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Compensation and Harmonic Elimination of Unbalance Currents in SEIG Based Statcom

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Abstract:

Induction generators are increasingly being used in non conventional energy systems. The self excitedinduction generators has some drawbacks such as poor voltage regulation, it requires reactive power source and while-connecting non-linear loads the harmonics are injected. When single phase loads are connected to three-phase SEIG itcause unbalance in source current. The three-phase static synchronous compensator (STATCOM) connected at thepoint of common coupling (PCC) to compensate the unbalance current and to eliminate the harmonics. The hysteresisbased control algorithm is used to generatethe switching pulses to the STATCOM. This method issimulated using MATLAB/SIMULINK software. The simulated results shows that SEIG terminal voltage ismaintained constant even with unbalanced loads using STATCOM based voltage regulation.

KEYWORDS:

Self Excited Induction Generator (SEIG); single-phase synchronousD-Q frame theory; Static Synchronous Compensator (STATCOM).

I.INTRODUCTION:

In remote areas, plenty of non-conventional energy sources are available. These non-conventional energy sourcesare used as prime input for the generating systems. Externally driven induction machine operates as a self-excitedinduction generator (SEIG) with its excitation requirements being met by a capacitor bank connected across itsterminals.

The SEIG has advantages like simplicity, maintenance free, absence of DC, brushless etc. as compare to the conventional synchronous generator.Self-excitation phenomenon in induction machines although known for more than a half century. This inductiongenerator is self excited by a suitable capacitor banks across the terminals. This phenomenon is known as capacitor self-excitation and the induction generator is called a “SEIG” [2]. A major disadvantage of SEIG is its poor voltageregulation requires a variable capacitance bank to maintain constant terminal voltage under varying loads.Attempts have been made to maintain constant terminal voltage by using passive elements [5], short –shunt [6] andlong -shunt method for a three-phase SEIG [7]. fixed capacitor and thyristor-controlled inductor known as static varcompensator (SVC) [10] for voltage compensation. By the invention of solid-state self-commutating devices, it ispossible to make a static, noiseless voltage regulator, which can provide continuously variable reactive power to theSEIG with varying load to keep terminal voltage constant. This system called STATCOM has specific benefitscompared to SVC [12], Schauder and Mehta [13] have derived governing equations of STATCOM to determine the response of the STATCOM.In this paper, the single phase linear and non-linear loads are connected to the three-phase SEIG which causeunbalance current and draws non-sinusoidal current due to non-linearity of load which injects harmonics into thesystem. The STATCOM is introduced to eliminates the harmonics, provides load balancing and supplies the reactive power and feeding single-phase loads using a three-phase SEIG without de-rating the machine. The transient analysis of the SEIG-STATCOM system under balanced/ unbalanced single-phase linear and non-linear loads and simulated results show that the SEIG-STATCOM system behaves an ideal supply under these unbalanced loads.

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II.PROPOSED SYSTEM SELF EXCITED INDUCTION GENERATOR (SEIG)

Induction generator:

The induction generators offer advantages over synchronous machines, resulting in a simplified installation with-economy in first cost and in operating and maintenance expenses. The attractive feature of the induction generator is simplicity of operation.

Process of self excitation:

When an induction machine is driven at a speed greater than the synchronous speed then therewill be negativeslip. By means of an external prime mover, the direction of induced torque is reversed and it starts working as an-induction generator. When the slip is negative then the induction machine draws a current, which lags the voltage bymore than 90. This means that real power flows out of the machine but the machine needs the reactive power. To buildup voltage across the generator terminals, excitations must be provided by two modes (i.e., grid connected and isolatedmode). In case of a grid-connected mode, the induction generator can draw reactive power either from the grid but itwill place a burden on the grid For an isolated mode, there must be a suitable capacitor bank connected across thegenerator terminals. This phenomenon is known as capacitor self-excitation and the induction generator is called a"SEIG."

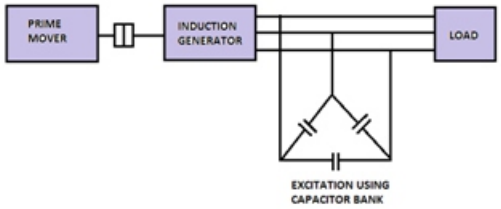

Figure 1: self excitation of induction generator

STATIC SYNCHRONOUS COMPENSATOR (STATCOM)

The static synchronous compensator is a shunt-connected reactive power compensation device which provides voltage support by generating or absorbing reactive power at the point of common coupling without the need of large external reactors or capacitor banks.

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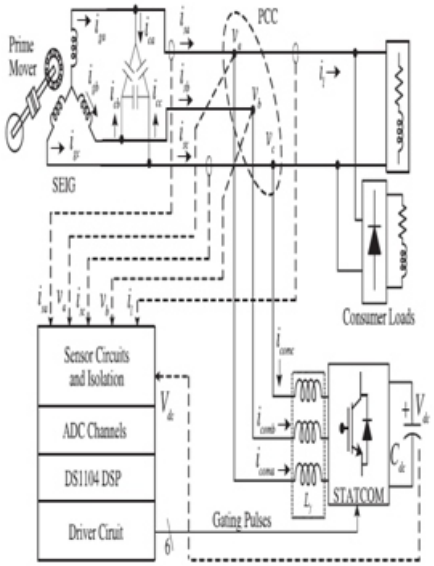

Fig. 2. Schematic diagram of the SEIG–STATCOM system feeding single-phase loads.

III. CONTROL ALGORITHM OF THE STATCOM:

Modelling of control scheme of STATCOM:

The control scheme of STATCOM is based on "bang-bang controller". This controller uses a hysteresis current-control technique with fuzzy logic controller. The control scheme for generating the switching signals. The control algorithm needs the measurements of variables such as three-phasesource current, DC voltage, inverter current. The current control block receives an input of reference current and actual current are subtracted to activate the operation of STATCOM in current control mode.

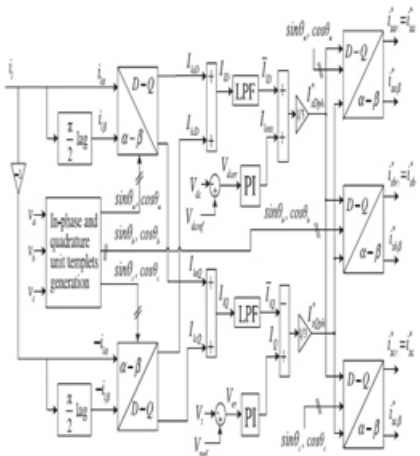

Fig. 3. Block diagram of the single-phase synchronous D-Q theory control algorithm for the STATCOM.

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IV.SIMULATION RESULTS

STEADY STATE PERFORMANCE OF THE SEIG-STATCOM SYSTEM FEEDING SINGLE-PHASE NONLINEAR LOADS:

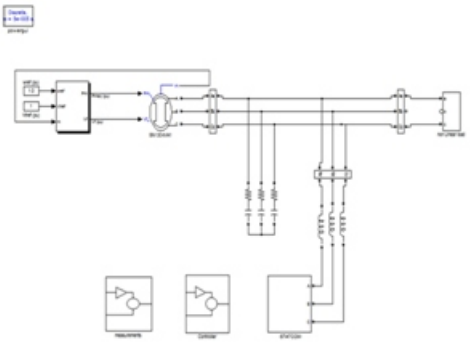
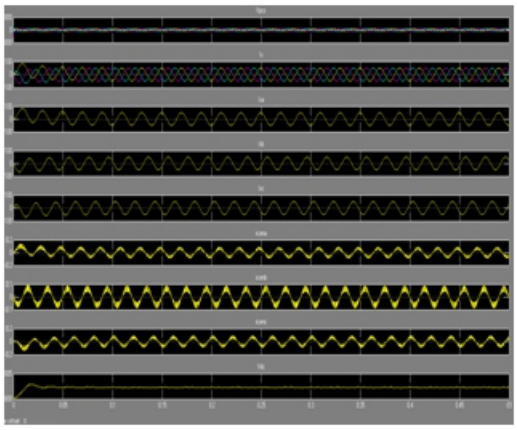
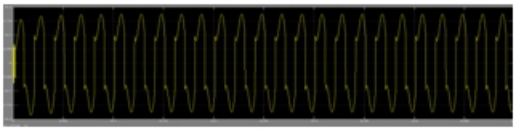


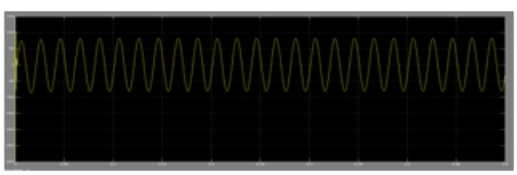
Fig.4 Steady-State Simulation block diagram of the SEIG–STATCOM System Feeding Single-Phase Nonlinear Loads.



(a)



(b)



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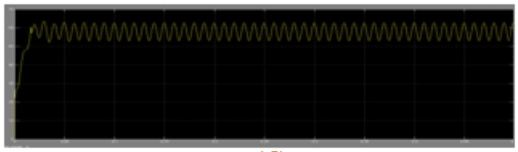


(d)

Fig. 5 Steady-state performance of the SEIG–STACOM system feeding single- phase nonlinear loads. (a) Vpcc, Is, Isa, Isb, Isc, i_coma, i_comb, i_comc, Vdc (b) I_la (c) Vt (d) VtRMS

DYNAMIC PERFORMANCE OF THE SEIG-STATCOM SYSTEM FEEDING SINGLE-PHASE NONLINEAR LOADS

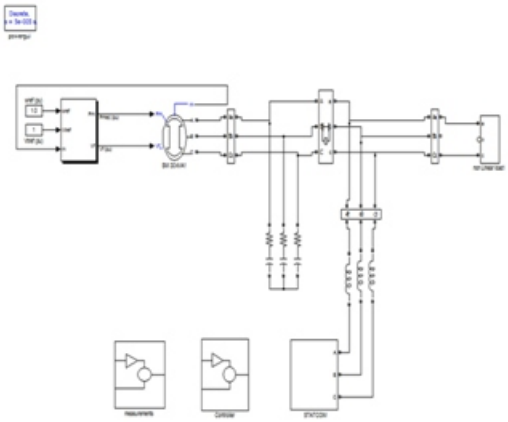
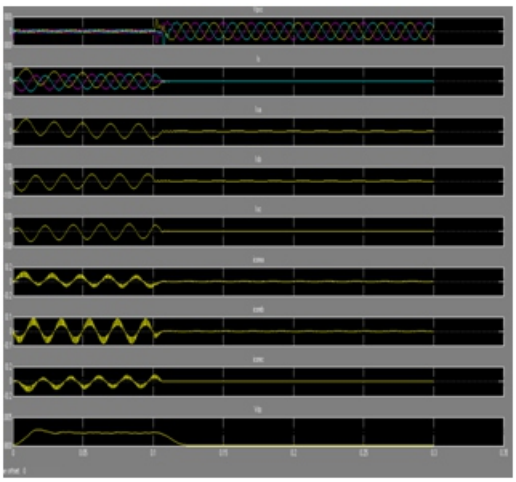
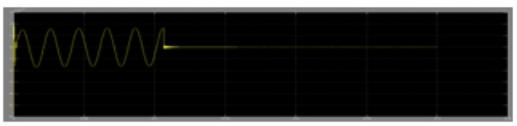


Fig.6Dynamic Simulation block diagram of the SEIG–STATCOM During load removal.



(a)



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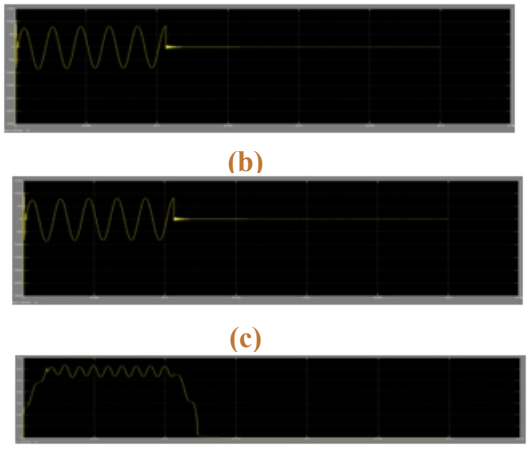

(b)

(c)

(d)

Figure 7 Dynamic performance of the SEIG–STATCOM during load Removal (a)Vpcc, Is, Isa, Isb, Isc, i_coma, i_comb, i_comc, Vdc (b) I_la (c) Vt (d) VtRMS.

V. CONCLUSION:

The proposed method of feeding single-phase loads from a three-phase SEIG with STATCOM combinationhas been tested, and it has been proved that the SEIG is able to feed single-phase loads up to its rated capacity current balancing of the SEIG system. From the simulated results, it is found that SEIG terminalvoltage remains constant and sinusoidal feeding the three-phase or single-phase rectifiers with R and R-L loads. Theproposedwith conventional PI controller. Therefore, it is concluded that STATCOM acts as voltage regulator, load balancer and lso harmonic eliminaton.

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