SHODH SANGAM -- A RKDF University Journal of Science and Engineering

Power entity Stability Improvement USING STATCOM

Shahid Iqbal [#1], Varsha Mehar [*2]

MTech scholar[1] & Assistant Professor[2] Department of Electrical Engineering
Bhabha College of Engineering, (RKDF) Bhopal

[1] mshahid9281@gmail.com

[2] varshamehar86@gmail.com

Abstract: During the past 2 decades, increase in electrical energy clamor has presented higher obligation by the power industry. More power plants, base station and transmission lines need to be buildup. so that the most frequently used devices in the day-to-day power entity grid are perfunctorily switched circuit breakers. The long switching periods are seprate operation makes them hard to handle the frequently changed load fluently and damp out the ephemeral oscillations quickly. In order to counterbalance these drawbacks, large operational perimeter and redundancies are well-kept to protect the entity from dynamically allomerosum and recovers from faults. This not only increases the cost and lowers the efficiency, but also increases the faults. This not only mount the cost and incline the figure of merit, but also mount the complexity of the entity and increase the difficulty of transaction and control. Severe black outs coincide recently in power network worldwide and these have excavate that stodgy transmissions are unable to manage obligation of complicated interconnections and inconsistent power flow.

Now a day with the ever increasing demand of electrical power, absence of long term planning and need to provide open access to generating companies and companies and consumers it becomes more ambitious to maintain the protection , reliability, continuity, and orientalism of power supply. Further the incorporated power entity is strained by transient sfirmness; voltage firmness etc. due to sudden retardation in load, sudden enternalize in generator output, transmission line shift short circuits, and transmission lines is often subjected to traveler oscillations. So in order to secure the entity it is necessary to modernize the existing entity rather than to have new transmission line and power station for economical and environmental reasons. So the need of recent power flow comptroller capable of mounting transmission capacity and comptroller power flows within limit will certainly increase. Ideally there is a obligation of a comptroller which should be surefooted to manage the voltage, active and reactive power flow to allow the secure burden closer to the thermal margine of transmission lines. Because of increasing rate of growth of modern industries as well as populations it is not possible to generate that much amount of power due to limited

Keywords — *Complexity, STATCOM, SVC and Entity*

LITERATURE SURVEY

2.1 INTRODUCTION

For selecting the project topic we had studied various IEEE papers and journels and collected the information regarding the various difficulties occurring in the power entity. Further we focused on the unbalance that is taking place due to occurrence of the fault and tried to find out the solution to solve these difficulties.

2.2 LITERATURE REVIEW

- The balance of an internetwork power entity of its capability to return to normal or stable working condition after getting been subjected to some form of difficulties. Conversely, disturbance means a condition showing machine lost synchronism or falling away of step.

Accordingly power entity balance difficulties are differentiate into 3 basic type's steady state, dynamic and transient.

The study of constant state balance is normally concerned with the find out of the higher cap of machine burden before getting out of synchronism, provided the burden is increased gradually.

Dynamic imbalance is more probable than steady state imbalance. Small disturbances are continually occurring in a power entity which excites the entity into the state of natural oscillation. This kind of imbalance behavior constitutes a serious problem to entity security and creates very problematic managing conditions.

Following a sudden to disturbance on a power entity rotor speeds, rotor angular distinction and power flow undergo quick changes that cause the machines to fall out of step. This type of imbalance is known as transient imbalance [1].

- The important parameters of FACTS regulator and their capability to make better entity balance is the main concern for effective & economic working of the power entity. The location and response signals used for FACTS- based imbrue regulator were discussed. The organization problem between different manage schemes was also advised. Performance compare of different between FACTS regulator has been analyzed.

The likely future direction of FACTS skill was discussed. A brief review of FACTS application to optimal power flow and deregulated electricity market has been presented [2].

- Voltage profile improvement and balance enhancement of power entity using UPFC is presented in the paper. Simulink models of five bus test entity and UPFC are developed. The test entity was analyzed with and without incorporating UPFC. Thus, it was concluded that balance of power entity and voltage profiles improves with incorporation of UPFC [3].
- When an LLG fault is considered under different cases i.e. sending end, receiving end and intermediate of conduction line it is observed that UPFC improve the entity act by the way of maintain voltage, power and current under fault condition [4].
- Real power flow manages by reactive voltage injection.
- oblique reactive power stream manage by manage of electrical energy at the 2 ports of the UPFC. The regulator are intended independently and use locally accessible measurements. The simulation outcome for a case study shows that this is a feasible manage plan. By modulate the active power it is likely to bring a vast improvement in momentary balance and damping [5].

STATCOM

5.1 INTRODUCTION

A static contemporaneous give the waste power (STATCOM) is a regulating apparatus used on A.C electricity transmission mesh. It is setup on a power electronics voltage supply convertor and can do something as either a supply or sink of imprudent AC power to an electricity mesh. Usually a STACOM is constructed to sustain electricity mesh that has a reduced power factor and over and over again reduced voltage regulation. There are on the other hand, other use, the most general use is for voltage balance. The document is depends on systematic and simulation examination, and conclusion can be utilized as power industry guidelines. In this document, we give information the principle formation of STATCOM and the impact of these tools on midpoint voltage guideline.

Static Compensator (STATCOM) is a 2 generation's shunt coupled FACTS devices dependes on a voltage basis converter (VSC) by means of GTOs. STATCOM balance the bus voltage by supply the obligatory reactive power yet at low bus voltages and improves the power sway damping. STATCOM has a sum of recompense over the traditional Static Var Compensation (SVC).

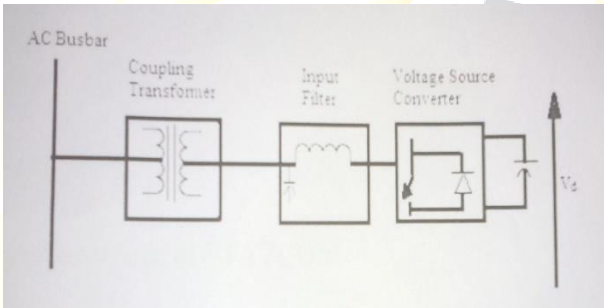
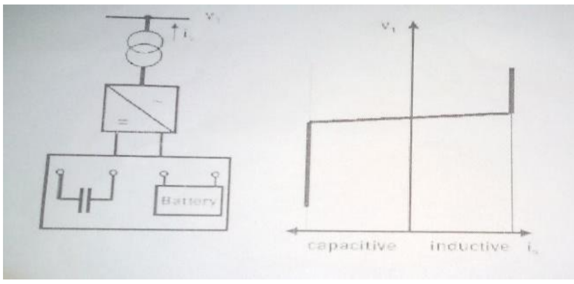


Figure 5.1 Circuit with STATCOM

STATCOMs are typically applied in long distancetransmission entitys, power substations andheavy industries where voltage balance is theprimary concern.In addition, static contemporaneous compensatorsare installed in select points in the powerentity toperform the following:

Voltage support and controlVoltage fluctuation and flickermitigationUnsymmetrical load balancingPower factor correctionActive harmonics cancellationImprove transient steadiness of the control entity Design.



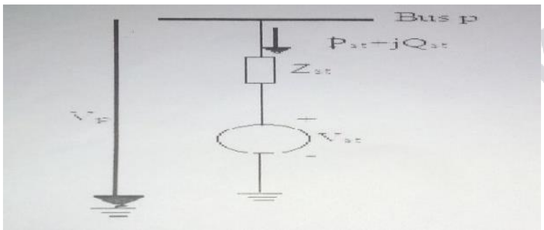


Figure 5.2 Phasor diagram of STATCOM   Figure 5.3 Equivalent circuit of a STACOM

5.2 BASIC managing PRINCIPLE

- Here the controllable reactive control is generated without the utilization of AC capacitors or reactors.
- Working of STATCOM is analogous to contemporaneous machine used as contemporaneous condenser by controlling the excitation of which in twirl controlles the amplitude of induce emf E w.r.t. to voltage V the reactive power stream can be restricted.
- If E>V machine is over excited and leading current close in AC entity and machine is see as capacitor.
- If E < V machine is under thrilled and lagging current secure in AC entity and machine is seen as inductor.
- In a STATCOM from a DC key in voltage source provided by capacitor the voltage source convertor make a set of convenient 3 phase O/P voltages with Freq of AC entity.

By varying amplitude of output produced by convertor the imprudent power swap can be restricted. In real transmission appliance sum of elementary convertors like three phase two level six pulse or twelve pulse with pulse width modulation schemes are used. If only reactive power is to be controlled the dimension of DC capacitor is relatively small, if the convertor is used to manage both active as sound as reactive power a DC capacitor with energy storage of significant capacity required.

5.3 BASIC MANAGE SCHEME

The gating commands for the turn off devices the convertor are generate by the internal convertor manage as per to the demand of reactive and active power required major purpose of this scheme is to operate the convertor power switch so as to make a contemporaneous output waveform with demanded enormity and phase angle at same Freq of AC entity. For external entity, the input I_p reference and $I_q$reference are provided for the calculation of enormity and phase angle of the required output voltage.

Depending on the enormity of V_0 and a coordinated timing waveform gating pattern is generated which determines the on-off periods of each switch of convertor.

CASE STUDY

Our project mainly deals with the balance of power which is achieved by using the FACTS skill. We have observed the various effects of FACTS devices on the entity balance due to the occurrence of any faulty condition by doing simulation on MATLAB.

Basically, we designed a power entity having two power plants generating 500 MW and 1000 MW and connected by a double circuit line. In our project we are mainly focusing on the rotor angle deviation due to inbalance and to create this inbalance, we inserted a LLLG fault in the transmission line results have been observed for the rotor angle deviation dω and the peak overshoot of the oscillation and its settling time are noted.

A UPFC be used to handle the power flow in a 500 kV /230 kV spread entity. The entity, coupled in a loop design, consists fundamentally of five buses (B1 to B5) organized through transmission lines (L1, L2, L3) and two 500 kV/230 kV Xmer banks Tr1 and Tr2. 2 power plants situated on the 230-kV entity create a total of 1500 MW which is transmitted to a 500-kV 15000-MVA the same and to a 200-MW load coupled at bus B3. The plant model include a rate regulator, an excitation entity as well as a power entity preservative (PSS). In normal process, most of the 1200-MW generation capability of power plant #2 is export to the 500-kV the same through three 400-MVA Xmer connected among buses B4 and B5. We are permit for a eventuality case somewhere only two Xmer out of three are accessible (Tr2= 2*400 MVA = 800 MVA).

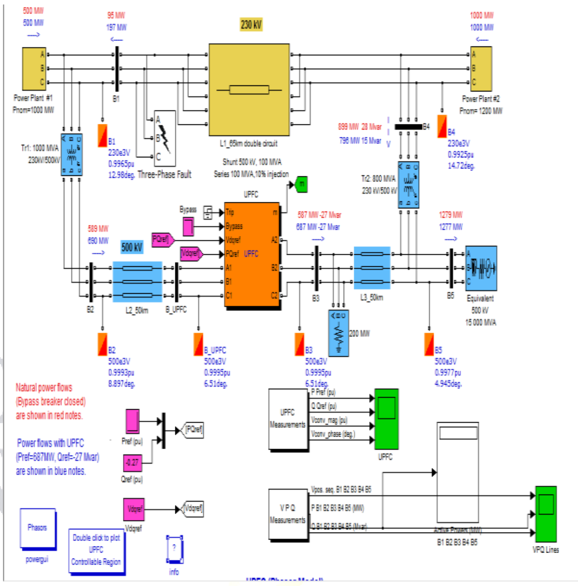
Using the stack flow choice of the powergui obstruct, the model has been started with plants #1 and #2 generating in that order 500 MW and 1000 MW and the UPFC out of service (Bypass breaker closed). The ensuing power stream obtains at buses B1 to B5 is indicate by red sum on the circuit diagram. The load stream shows that the majority of the power generate by plant #2 is transmit through the 800-MVA Xmer bank (899 MW out of 1000 MW), the rest (101 MW), circulating in the ring. Xmer Tr2 is therefore filled to capacity by 99 MVA. The example illustrate how the UPFC can reduce this power jamming.

The UPFC to be found at the precise last part of line L2 is used to hang on the active as well as reactive energy by the side of the 500-kV bus B3, as fine as the electrical clout by the side of bus B_UPFC. It made of a phasor sculpt of two 100-MVA, IGBT-based, changer (one connected in shunt and one connected in string and both unified through a DC bus on the DC part and to the AC power entity, all the way through coupling reactors and transformers). ratings of the UPFC power apparatus are given in the dialog box. The string changer can inject a utmost of 10% of titular line-to-ground voltage (28.87 kV) in string with line L2. The blue numbers on the diagram show the power stream with the UPFC in overhaul and calculating the B3 active and reactive powers in that order at 687 MW and -27 Mvar.

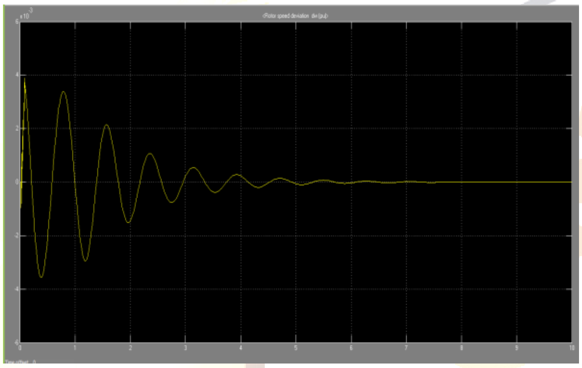
Next, the UPFC is replaced by a different FACTS device STACOM with evaluation same as sooner than various reproduction results are obtaining by means of STACOM and afterward is synchronized with PSS.

STATCOM has a rating of +/- 100MVA. This STATCOM is a phasor sculpt of a typical 3-level PWM STATCOM. If you unwrap the STATCOM dialog container and choice "Display Power data", you resolve see that our sculpt represent a STATCOM have a DC link titular voltage of 40 kV by means of an the identical capacitance of 375 uF. Scheduled the AC side, its entire the identical impedance is 0.22 pu on 100 MVA. This impedance represents the Xmer leakage reactance and the phase reactor of the IGBT Bridge of an authentic PWM STATCOM.

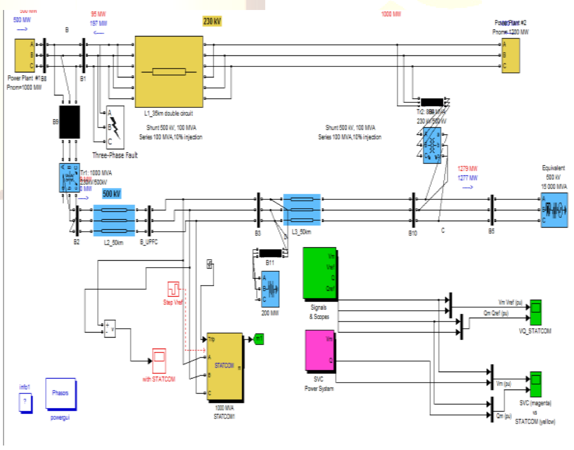
It is pragmatic that the settle instance of oscillation peak overshoot is pretty less. Here is a markable change in the result comparing to the previous result.

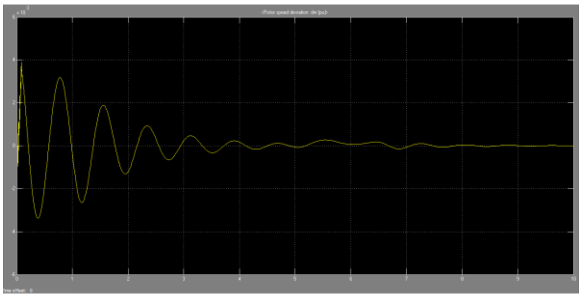


Power entity Model with UPFC

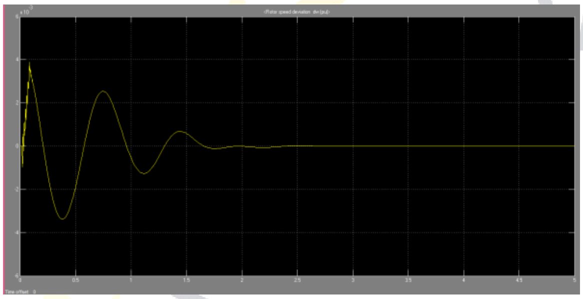


Simulation result for above system

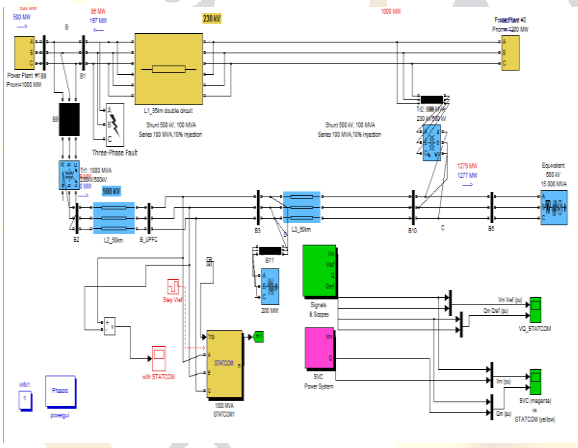


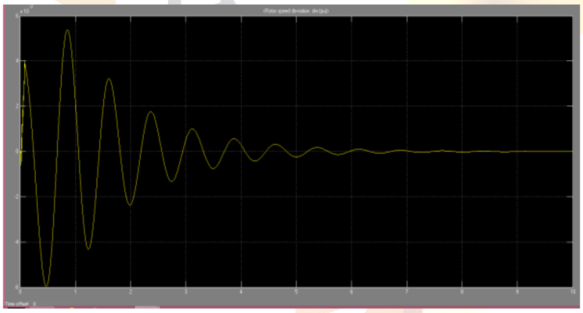


simulation result for UPFC without PSS

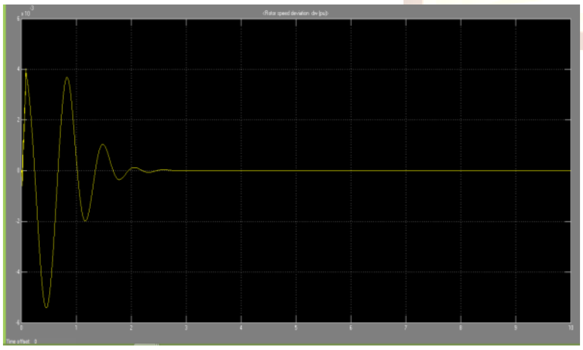


Simulation result for UPFC and PSS

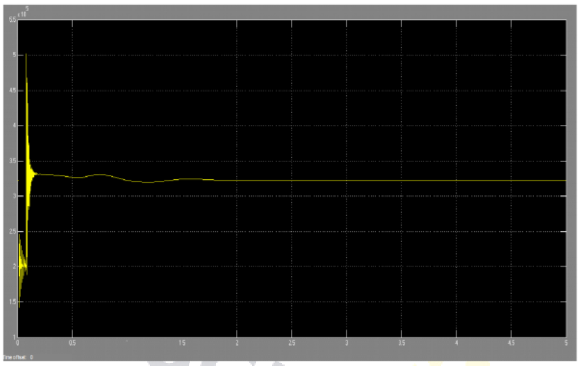




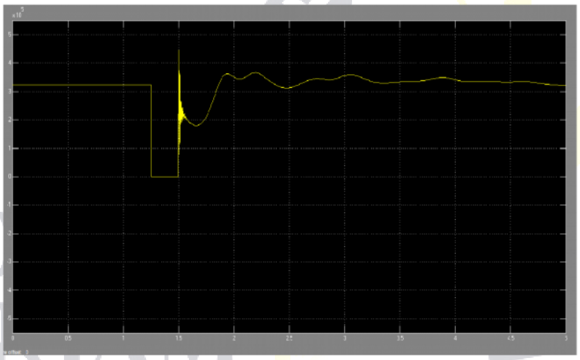
Simulation result for STATCOM without PSS



Simulation result for STATCOM and PSS



Plant no. 2 voltage Without Fault



Plant no. 2 Voltage with Fault (time 1.25sec- 1.5sec)

CONCLUSION

The project deals with individual and coordinated performance of UPFC, STATCOM and PSS in interconnected non-linear power entity for the purpose of entity security. The simulation results obtained by using MATLAB (2011b) shows the performance of Voltage, power and generator rotor oscillation under different entity condition with coordinated use of UPFC along with PSS and STATCOM along with PSS improves the entity performance, ultimately increases the reliability and power is stabilized.

It is observed that the simulation results, by using UPFC and STATCOM individually and UPFC along with PSS and STATCOM with PSS and concluded that when UPFC and PSS are used in dexterity the settling time and peak overshoot time is reduced also use of STATCOM in dexterity with PSS gives the best result.

Initially work was done on a simple power entity and incorporated a fault. The output for rotor angle deviation were observed. It is seen that the oscillation damp out in 14 sec and the peak overshoot is 3.891x 10^{-3} sec. when UPFC is installed in the entity the settling tome is slightly reduced to

12 sec and peak overshoot is 3.88×10^{-3}. To observe clear result we added PSS along with UPFC. The results are such that the settling time of oscillation is greatly varied and it takes 9.17 sec to damp out. Also, the peak overshoot is $3.888x10^{-3}$.

Next, UPFC was replaced from the entity with STACOM and observed the result, the time required for damping out the oscillation is very less comparatively with UPFC it took 9.17 sec. the peak overshoot time is $5.4x10^{-3}$ sec. When STATCOM was coordinated with PSS the oscillation were damped out very quickly in very short duration of time i.e. in 2.4 sec and the peak overshoot time is $4x10^{-3}$ sec. The severity of fault is very less.

We concluded that when STACOM coordinated with PSS gives the best and required results. The oscillation were damped out very quickly i.e. the settling time required is very less for the balance of entity; and severity of fault is also very less. Hence entity becomes stable.

After working on the generator rotor angle deviation the effect of occurance of fault sending end voltage of power plant II were observed. The sending end voltage of II power plant is 230 kV i.e. rms value is 325.26 kV which is shown in fig 8.9 later, we created a fault with transient time 1.25 sec to 1.5 sec during this time voltage becomes zero after clearance of fault some oscillation are seen and the voltage goes to its initial rated value i.e. 325.26 kV shown in fig 8.10.

Thus we concluded that during fault period the sending end voltage at power plant II becomes zero and after its clearance the voltage becomes normal rated voltage

Power entity Model For STATCOM

REFERENCE

[1]Mohammadali Rostami, Saeed Lotfifard, "Scalable Coordinated Manage of Energy Storage entitys for Enhancing Power entity Angle Balance", Sustainable Energy IEEE Transactions on, vol. 9, pp. 763-770, 2018, ISSN 1949-3029.

[2] Shah Arifur Rahman, A C Mahendra, Rajiv K. Varma, Wayne H. Litzenberger, "Bibliography of FACTS 2012–2013: IEEE working group report", PES General Meeting | Conference & Exposition 2014 IEEE, pp. 1-35, 2014.

[3] Optimal Operation Planning for Orchestrating Multiple Pulsed Loads with Transient Balance Constraints in Isolated Power entitys Fan Li; Ying Chen; Rui Xie; Chen Shen; Lu Zhang; Boyu Qin IEEE Access Year: 2018, Volume: PP, Issue: 99

[4] mpact of multi-output regulator to consider wide area measurement and manage entity on the power entity balance Hamid Reza Moradi; Heydar Chamandoust
2017 IEEE 4th International Conference on Knowledge-Based Engineering and Innovation (KBEI)Year: 2017 Pages: 0280 - 0288

[5] Harmonic Balance in Power Electronic Based Power entitys: Concept, Modeling, and Analysis Xiongfei Wang; Frede Blaabjerg IEEE Transactions on Smart Grid Year:2018, Volume: PP, Issue: 99 Pages: 1 - 1

[6] Power hardware-in-the-loop setup for power entity balance analyses Ron Brandl; Mihai Calin; Thomas Degner CIRED - Open Access Proceedings Journal
Year: 2017, Volume: 2017, Issue: 1Pages: 387 - 390

[7] Challenge of retrofitting old decentralised power plants in Germany in terms of power entity balance Stephan Brandt; Frederik Kalverkamp; Rhea Heßler; Sebastian Weber CIRED - Open Access Proceedings Journal Year: 2017, Volume: 2017, Issue: 1
Pages: 1618 - 1620

[8] Anti-islanding protection of distributed generators with regard to sensitivity in a balance and power entity balance Marijan Lukač; Zdravko Matišić CIRED - Open Access Proceedings Journal Year: 2017, Volume: 2017, Issue: 1 Pages: 943 - 946

[9] Combined active and reactive power manage strategy to improve powerentity Freq balance with DFIGs Congwei Tu; Jun Cao; Lei He; Ye Fang The Journal of Engineering
Year: 2017, Volume: 2017, Issue: 13 Pages: 2021 - 2025

[10] Solution of voltage balance assessment fo complicated power entityincorporating wind powerHao Chen; Libao Shi; Yixin NiThe Journal of EngineeringYear: 2017, Volume: 2017, Issue: 13Pages: 2292 - 2297

[11] Voltage balance indices sensitivity evaluation under load variation in electrical power entityAziz Oukennou; Abdelhalim Sandali 2017 International Conference on Electrical and Information Technologies (ICEIT)Year: 2017Pages: 1 - 5

[12] Small signal balance assessment of a DFIG based wind power entitys Jawaharlal Bhukya; Vasundhara Mahajan 2017 2nd IEEE International Conference on Recent Trends in Electronics, Information & Communication Skill (RTEICT) Year: 2017 Pages: 29 - 34

[13] Optimal photovoltaic placement at the southern sulawesi power entityfor balance improvementArdiaty Arief; Muhammad Bachtiar Nappu; Sitti Marwah Rachman; Mustadir Darusman2017 4th International Conference on Information Skill, Computer, and Electrical Engineering (ICITACEE)Year: 2017 Pages: 87 - 92

[14] Voltage balance improvement in power entity using optimal power flow with constraintsS. Punitha; K. Sundararaju2017 IEEE International Conference on Electrical, Instrumentation and Communication Engineering (ICEICE)Year: 2017 Pages: 1 - 6

[15] FACTS performance in the dynamic voltage balance of an electric powerentity
R. M. Monteiro Pereira; Adelino J. C. Pereira; C. M. Machado Ferreira; F. P. Maciel Barbosa 2017 52nd International Universities Power Engineering Conference (UPEC) Year: 2017 Pages: 1 - 5

[16]. Modern power entity analysis by I. J. Nagrath D. P. Kothari

[17]. Power entity Balance Improvement Using FACTS Devices International journal of modern engineering research (IJMER) AlokKumar Mohanty, Amar Kumar Barik.

[18]. Voltage Manage and Power entity Balance Enhancement using UPFC International conference on renewable and power quality (ICREPQ) VireshkumarMathad, Basanagouda F. Ronad, Suresh H. Jangamshetti..

[19]. Impact of UPFC on Power entity Behavior During Different Fault Location ,Neha Srivastava, Sudhir Srivastava.

[20] Understanding FACTS concept and skill of flexible AC transmission entity, N. G. Hingorani and Laszlo Gyugyi.

[21]. Manage Design and Simulation of Unified Power Flow Regulator, K. R. Padiyar, A. M. Kulkarni.

[22]. Power Flow Manage In A Transmission Line Through UPFC, International journal of Emerging Skill and Advanced Engineering, Parvej Khan, Himmat Singh.

[23] Balance analysis and manage of cascaded dc power entity using a virtual capacitor based on TS fuzzy modelMinchi Xie; Yigeng Huangfu; Yongliang Yang; Shengzhao Pang; Liang Guo IECON 2017 - 43rd Annual Conference of the IEEE Industrial Electronics Society Year: 2017 Pages: 7878 - 7883

[24] A comparative study of voltage balance indices used for power entityoperation
Arkadipta Chandra; Ashok Kumar Pradhan; Avinash Kumar Sinha 2016 21st Century Energy Needs - Materials, entitys and Applications (ICTFCEN) Year: 2016 Pages: 1 - 4