Power Quality Enhancement of MPPT for Single Stage PV-Grid Connected System Using PI Controller Distributed Particle Swarm Optimization (PI-DPSO)

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***Abstract*—The power quality resources have continuously played an important role in the growth of human livings. PSO tuned PI controller are compared and a mark reduction in total harmonic reduction is with number of generations. PI Controller distributed Generation units that encompass a portion of an electric power distribution system and may rely on different energy sources. Functionally, the PI controller is required to provide adequate levels and quality of power to meet load demands. The issue of power quality is significant as it directly affects the characteristics of the PI controller operation. This problem can be defined as an occurrence of short to long periods of inadequate or unstable power outputs by the PI controller. In a stand-alone operation mode, the system voltage and frequency must be established by the PI controller; otherwise the system will collapse due to the variety in the PI controller component characteristics. When more accuracy is required, this rule should be used. Simulation and experimental results are provided for both numerical statistical techniques Simpson's such as under the same atmospheric condition. From the simulation and experimental results, the particle swarm optimization (PSO) based maximum power point tracking (MPPT) for PV system is presented which is interrelated with other control schemes such as synchronization with grid and current control finding lower error event as compare with PVMPPT with same saturated voltage which can deliver more power than the conventional MPPT Technique. In our proposed scheme is to define the global and local best fitness for the STATCOM in order to improve power quality and minimize power losses in the grid with PI controller and RLC branch, using Particle Swarm Optimization algorithm and we also comparing with base Genetic algorithm which implement programming and Simulink design in MATLAB tool.**

***Index Terms*—Distributed particle swarm optimization (DPSO), voltage stability, Unified Power Flow Controller (UPFC), PI controller**

I. INTRODUCTION

A Power quality problem is an occurrence manifested as a Non standard voltage, current or frequency that results in a distribution network, sensitive industrial loads and critical commercial operations suffer from various types of outages and service interruptions which can cost significant financial losses. This dissertation is dedicated to a comprehensive study of static synchronous compensator (STATCOM) systems utilizing cascaded-multilevel converters (CMCs). Among flexible AC transmission system (FACTS) controllers, the STATCOM has shown feasibility in terms of cost effectiveness in a wide range of problem solving abilities from transmission to distribution levels. Voltage swells are not as important as voltage sags because they are less common in distribution systems. Voltage dips are one of the most occurring power quality problems. Off course, for an industry an outage is worse, than a voltage dip, but voltage dips occur more often and cause severe problems and economical losses. In a PI controller, the problems of the power quality challenge the reliability and stability of the system operation. Disturbances to the supplied power, which are related to the voltage, frequency, active power, reactive power, harmonic distortion, and dynamic response, can impact performance for both PI controller operation modes: islanding and grid-connected. Recently, researchers have focused on improving power quality by investigating optimal PI controller designs and optimal locations for the connected DG units. This work proposes a new power control strategy, based on a real-time distributed Particle Swarm Optimization technique, to improve the quality of the power supply in a PI controller. Therefore, the benefits of this work can be summarized as follows.

1. Enhancing the market penetration of micro-sources.
2. Protecting sensitive systems from the detrimental effects of power quality and reliability problems.
3. Reducing the capital cost, in particular when the PI controller is designed for Peak Shaving application.
4. Ensuring best utilization of the PI controller's output power .
5. Providing stable and reliable operation of the PI controller in response to the load demand.

II. POWER QUALITY

Power Quality is a term that mean different to different people. Institute of Electrical and Electrical Engineers (IEEE) standard IEEE 1100 defines power quality as "the concept of powering and grounding sensitive electronic equipment in a manner suitable for the equipment." A simpler words Power quality is a set of electrical boundaries that allow a piece of equipment to function in its intended manner without significant loss of performance or life expectancy. This definition embraces two things that we demand from an electrical device which are performance and life expectancy.

A. Problems Regarding Power Quality

1. Voltage Sag (Or Dip)

It is defined as a decrease of the normal voltage level between 10 and 90% of the nominal RMS Voltage at the power frequency, for durations of 0. 5 cycle to 1 minute.

2. Very Short Interruptions

Manuscript received June 23, 2017.

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Total interruption of electrical supply for duration from few milliseconds to one or two seconds is termed as Very Short Interruption.

3. Long Interruptions

It is the total interruption of electrical supply for duration greater than 1 to 2 seconds

4. Voltage Spike

It is a very fast variation of the voltage value for durations from a several microseconds to few milliseconds. These variations may reach thousands of volts, even in low voltage.

5. Voltage Swell

It is the momentary increase of the voltage, at the power frequency, outside the normal tolerances, with duration of more than one cycle and typically less than a few seconds.

6. Harmonic Distortion

It is seen to take place when the voltage or current waveforms assume non-sinusoidal shape. The wave form corresponds to the sum of different sine-waves with different magnitude and phase, having frequencies that are multiples of power-system frequency.

7. Voltage Fluctuation

The oscillation of voltage value, amplitude modulated by a signal with frequency of 0to 30 Hz is called Voltage fluctuation.

8. Noise

Superimposing of high frequency signals on the waveform of the power-system frequency is called Noise.

9. Voltage Unbalance

A voltage variation in a three-phase system in which the three voltage magnitudes or the phase angle differences between them are not equal we say that there is a Voltage imbalance.

B. *Efffects of Poor Quality on Power System Devices*

Poor electric power quality has many harmful effects on power system devices and end users. What makes this phenomenon so important is that its effects are often not known until failure occurs. Therefore, insight into how disturbances are generated and interact into how they affect components is important for preventing failures. Even if failure does not occur, poor power quality and harmonics increase losses and decrease the lifetime of power components and end-use devices.

III. METHOD

Increasing automation in modem industry and deregulation has changed the requirements on Power Quality. Computer and process control equipment as well as drive converters are sensitive to deviations of the line voltage from the ideal sinusoidal. Voltage sags, harmonic distortion, flicker and interruption of power supply are the most common problems. In an increasing number of cases, where conventional equipment cannot solve these problems, PWM converter-based shunt connected Power Conditioners named DSTATCOM (Distribution Static Compensator) have been introduced. With energy storage added to the Power Conditioner even more flexibility in system operation and planning is provided for utilities and industry. In this thesis work, Simulink model of test system is analyzed. In this test model two similar loads with different feeders are considered. One of the feeder is connected to DSTATCOM and the other is kept as it is. This test system is analyzed under different fault conditions. System is also analyzed with non linear load under same fault conditions. The control technique implements a PI controller which starts from the difference between the injected current (DSTATCOM current) and reference current (identified current) that determines the reference voltage of the inverter (modulating reference signal).

A. *Parameters of the test system*

The modeled system has been tested on different fault conditions with linear as well as non linear load. The system is employed with three phase generation source with configuration of 25KV, 50 Hz. The source is feeding two transmission lines through a three phase, three windings transformer with power rating 250MVA, 50 Hz.

Winding 1: V1rms (ph-ph) = 25 KV, R1 = .002 (pu), L1 = .08002 (pu).

Winding 2: V2rms (ph-ph) = 11 KV, R2 = .002 (pu), L2 = .08002 (pu).

Winding 3: V3rms (ph-ph) = 11 KV, R3 = .002 (pu), L3 = .08002 (pu).

Optimal Power flow (OPF) is allocating loads to plants for minimum cost while meeting the network constraints. It is formulated as an optimization problem of minimizing the total fuel cost of all committed plant while meeting the network(power flow) constraints. The variants of the problems are numerous which model the objective and the constraints in different ways.

The basic OPF problem can described mathematically as a minimization of problem of Minimizing the total fuel cost of all committed plants subject to the constraints.

$$Minimize \sum_{i=1}^{n} F_i(P_i)$$

$F(P_i)$ is the fuel cost equation of the 'i'th plant. It is the variation of fuel cost ($ or Rs) with generated power (MW).Normally it is expressed as continuous quadratic equation.

$$F_i(P_i) = a_i P_i^2 + b_i P_i + c_i, \quad P_i^{min} \le P_i \le P_i^{max}$$

The total generation should meet the total demand and transmission loss. The transmission loss can be determined from power flow.

$$\sum_{i=1}^{n} P_i = D + P_l$$

$$P_i = real(\sum_{j}^{n} V_i Y_{ij}^* V_j), i = 1,2,..n$$

$$Q_i = imag(\sum_{j}^{n} V_i Y_{ij}^* V_j), i = 1,2,..n$$

$V_i^{min} \le Vi \le V_i^{max}$

$LF_{ij} \le$ Line flow limits

B. *PSO Algorithm*

1. Collect the busdata,line data and cost coefficients and their limits.

2. Convert the constrained optimization problem as an unconstrained problem by penalty function method.

Minimize

$$\sum_{i=1}^{n} F_i(P_i) + 1000 * abs(\sum_{i=1}^{n} P_i - D - P_l)$$

3. The file .opf2.m is a function file which returns the fuel cost, voltage ,Generation, and transmission loss. Pflow.m is the power flow routine

I am using the PSO toolbox developed by Mr Brian birge.I thank him for the excellent tool. It can be downloaded form MATLAB central file exchange.

4. Change your default folder as PSOOPF. Just run psoopf26 or psoopf30 to simulate the OPF. The results will be displayed on the command window. This is the simulation result of IEEE 30 bu system.

5.Distributed Particle swarm optimization (D-PSO) is a computational method that optimizes a problem by iteratively trying to improve a candidate solution with regard to a given measure of quality.

6.DPSO optimizes a problem by having a population of candidate solutions, here dubbed particles, and moving these particles around in the search-space according to simple mathematical formulae over the particle's position and velocity.

7.Each particle's movement is influenced by its local best known position and is also guided toward the best known positions in the search-space, which are updated as better positions are found by other particles. This is expected to move the swarm toward the best solutions.

8.A Program is written naming fitness taking the overall objective function. This fitness is linked to another program named DPSO. This DPSO program consists of population size (26) and number of iterations (50); the numbers of iterations are taken as 50 because the more the no: of iterations, the more is the chance of getting the best solution.

9.This DPSO is executed and after running the given no: of iterations the result is shown in the command window. The current position corresponds to the values of kp and ki and fitness function corresponds to the error in DC link.

IV. RESULTS

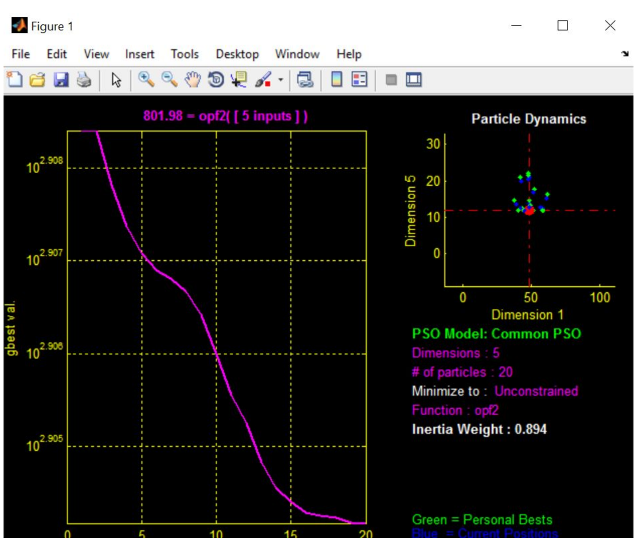

Figure 5.1: gbest value with best fitness in voltage regulation and improving weight inertia i.e 0.894

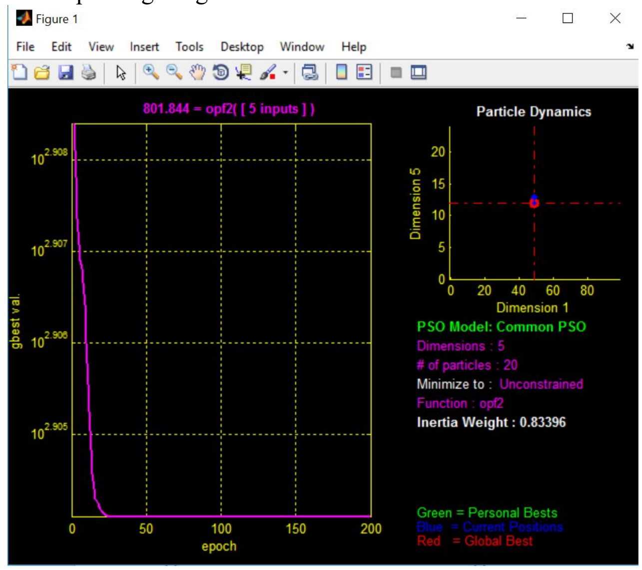

Figure 5.2: gbest value with best fitness in voltage regulation and improving weight inertia i.e 0.83396

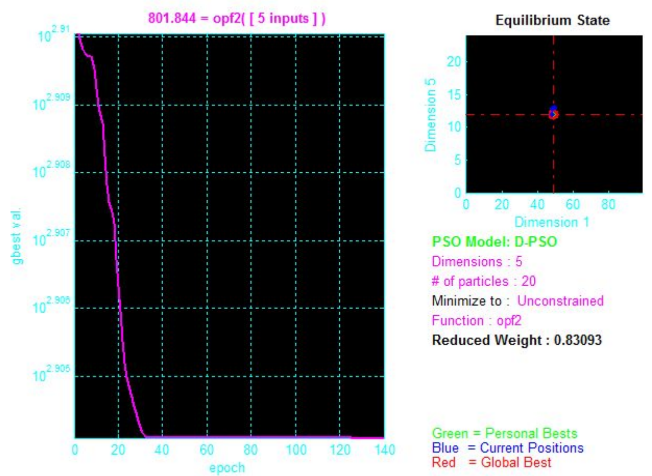

Figure 5.3: gbest value with best fitness in voltage regulation and improving weight inertia i.e 0.83093

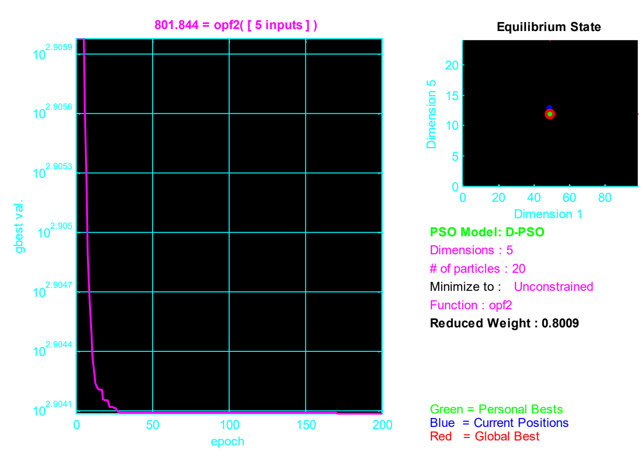

Figure 5.4 Final Improved weight with maximum coverage of voltage

V. CONCLUSION

In this work, the investigation on the role of STATCOM is carried out to improve the power quality in distribution networks with static linear and non-linear loads. PI controller is used with the device to enhance its performance. Test system is analyzed and results are presented in the previous chapter. Conditions and it can be concluded that STATCOM effectively improves the power quality in distribution networks with static linear. The values of the DC link capacitor and battery source were optimized using the D-PSO and the simulations results were compared with that of the system without compensation and with STATCOM, under both optimized and un-optimized conditions. STATCOM provides an improvement in power quality and active power consumption stabilization. This effect could be used in applications where a variable load voltage should be compensated. It would result in a power stability improvement and decrease a risk of critical events caused by those sources. Using STATCOM, we are able to control the voltage at the node to which this device is connected and at the same time it is possible to reduce active power losses and provides information for STATCOM design and placement in power grids. Applying Particle Swarm Optimization showed the potentials to use this method in power grids to improve their operation and selected criteria. Utilized for determining the amount of reactive power generated or absorbed by each STATCOM.

Installation and utilization of the STATCOM in distribution networks leads to especially significant for network qualities such as reducing of ohmic losses in transmission lines, improve voltage profiles and system efficiency. The optimal placement of each STATCOM is computed by the ant colony algorithm. In order to optimize placement for each STATCOM, two groups of ant are selected, which respectively located in near nest and far from the nest. Moreover, for every output simulation of DSTATCOM that is used to produce or absorb of reactive power, a PSO algorithm to minimizing the total network losses is applied. used to mitigate the power quality problems such as voltage flicker and harmonics and also reduced the switching losses. It indicates that mitigation of flicker with STATCOM and with PI controller is more effective for the power factor. it has better dynamic performance than the conventional PI controller based on carrier-less hysteresis current control is used for quick response. Additionally, in contrast to the different control strategies; the id-iq method is used for obtaining the reference currents in the system.

This is due to the fact that the angle „θ‟ is calculated directly from the main voltage which enables an operation which is frequency independent and avoids large number of synchronization problems. It can also be seen that the DC voltage regulation system is a stable and steady-state error free system. Receiving and converting microwave energy into Directly Current (DC) that is a receiving antenna covers a large area, allows having relatively high effective radiated power and acceptable gain. This research document suggests a novel methodology using a novice technique to transfer energy using the oil and gas pipeline as a circular waveguide. The controller scheme is composed of an inner current control loop and an outer power control loop based on a synchronous reference frame and the conventional PI regulators. Particle Swarm Optimization (PSO) is an intelligent searching algorithm that is applied for real-time self-tuning of the system which show that the proposed controller provides an excellent dynamic response with acceptable harmonics level. . A PSO algorithm is incorporated in the (Vf) power control strategy in order to implement real-time self-tuning, especially when the micro grid is islanded from the grid.

REFERENCES

[1] Bhim Singh, Alka Adya, A.P. Mittal, J.R.P Gupta, "Power Quality Enhancement with DSTATCOM for Small Isolated Alternator feeding Distribution System", conference on Power Electronics and Drive Systems, vol.1, pp. 274-279, 2005.

[2] Wei-Neng Chang and Kuan-Dih Yeh, "Design and Implementation of Dstatcom for Fast Load Compensation of Unbalanced Loads", Conference on Journal of Marine Science and Technology, vol. 17, No. 4, pp. 257-263, 2009.

[3] Arindam Ghosh and Gerard Ledwich, "Load Compensating DSTATCOM in Weak AC Systems", Conference on IEEE Transactions on Power Delivery Publication, vol.18, pp.1302 – 1309, 2003

[4] H.Nasiraghdam and A. Jalilian, "Balanced and Unbalanced Voltage Sag Mitigation Using DSTATCOM with Linear and Nonlinear Loads", Conference on World Academy of Science, Engineering and Technology, pp. 20–25, 2007.

[5] J. Sun, D. Czarkowski and Z. Zabar, "Voltage Flicker Mitigation Using PWM-Based Distribution STATCOM", Conference on Power Engineering Society Summer Meeting, Publication, vol.1 ,pp. 616 – 621,2002.

[6] Sung-Min, Woo Dae-Wook Kang, Woo-Chol Lee and Dong-Seok Hyun, "The Distribution STATCOM for Reducing the Effect of Voltage Sag and Swell", Conference on IECON'O1: The 27th Annual Conference of the IEEE Industrial Electronics Society Publication, vol.2, pp.1132 - 1137,2001.

[7] Bhim Singh, Alka Adya, A.P.Mittal and J.R.P. Gupta, "Modeling, Design and Analysis of Different Controllers for DSTATCOM", Conference on Power system technology and IEEE Power India Conference, 2008, pp.1 -8, 2008.

[8] Dinesh Kumar and Rajesh, "Modeling, Analysis and Performance of a DSTATCOM for Unbalanced and Non-Linear Load", Conference on Transmission and Distribution conference and Exhibition Asia and pacific, IEEE/PES Publication, pp. 1 – 6, 2005.

[9] Walmir Freitas, Andre Morelato, Wilsun Xu and Fujio Sato, "Impacts of AC Generators and DSTATCOM Devices on the Dynamic Performance of Distribution Systems", Conference on IEEE Transactions on Power Delivery, pp. 1493 – 1501, 2005

[10] M. G. Molina, P. E. Mercado, "Control Design and Simulation of DSTATCOM with Energy Storage for Power Quality Improvements", Conference on IEEE PES Transmission and Distribution Conference and Exposition Latin America, Venezuela, pp.1 - 7, 2006.

[11] Pierre Giroux, Gilbert Sybille Hoang Le-Huy, "Modeling and Simulation of a Distribution STATCOM using Sirnulink's Power System Blockset", Conference on IECON 0l: The 27th Annual Conference of the IEEE Industrial Electronics Society, vol. 2, pp. 990 – 99, 2001.

[12] Afshin Lashkar Ara and Seyed Ali Nabavi Niaki, "Comparison of The Facts Equipment Operation In Transmission And Distribution Systems" Conference on 17th International

[13] Conference on Electricity Distribution Barcelona, vol.2, pp.44,2003. Ben-Sheng Chen and Yuan-Yih Hsu, "An Analytical Approach to Harmonic Analysis and Controller Design of STATCOM", Conference on IEEE Transactions on Power Delivery, vol.22, 2007.