Voltage Profile Management in Restructured Power System

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Abstract— One of the major aims of system operator is to maintain system parameters within permissible limit. During certain period of time in a day load changes very rapidly, especially when it tends to increase, a generalized voltage decrement and stressed conditions for reactive power sources occurs. Maintaining Voltage profile under varying load conditions is need of today under unpredictable load scenario. This paper presents First the weak bus is identified using Predictor-Corrector method considering the proximity of the voltage collapse region on P-V Curve. Considering the weak bus as a best place for placement of reactive power improvement device voltage profile is being maintained. This process implement on IEEE5 bus system for voltage improvement for various loading.

Key words: IEEE5 Bus System, Weak Bus, Voltage Improvement

I. INTRODUCTION

Power systems have been experiencing continuing growth in interconnections, the use of new technologies and controls, and the increased operation in highly stressed conditions. Simply we can say that the operation of an electrical power system (EPS) has become a very complex issue, mainly due to:

1) Continuing increases in demand.
2) The transfer of high powers between several interconnected areas and
3) Economic and environmental constraints that have resulted in investment delays.

Present Power system divide into three major parts Generation, Transmission and Distribution for study purpose. Now a days progress in the direction of improve power system reliability and efficiency, power system engineer take their leg in the direction of reduce losses in the system for made it most efficient. As the transmission networks need to be utilized ever more efficiently the transfer capacity of an existing transmission network needs to be increased without major investments but also without compromising the security of the power system. The more efficient use of transmission network has already led to a situation in which many power systems are operated more often and longer close to voltage stability limits.

Currently, most electrical power systems operate very close to their stability limits and it is crucial to keep both their efficiency and security at appropriate levels. A power system stressed by heavy loading has a substantially different response to disturbances from that of a non-stressed system. The potential size and effect of disturbances has also increased:

When a power system is operated closer to a stability limit, a relatively small disturbance may cause a system upset. In addition, larger areas of the interconnected system may be affected by a disturbance. Voltage instability problems in an electrical power system are associated with an uncontrolled, monotonic voltage drop that eventually leads to a voltage collapse and this voltage collapse may become reason behind major blackout also.

In practice, it is not possible to work or to serve without electricity in modern society so this problem study become necessary for prevent this type of black out. Even although these problems are essentially dynamic in nature, they can be studied using static analysis methods to obtain bus voltage profiles for load and/or generation changes (PV and QV curves). These curves can be helpful in analyzing and discussing system operating conditions under different load and/or topology scenarios.

Many studies exist in which these profiles are used to:

1) Determine power transfer limits,
2) Determine voltage security margins,
3) Observe bus voltage performances,
4) Determine the proximity to voltage collapse and v.) Compare planning strategies.

Out of all above uses determination of the proximity to voltage collapse point is coming into picture after the lots of collapse take place in the past and due to that large power system blackout also. So now it's become necessary to design such tool to give the complete solution of voltage collapse before it take place by tracing PV-curve with maximum loading point.

Continuation power flow is most efficient tool for steady state voltage stability analysis because it gives the complete solution of voltage collapse before it take place by complete tracing PV-curve with maximum loading point or critical point for the given system. Finally from collapse point we can improve voltage profile.

II. IMPLEMENT ON IEEE5 BUS SYSTEM

The network configuration of IEEE 5 bus system is shown in Fig.1

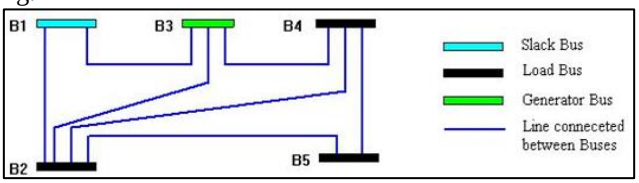

Fig. 1: Network Diagram of IEEE 5 Bus System

The bus data of IEEE 5 bus system shown below:

Bus No.	Bus Type	Generation		Load Initial			Synchronous Condenser
		MW	MVAR	MW	MVAR	Voltage (pu)	
1	1	0	0	0	0	1.06	0
2	3	40	30	20	10	1	0
3	2	0	0	45	15	1	0
4	2	0	0	40	5	1	0
5	2	0	0	60	10	1	0

Table 1: Base = 100 MVA

Here, in bus data second column bus type 1 refers to slack bus, bus type 2 refers to load bus (PQ bus) and bus type 3 refers to generator bus (PV bus). In this case bus 1 taken as the slack bus with 1.06 pu voltage value. Also initial voltage angle (ä) at all the buses taken as zero.
The line data (Branch data) of IEEE 5 bus system shown below:

From bus (Tap bus)	To bus (Z bus)	Resistance (pu)	Reactance (pu)	Full Line Charging Admittance (pu)	Transformer Turns Ratio
1	2	0.02	0.06	0.06	1
1	3	0.08	0.24	0.05	1
2	3	0.06	0.18	0.04	1
2	4	0.06	0.18	0.04	1
2	5	0.04	0.12	0.03	1
3	4	0.01	0.03	0.02	1
4	5	0.08	0.24	0.05	1

Table 2:

Here, First column of above table shows Tap bus means this bus side where transformer is connected. Similarly, second column Z bus means bus on opposite side of tap bus or bus side where Impedance or Admittance is connected.

One should be noticeable that here full line charging admittance are given so done divide by two when used or use half of this for accounting single bus.

As shown in fig.2 we get complete PV-Curve using continuation power flow technique. Also voltage collapse point which is main concentric part of this thesis gives the better idea about on which loading level the voltage collapse will take place so we take care before it take place and save our power system from major black out.

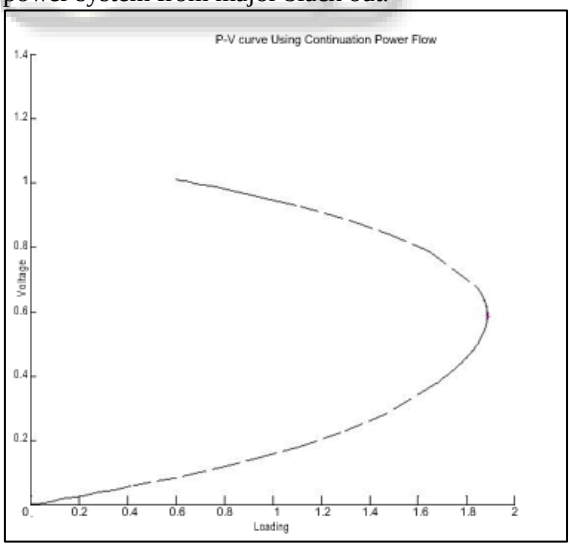

Fig. 2: PV-Curve for IEEE 5 Bus System Using

A. Continuation Power Flow

As shown in graph we easily decide the voltage stability region such that the voltage collapse event would not take place.Upper part show the stable region and lower part or part of the curve after critical point show the unstable region for operating system based on present loding on that particular system.Using continuation power flow for IEEE 5 bus system critical point get at 1.8855 pu active power loading at volage 0.5890 pu. PV- curve for the IEEE 5 bus system at weakest bus no.5 at given loading shown in Fig.2

B. Voltage Profile Management for Various Loading

Bus No.	Bus Type	Generation		Voltage (pu)
1	1	131.18	95.34	1.06
2	3	20	-61.32	1
3	2	-45	-14.99	0.9839
4	2	-40	-5.00	0.9806
5	2	-59.99	-9.99	0.9689

Table 3: Load Flow for base load

C. Increase Load on PQ Bus by 50%

Bus	Bus	Generation		Voltage (pu)
1	1	210.36	83.53	1.06
2	3	19.97	-14.08	1
3	2	67.49	-22.46	0.9636
4	2	-59.47	-7.49	0.9603
5	2	-89.94	-14.96	0.9470

Table 4: Load Flow for increase load on PQ bus by 50%

Bus No.	Bus Type	Generation		Voltage	Synchronous
1	1	210.09	81.82	1.06	0
2	3	19.98	-36.81	1	0
3	2	-67.49	-22.46	0.9678	0
4	2	-59.47	-7.49	0.9656	0
5	2	-89.97	-14.98	0.9687	0.25

Table 5: Load Flow for Voltage Profile Improvement

III. CONCLUSION

From above table we can say that for various loading condition on PQ buses, first voltage goes down and then we can improve voltage using reactive power source. This reactive power source place at suitable place, it is nothing but weak bus. In our case there is IEEE 5 bus system. In this system 5, 4 and 3 are weak buses respectively.so that voltage improve capacitor is place on 5, 4, and 3 buses respectively.

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