A New Design and Analysis for Voltage-Controlled DSTATCOM

R.Chander[1], Md Washir[2]
Department of Electrical Engineering, University College of Engineering (A),Osmania University, Hyderabad, Telangana, India
M.Tech student, P.E, Chaitanya Institute Of Technology And Science, Warangal, Telangana, India

Abstract-**This assignment has a tendency examine the fixing the sag problems through usingcustom energy gadgets inclusive of Distribution Static compensator (D-STATCOM).Proposed scheme follows a newalgorithm to generate reference voltage for a distribution static compensator (DSTATCOM) operating involtage-control mode. The proposed scheme guarantees that cohesion electricity aspect (UPF) is achieved on the loadterminal in the course of nominal operation, which is not possible inside the conventional method. additionally, the compensatorinjects decrease currents therefore, reduces losses within the feeder and voltage-supply inverter. further, a saving inthe score of DSTATCOM is finished which increases its capability to mitigate voltage sag. nearly UPF ismaintained, while regulating voltage at the load terminal, at some stage in load trade. The nation-space model of DSTATCOM is included with the deadbeat predictive controller for immediate load voltage regulation duringvoltage disturbances. With these features, this scheme allows DSTATCOM to tackle power-exceptional issues by providing electricity thing correction, harmonic elimination, load balancing, and voltage regulation based on theload requirement.**

Index Terms- **DSTATCOM, power quality, Reactive power compensation, power control and power quality.**

I. INTRODUCTION

One of the most common electricity best problems nowadays isvoltage dips. A voltage dip is a brief time (10 ms to 1minute) event throughout which a reduction in r.m.s voltagemagnitude occurs. It's far regularly set only with the aid of parameters,intensity/significance and length. The voltage dip magnitude isranged from 10% to ninety% of nominal voltage (whichcorresponds to ninety% to 10% last voltage) and with aduration from half of a cycle to 1 min. In a three-phase systema voltage dip is through nature a three-segment phenomenon, whichaffects each the phase-to-floor and section-to-phasevoltages. A voltage dip is caused by a fault in the utilitysystem, a fault in the client"s facility or a largeincrease of the weight modern-day, like beginning a motor or transformer energizing. Typical faults are unmarried-segment ormultiple-phase brief circuits, which leads to excessive currents.the high modern outcomes in a voltage drop over the networkimpedance. At the fault area the voltage within the faultedphases drops near zero, while inside the non-faultedphases it stays greater or much less unchanged [1, 2].voltage dips are one of the most taking place powerquality troubles. Off course, for an enterprise an outage isworse, than a voltage dip, however voltage dips arise more oftenand reason severe troubles and least expensive losses. Utilitiesoften awareness on disturbances from give up-user gadget as themain power high-quality issues. This is accurate for manydisturbances, flicker, harmonics, and so on., but voltage dipsmainly have their beginning within the better voltage tiers. Faultsdue to lightning, is one of the maximum not unusual causes tovoltage dips on overhead lines. If the budget friendly losses dueto voltage dips are extensive, mitigation moves can beprofitable for the purchaser or even in some instances for theutility. On account that there may be no widespread solution on the way to workfor every website online, every mitigation movement ought to be carefullyplanned and evaluated. There are specific approaches to mitigatevoltage dips, swell and interruptions in transmission anddistribution structures. At present, a extensive variety of veryflexible controllers, which capitalize on newly availablepower electronics additives, are rising for custompower packages [3, 4]. Among these, the distributionstatic compensator and the dynamic voltage restorer aremost effective devices, both of them based totally at the vscprinciple.

Due to elevated cutting-edge injection, the vsi is de-rated insteady-state condition. Consequently, its capability tomitigate deep voltage sag decreases. Additionally,upfcannotbeachievedwhenthepccvoltage is1p.u.intheliterature,thus far, the operation of dstatcom isn't always suggested wherethe blessings of each modes are executed primarily based on loadrequirements even as overcoming their demerits.this paper considers the operation of dstatcom in vcmand proposes a control algorithm to obtain the referenceload terminal voltage. This set of rules provides thecombined benefits of ccm and vcm. The upfoperation at the p.c is carried out at nominal load, whereasfast voltage law is supplied at some point of voltagedisturbances. Also, the reactive and harmonic element ofload current is provided by means of the compensator at any time ofoperation. The deadbeat predictive controller [15]–[17] isused to generate switching pulses. The manage method istested with a three-segment 4-twine distribution device. Theeffectiveness of the proposed set of rules is established throughdetailed simulation and experimental effects.

II. POWER QUALITY AND RELIABILITY

Electricity fine and reliability fee the enterprise largeamounts because of particularly sags and quick-time period interruptions.Distorted and undesirable voltage wave bureaucracy, too. Right here we define the reliability as thecontinuity of supply. As shown in Fig.1, the hassle ofdistribution lines is divided into two main categories. Firstgroup is strength pleasant, second is power reliability. Firstgroup includes harmonic distortions, impulses and swells.second institution consists of voltage sags and outages. Voltagesags is a great deal more extreme and can reason a big quantity ofdamage. If exceeds a few cycle, automobiles, robots, servo drivesand system equipment can't hold manipulate of system.

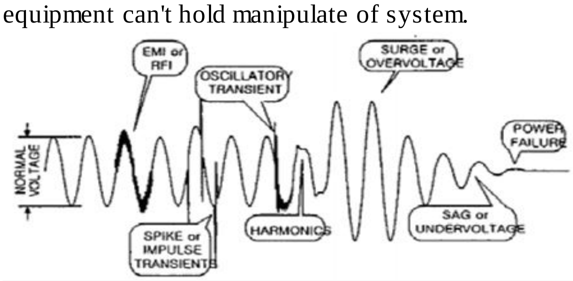


Fig.1. *power quality and reliability*

Both the reliability and fine of deliver are equallyimportant. As an example, a patron this is connected to thesame bus that components a big motor load can also must face asevere dip in his supply voltage whenever the motor load isswitched on. In some intense cases even we have to bearthe black outs which isn't always suitable to the purchasers.there are also sensitive loads including hospitals (existence help,operation theatre, and patient database gadget), processingplants, air visitors manipulate, economic establishments and numerousother records processing and carrier companies that requireclean and uninterrupted electricity. In processing plants, a batchof product can be ruined with the aid of voltage dip of very shortduration. Such clients are very wary of such dips sinceeach dip can value them a considerable amount of cash. Evenshort dips are enough to reason contactors on motor drivesto drop out. Stoppage in a portion of process can damage theconditions for satisfactory control of product and requirerestarting of manufacturing. For this reason in this scenario in whichconsumers increasingly demand the first-class power, the termpower great (pq) attains elevated significance.

Transmission traces are exposed to the forces of nature.furthermore, each transmission line has its load potential limitthat is often decided with the aid of either balance constraints or bythermal limits or by way of the dielectric limits. Despite the fact that thepower fine trouble is distribution side trouble,transmission lines are regularly having an impact at the qualityof the electricity furnished. It's miles however to be stated that whilemost issues associated with the transmission systemsarise because of the forces of nature or because of the interconnectionof energy systems, person customers are responsible formore extensive fraction of the problems of powerdistribution structures.

III. PROPOSED CONTROL SCHEME

Electricity law in a allotted energy machine (dps) is atrival and most critical challenge, which affects the nice ofpower being provided from the dps. The strength and voltagelevels from the dps may additionally get disturbed with the aid of several factorslike line impedance versions due to getting old of the line,accelerated warmness at some point of summer time, unnecessary snow and rainfall, corrosion, thunders and storms. However all of the applicationswhich rely for their operation on electric strength from thedps required the power to be provided at the desired ratedlevel. The electricity exceptional of the strength distribution linebus(pdlb) may additionally get fluctuated due to a unexpected variant inthe load impedance, source modern-day degrees and enter powerfluctuations. Anything it can be the motive for powerfluctuation, but the utilities of electrical strength from thedps cannot keep regular operation, there through disturbing regulated rated electricity nice for lossless and destructionless operation in their inner discrete components. Thusregulations of strength levels from the dps are the mostimportant assignment and to perform that assignment, several methodswere proposed in the literature. But among them we foundthat the disbursed static compensator is quality inperformance in all elements in comparison to all other existingtechniques. When you consider that from the operational understanding of thedstatcom we discovered that, the salient performancefeatures of dstatcom are advised by using the proper selectionof appropriate threshould/reference voltage. Thedstatcom offers nice of its performance if the referencevoltage changed into decided on as it should be, otherwise itsperformance won't be exceptional. Hence properselection of reference voltage for the dstatcom decidesthe effectiveness of dstatcom in distributed powerregulation sports. On this project we are going to designthe reference voltage for the dstatcom which isdesigned and carried out using fuzzy common sense and beingoperated in the control mode. The circuit diagram of adstatcom -compensated distribution system is shown infig(1). It uses a three- segment, 4-wire, -level,neutralpoint-clamped voltage switching inverter (vsi).thisstructure allows independent control to each leg of the vsi[7].

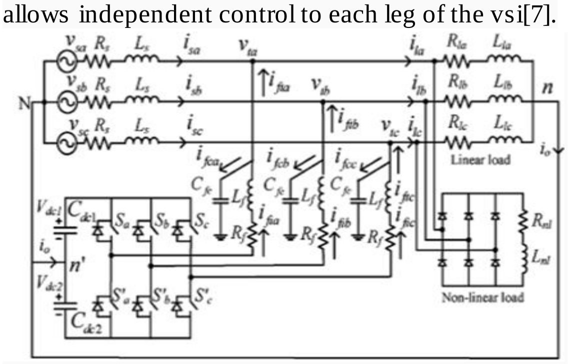


Fig.2:*Circuit diagram of the DSTATCOMcompensated distribution system*A

Fig.(3) shows the single-phase equal representationof Fig.(2). Variable "U" is a switching feature, and may beeither +1 or -1 relying upon switching country. Filterinductance and resistance are L_fandr_f, respectively.Shunt capacitor C_feliminates excessive-switching frequencycomponents. First, discrete modeling of the device ispresented to acquire a discrete voltage manipulate regulation, and it isshown that the p.c voltage can be regulated to the desiredvalue with well selected parameters of VSI. Then, aprocedure to design VSI parameters is supplied. Aproportional-crucial (PI) controller is used to adjust thedc capacitor voltage at a reference value.

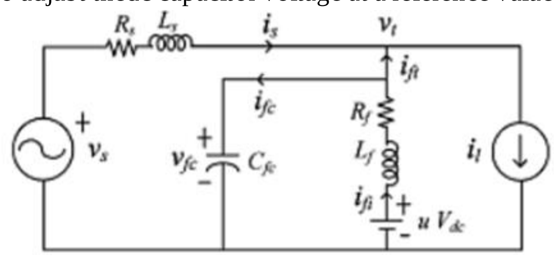
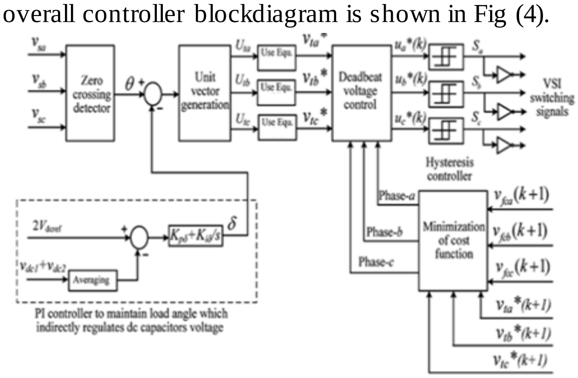


Fig.3: *Single-phase equivalent circuit of DSTATCOM*

Basedon instantaneous symmetrical component theory andcomplex Fourier transform, a reference voltage magnitudegeneration scheme is proposed that provides the advantagesof CCM at nominal load. The overall controller blockdiagram is shown in Fig (4).



The state-space equations for the circuit shown in Fig (3)are given by

$$x = Ax + Bz \rightarrow (1)$$

Where

$$A = \begin{bmatrix} 0 & \frac{1}{C_{fc}} & 0 \\ \frac{-1}{L_f} & \frac{-R_f}{L_f} & 0 \\ \frac{-1}{L_s} & 0 & \frac{-R_s}{L_s} \end{bmatrix}$$

$$B = \begin{bmatrix} 0 & -\frac{1}{C_{fc}} & 0 \\ \frac{V_{dc}}{L_f} & 0 & 0 \\ 0 & 0 & \frac{1}{L_s} \end{bmatrix}$$

$$x = [V_{fi}\, i_{fi}\, i_s]^t$$

$$z = [u\, i_{ft} v_s]^t$$

The general time-domain solution of equation (1) tocompute the state vector x(t) with known initial value x(t0)is given as follows:

$$x(t) = e^{A(t-t_0)}\, x(t_0) + \int_{t_0}^{t} e^{A(t-\tau)} Bz(\tau)d\tau \rightarrow (2)$$

The equivalent discrete solution of the continuous state isobtained by replacing t0=kTd and t=(k+1)Td as follows:

$$x(k+1) = e^{AT_d}\, x(k) + \int_{kt_d}^{T_d+kT_d} e^{A(T_d+kT_d-\tau)} Bz(\tau)d\tau \rightarrow (3)$$

Where k and T_d represents the k^{th} sample and samplingperiod respectively. During the consecutive samplingperiod, the value of z(τ) is held constant, and can be takenas z(k). After simplification and changing the integrationvariable, equation (3) can be written as

$$x(k+1) = e^{AT_d} + \int_0^{T_d} e^{A\lambda} B d\lambda z(k) \rightarrow (4)$$

This equation is written as follows:

x(k+1)=Gx(k)+ Hz(k) → (5)

where H and G are sampled matrices, with the sampling time of T_d. For small sampling time G and H are calculated as follows:

$$G = \begin{bmatrix} G_{11} & G_{12} & G_{13} \\ G_{21} & G_{22} & G_{23} \\ G_{31} & G_{32} & G_{33} \end{bmatrix} = e^{AT_d} \approx 1 + AT_d + \frac{A^2T_d^2}{2} \rightarrow (6)$$

$$H = \begin{bmatrix} H_{11} & H_{12} & H_{13} \\ H_{21} & H_{22} & H_{23} \\ H_{31} & H_{32} & H_{33} \end{bmatrix} = \int_0^{T_d} e^{A\lambda} B d\lambda \approx \int_0^{T_d} (1 + \lambda) B d\lambda \rightarrow (7)$$

Hence the capacitor voltage is given by

$$v_{fc}(k+1) = G_{11} v_{fc}(k) + G_{12} i_{fi}(k) + H_{11} u(k) + H_{12} i_{ft}(k) \rightarrow (8)$$

As seen from eq(8), the terminal voltage can be maintained at a reference value depending upon the VSI parameters V_{dc}, C_{fc}, L_f, R_f and sampling time T_d. therefore, VSI parameters must be chosen carefully. Let v_t^* be the referece load terminal voltage. A cost J is chosen as follows.

$$J = [v_{fc}(k+1) - v_t^*(k+1)]^2 \rightarrow (9)$$

The cost function is differentiated with respect to u(k) and its minimum is obtained at

$$v_{fc}(k+1) = v_t^*(k+1) \rightarrow (10)$$

The deadbeat voltage-control law, from (8) and (10), is given as

$$u^* = \frac{v_t^*(k+1) - G_{11} v_{fc}(k) - G_{12} i_{fi}(k) - H_{12} i_{ft}(k)}{H_{11}} \rightarrow (11)$$

The schematic overall block diagram of the proposed controller to control the DSTATCOM in distributed powersystem is shown in fig(3),which consists of a zero crossingdetector which detects the zero crossing points in threephasor voltage waveforms. Using the result from the zerocrossing detector and load angle from the PI controller tomaintain dc capacitor voltage, the Unit Vector Generator(UVG) generates three unit threshould vectors for threephasor voltage lines of the DSTATCOM which will befurther optimized according to the characteristic equation

$$V_t^* = \sqrt{V^2 - (|\overline{I^+}|X_s)^2} - |\overline{I^+}|R_s \rightarrow (12)$$

IV. SIMULATION RESULTS

The practical implementation of the proposed algorithm forgenerating the reference voltage of the Distributive StaticCompensator (DSTATCOM) operating in the control modefor voltage stability control and analysis of a distributedpower system is done by designing the correspondingSimulink models hierarchically to replicate variousprocessing stages involved in designing the DSTATCOMand various processing models usingMATLAB/SIMULINK software. The proposed algorithmwill includes the design and analysis of variousDSTATCOM models as given under.

V. CONCLUSION

The overall performance of the proposed scheme is compared with the conventional voltage controlleddstatcom. The proposed approach affords the subsequent benefits- at nominal load, the compensatorinjects reactive and harmonic components of load currents, resulting in upf; almost upf is maintained for aload exchange; speedy voltage law has been completed in the course of voltage disturbances and losses within the vsi andfeeder are reduced substantially, and have better sag supporting functionality with the same vsi score comparedto the traditional scheme. One-of-a-kind forms of voltage sag situations ought to implemented compensated in simulink environment. Additionally power issue correction and voltage law the harmonics also are checked, 20p.cvoltage sag removed underneath t=0.five to 1sec, for this reason the simulation effects show that the proposed scheme providesdstatcom, a capability to improve numerous energy best problems (related to voltage and present day).

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