage stability has not dropout but some oscillatory nature. So we again studied the system in case6.

CASE 6:

The oscillation can be occurred also if load is lesser than generation, so in this case we have connected a asynchronous load to the line and get a stable output, which is aim of this analysis.



RESULT: We get stable output.



OVERALL ANALYSIS

This paper is a part of work in dynamic voltage stability. Here we have studied a demo real network and analysis different kind of stability. That is how a network system become unstable and how can we bring back its stability. After researching we can concluded a idea that the system instability occur due to high load and lack of supply if in the transmission line has low power then load then extra burden occur in the generators and system (line) voltage has sharply fall down though generation has been controlled by automatic generation. As load is increasing system transient oscillation are not minimize which creates dynamic instability. So at that time required extra source if supply power from grid network or other supply by parallel operation than system voltage will be improved but some oscillation present due to reactive power generation by load side. So to get better stability line has required compensation ,then only the system voltage will be in stable limit. Thus we can improve the dynamic stability of a real power network system also.

FUTURE SCOPE

The future scope of this paper is that this idea can be implemented in real system network. We can easily analysis of a heavily network circuit very easily. This research work can be further proceed by using others facts device also and analysis system stability

APPLICATIONS & FUTURE SCOPE OF THIS PAPER

The main application of this paper to researcher is get a clear and simple idea of voltage and overall dynamic stability idea. This idea can be implemented in any power network for stability analysis.

CONCLUSION

We get clear concepts of voltage and dynamic stability, the load characteristics in a bulk power network. As the power system is a vast network and now days to give highly reliable power to load side, we make our system more complex, so stability is always hampered. If we not analysis stability of the system always then unstable voltage breakdown the longevity of the load side. So unstable voltage is creates unstable current to load area which is very harmful as load area and also transmission network also. Unstable voltage creates reactive vars in transmission lines which is harmful for transmission and generation also. So to supply the stable voltage to our load area is our prime objectives. For that reason we should always analysis the system stability.

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