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Analysis of Power System Stability by using Facts Devices

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Abstract: - The existing years power structure is a big composite unified network that contains of n number of buses and hundreds of power plants. The placing of fresh positions or fixing of new generating unites executes many conservation and economic limitations. As an effect, the present transmission lines are more severely stressed than forever before and which in turn can leave power system exposed to instabilities. To continue safety of such systems, it is necessary to design appropriate procedures to expand power system safety and growth voltage stability limitations. In this project the conclusion of three FACTScontrollers – SVC, UPFC and TCSC on voltage stability are studied. The IEEE-14 bus system is simulated with continuation power flow feature of PSAT software. The benefit of this simulated model is to progress a simple, fast and appropriate procedure which can be applied efficiently to improve the voltage stability.

***Keyword: - SVC,* UPFC, TCSC, Voltage Stability**

I. INTRODUCTION

In the power system economic and services are and will remain to request a more optimum and gainful process of the power classification with deference to generation, transmission and distribution. To complete both effective consistency and economic productivity, it has become clear that more well-organized consumption and control of the present transmission system organization is mandatory. A technically smart solution to solve above difficult is to use some effective controls with the help of FACTS devices. FACTS machineries allow for enhanced transmission system operation with nominal substructure speculation, ecological impact, and execution time compared to the structure of new transmission lines [1]. The FACTS auxiliary confidential into SVC and the phase unstable transformer (PST) in these methods are frequently used in power system, the choice of the FACTS can be different by employing the fresh methods in power electronics. The supervisors grounded on the power electronics is mostly dedicated on FACTS and the constancy of transmission system can be enhanced by the FACTS devices of the regulatory methods. [2][3].

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II. FACTS DEVICE

The power request is increasing quickly so we have to install the generation allowing to need of request by mounting new power plants and instituting new transmission lines. Additionally, this charging of lines up to its thermal limit was potential with the FACTS devices. A FACTS is a classification collected of inert system used for the AC transmission of electrical energy.

It means to improve controllability and growth power transfer ability of the system.

In this paper the FACTS Device is progress the voltage stability of the IEEE 14 bus system.

a. Modelling of SVC

SVC is a type of FACTS device, is used for shunt recompense to continue bus voltage Profile. SVC adjusts bus voltage to compensate unceasingly the change of reactive power loading. The most standard formation of this type of shunt-connected The thyristor firing angle α, is 90° to 180°.

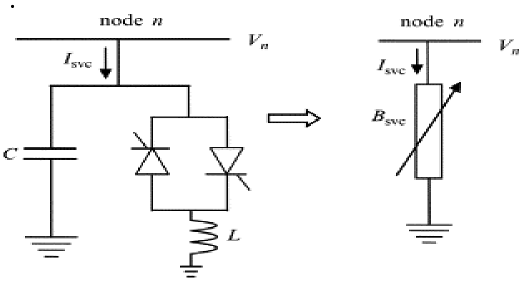

Fig: 1 Modeling of SVC

The adjustable SVC corresponding susceptanceB_{svc} at essential frequency can be achieved as shadows [6]:

Let the bus voltage be stated as $v_n(t) = v\sin \omega t$, where $v$is the peak value of the practical voltage and ω is the angular frequency of the source voltage. The TCR current is then specified by the ensuing variance equation

b. Modelling ofUPFC

UPFCis signified by means of the power inoculation model, UPFC contains of two end-to-end voltagesource converters connected to power system concluded series and parallel power transformers. Effects of UPFC on the network is reproduced by a series connected voltage source V_T and W_T, shunt current bases I_T and I_Q, connected to the network complete series and shunt transformers.

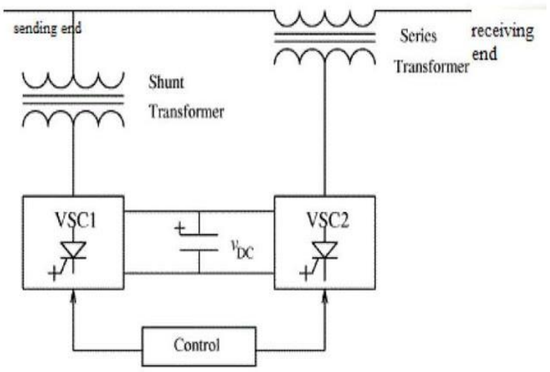

Fig: 2 Modeling of UPFC

Therefore, UPFC comprises three adaptable limitations: voltage level and phase angle of the sequence transformer ($V_T$and W_T) and reactive current I_{andQ} of the shunt transformer. UPFC can be modelled based on the following equation

$$I_i = I_T + I_q + I_i' \qquad (1)$$

$$I_T = \frac{Re[I_T \times I'^*]}{V_i} \qquad (2)$$

$$V_i = V_T + V_i + \qquad (3)$$

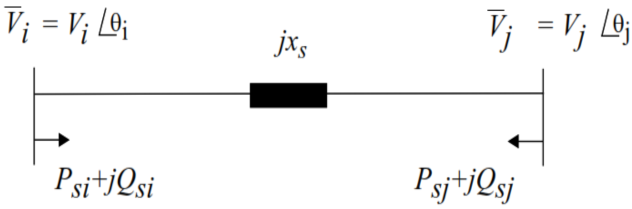

Fig.3 Power injection model of UPFC.

The reactive power additions at buses i and j with a UPFC unit connected in lineij can be communicated as

$$S_{ij} = P_{ij} + jQ_{ij} = V_i \times I_{ij} = V_i \times \left(I_i + \frac{jV_iB}{2}\right) \qquad (4)$$

$$S_{ji} = P_{ji} + jQ_{ji} = V_j \times I_{ji} = V_i \times \left(\frac{jV_iB}{2 - I_i}\right) \qquad (5)$$

The power inoculation methodology takes been proposed for inert modelling of FACTS. While there are numerous FACTS which can be used for supervisory power flow and voltage profile in the classification, only the UPFC have been measured in this study. Fig.1 shows an unassuming transmission line represent by its lump π-equivalent limits coupled between bus- (i, j). Let the complex voltages at bus-iandj be denoted by $Vi\angle\delta i$ andn $Vj\angle\delta j$, correspondingly.

$$P_{ij} = V^2{}_iG_{ij} - V_iV_j[G_{ij}\cos(\delta_{ij}) + B_{ij}\sin(\delta_{ij})] \qquad (6)$$

where$\delta_{ij} = \delta_i - \delta_j$. Likewise, the real power from bus-j to i (P_{ji})

$$Q_{ji} = -V^2{}_jG_{ij} - V_iV_j[G_{ij}\cos(\delta_{ij}) - B_{ij}\sin(\delta_{ij})] \qquad (7)$$

c. Modelling of TCSC

The basic Thyristor-controlled series compensator arrangement contains of a static sequence capacitor bank C in equivalent with a TCR as shown below. The series reactance is used to complete suitable difference of the firing angle (a), to allow definite amount of active power flow across the series-compensated line. The steady-state connection among the firing angle an and the TCSC reactance at fundamental frequency can be derived as follows Fig No.4

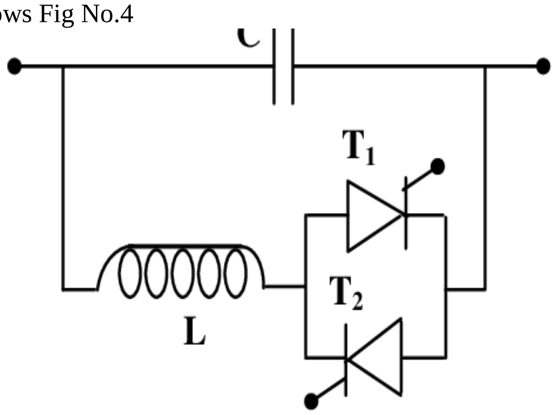

Fig: 4 Modeling of TCSC

The line current is invented to be the self-governing input adjustable and is demonstrated as an outward current source, it has been expected that a circlet current is ensnared in the reactor-capacitor circuit current cause. Below these conventions, the devices in steady-state voltage and current calculations that can be found from the investigation of an equivalent circuit with an adjustable inductance

$$X_L(\alpha) = X_L\frac{\pi}{\pi - 2\alpha - \sin 2\alpha} \qquad (8)$$

the range of 0 to 90 of α, XL(α)

$$x_{TCSC}(\alpha) = x_C + C_1(2(\pi-\alpha) + \sin(2(\pi-\alpha))) - C_2\cos 2(\pi-\alpha)(\varpi\tan(\varpi(\pi-\alpha)) - \tan(\pi-\alpha)) \qquad (9)$$

$$x_{LC} = \frac{x_C x_L}{x_C - x_L} \qquad (10)$$

$$C_1 = \frac{x + x_L}{\pi} \qquad (11)$$

$$C_2 = 4\frac{x_{LC}^2}{x_L\pi} \qquad (12)$$

$$\varpi = \sqrt{\frac{x_C}{x_L}} \qquad (13)$$

III. PROBLEM FORMULATION

In this Problematic equation to resolve the location of facts, the technique is submitted constructed on classify the branch and bus which are the extreme difficult and active with veneration to voltage safety enhancement There are two independent functions measured in this recommended technique. The first independent is to minimize generation cost of the line flow within limit in order to reduce Voltage Profile

$$FC = \sum_{i=l}^{NG} a_i P^2{}_{Gi} + b_i P_{Gi} + c_i \qquad (14)$$

$$P_{gi} - P_{di} = \sum_{i=1}^{N} |V_i|\,|V_j||Y_{ij}|\cos(\delta_i - \delta_j - \theta_{ij}) \qquad (15)$$

$$Q_{gi} - Q_{di} = \sum_{i=1}^{N} |V_i|\,|V_j||Y_{ij}|\cos(\delta_i - \delta_j - \theta_{ij}) \qquad (16)$$

The power inoculation of reactive and real power at each bus are reflect as zero. Where the P_{gi} and Q_{gi} power generation directions at bus g_i, separately compensation limit.

$$P_i^{min} \le P_{gi} \le P_i^{max}, Q_i^{min} \le Q_{gi} \le Q_i^{max} \quad (17)$$

$$V_i^{min} \le V_i \le V_i^{max}, S_i^{min} \le S_i \le S_i^{max} \quad (18)$$

IV. SIMULATION RESULT

The IEEE Fourteen Bus system is reserved as the Test system.in that 100 MVA is consider as a base and 69kv is consider as a base.

OVER LOAD CASE: in this case the reactive load is increase in sequence, and run the load flow from that we find the 9th Bus and 14th Bus are the weakest buses in the system.

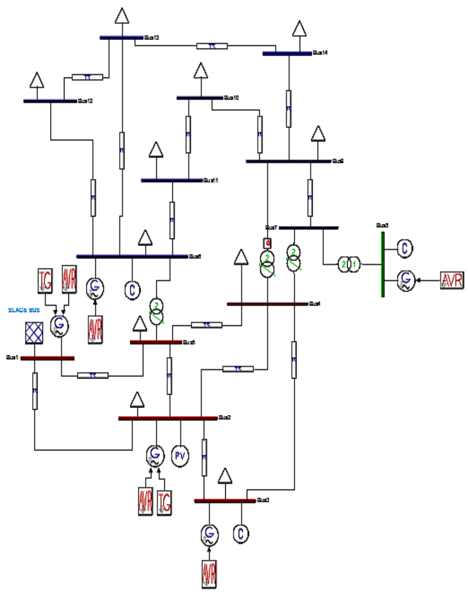

Fig: IEEE 14 Bus with Over Load

Table-1: Over Load Case Voltage Profile

BUS	BASE CASE	Overloaded 10%	Overloaded 20%
1	1.06	1.06	1.06
2	1.045	1.045	1.045
3	1.01	1.01	1.010
4	0.688	0.693	0.680
5	0.665	0.678	0.669
6	1.07	1.07	1.070
7	0.837	0.785	0.743
8	1.090	1.090	1.090
9	0.797	0.679	0.590
10	0.806	0.703	0.626
11	0.918	0.865	0.825
12	1.010	0.973	0.958
13	0.993	0.922	0.897
14	0.984	0.662	0.576

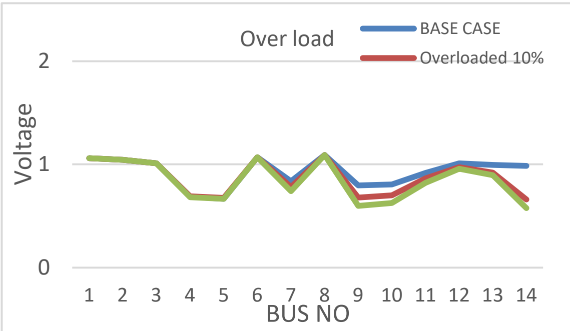

Fig. 6 Voltage Magnitude for over load case

From Table 1that voltage difference is more in nus 14 and 9 thus bus is considering as a weakest bus. Hence a superior shield structure to reduce voltage variability in the system by using FACTS.

SVC is used to improve the Voltage variability in the system. The model system of IEEE14 bus is integrating with svc at weakest bus is exposed in Fig. 7 Maximum load constraint k = 2.904

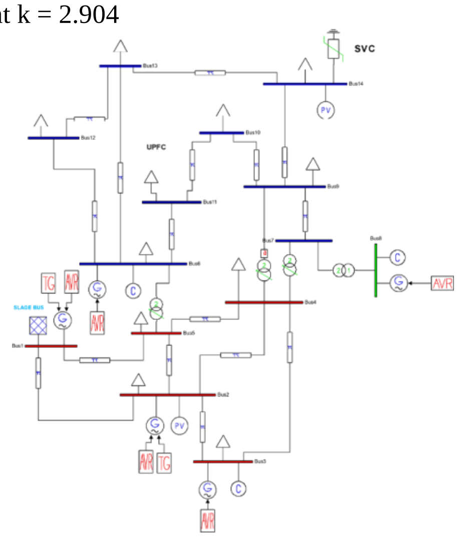

Fig:7IEEE 14 Bus with SVC

Voltage instability is improved by in means of UPFC. The model system of IEEE 14 bus is integrating UPFC in connected in between Bus 14 to Bus 9 is shown in Fig. 8 Maximum loading constraint k = 2.910

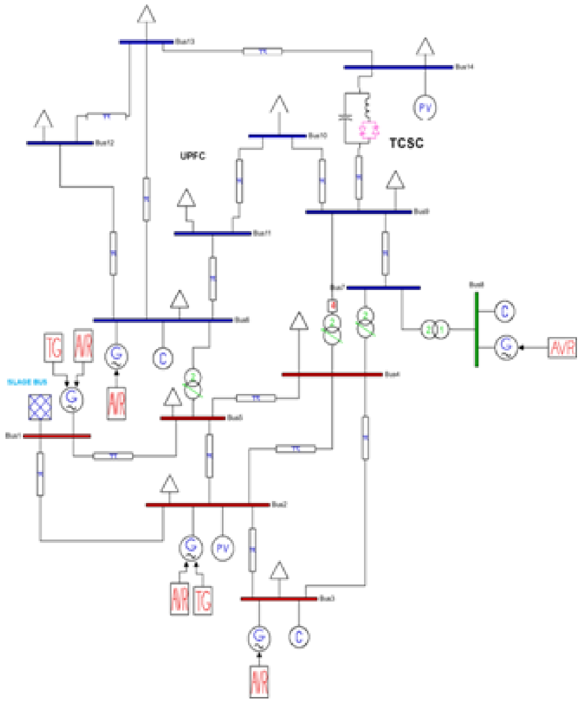

Fig:8 IEEE 14 Bus with UPFC

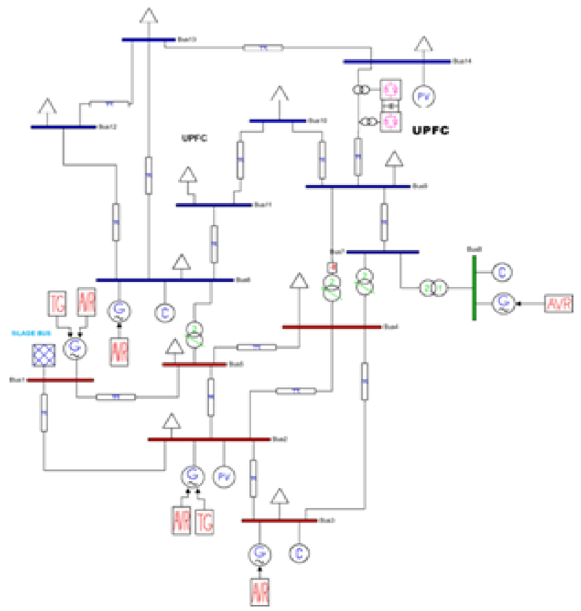

Fig:9 IEEE 14 Bus with TCSC

Voltage instability is enhancement by using TCSC in IEEE 14 bus system is connected in between Bus 14 to Bus 9 is shown in Fig. 9 Maximum loading constraint (k) = 2.916

Table 2 Voltages Profile

BusNo.	Voltage V p.u			
	Base Case	SVC	UPFC	TCSC
1	1.06	1.06	1.06	1.06
2	1.045	1.045	1.045	1.045
3	1.01	1.01	1.01	1.01
4	0.693	0.687	0.684	0.675
5	0.674	0.663	0.66	0.65
6	1.07	1.07	1.07	1.07
7	0.792	0.835	0.836	0.83
8	1.09	1.09	1.09	1.09
9	1.698	0.795	0.804	0.786
10	0.72	0.806	0.813	0.799
11	0.875	0.918	0.922	0.915
12	0.976	1.01	1.01	1.001
13	0.925	0.993	0.999	0.974
14	0.681	0.98	1.01	0.97

Table:3 DeterminedLoading Parameters (k_{max}) with different FACTS Devices

	BaseCase	SVC	UPFC	TCSC
k_{max}	2.8286	2.904	2.910	2.916

Voltage magnitude evaluation of without and with FACTS are shown in Table 2 and 3.

V. CONCLUSION

In this paper the reactive load is increases on IEEE-14 Bus System that shown on Table 1. the Voltage magnitude at 9th Bus and 14th Bus is the Weakestbus in the system and are extra disposed to voltage failure. To escape voltage failure of the system, superior Defense scheme by commissioning FACTS Device is merged into these buses. Table2shows that the voltage magnitude at frailest bus has enhanced. From Table3, shown that the supreme loading constraint (k_{max}) has enhanced afterwards using FACTS at the WeakestBus.

REFERENCES

1. C.Ravichandran, T A Raghavendiran (2013), "Flexible AC Transmission Systems".
2. Sujitha G.V.N and B.Narasimha Reddy, " Improvingtheloadability of the wind integrated powersystemusingSTATCOM placed at an optimal location" IEEE transactions,vol. 3, issue 1, january 2015.
3. NandaJ,MishraS,SaikiaLCMaidanapplication of bacterialforaging-basedoptimizationtechnique in multiareaautomaticgenerationcontrol. IEEETrans Power System 24 2:602–609.
4. AlokKumarMohanty, AmarKumarBarik, 'Power System Stability Improvement Using FACTS Devices 'IJMER 1999.
5. MusunuriS,DehnaviG Comparison of STATCOM, SVC, TCSC, and SSSCperformance in steady state voltage stability improvement. In: North American power symposium 2010

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