International Journal For Technological Research In Engineering
Volume 2, Issue 12, August-2015 ISSN (Online): 2347 - 4718

A LONG TRANSMISSION LINE WITH THE IMPLEMENTATION OF GENETIC ALGORITHM BASED DISTRIBUTED POWER FLOW CONTROLLER FOR REACTIVE POWER COMPENSATION AND IMPROVED VOLTAGE REGULATIONS

Mr Uditveer Singh[1], Mr. Syed Waseem Ali[2], Mr. Santosh Kumar Tembhare[3]

ABSTRACT: Compensation of reactive power is done by series, shunts and combined compensators. But there application is found costly per KVA as they share a common D.C LINK, hence in this paper a new approach is adopted by disabling common D.C link and by making it a distributed power flow controller. Also the controlling is modified with genetic algorithm coding due to which a better change is seen in the reactive power compensation and fluctuations
Key words: DPFC, GENETIC ALGORITHMS, LONG TRANSMISSION LINE

I. INTRODUCTION

A combined device is a two-port device that is connected to the grid, both as a shunt and in a series, to enable active power exchange between the shunt and series parts. Combined devices are suitable for power flow control because they can simultaneously vary multiple system parameters, such as the transmission angle, the bus voltage magnitude and the line impedance. Although the UPFC and the IPFC have superior capability to control power flow, there is no commercial application currently. The main reasons are: The first concern with combined FACTS is cost. Typically, a FACTS cost around 120-150 $ per kVA, compared to 15-20 $ per kVA for static capacitors One of the reasons for the high cost is that the ratings of FACTS devices are normally in 100 MVA, with the system voltage from 100 kV to 500 kV. This requires a large number of power electronic switches in series and parallel connection Secondly, as the FACTS devices are installed at different locations for different purposes, each of them is unique. As a result, each FACTS device requires custom design and manufacturing, which leads to a long building cycle and high Cost. Lastly, A FACT is a complex system, and requires a large area for installation and also well-trained engineers for maintenance. The second concern is possible failures in the combined FACTS. Two issues are considered: the reliability of the device itself and its influence on power system security. Due to these two major drawbacks, the UPFC and IPFC are not widely applied in practice. Even when there is a large demand of power flow control within the network, the UPFC and IPFC are not currently the industry's first choice. Power flow is controlled by adjusting the parameters of a system, such as voltage magnitude, line impedance and transmission angle. The device that attempts to vary system parameters to control the power flow can be described as a Power Flow Controlling Device (PFCD). Depending on how devices are connected in systems, PFCDs can be divided into shunt devices, series devices, and combined devices (both in shunt and series with the system),

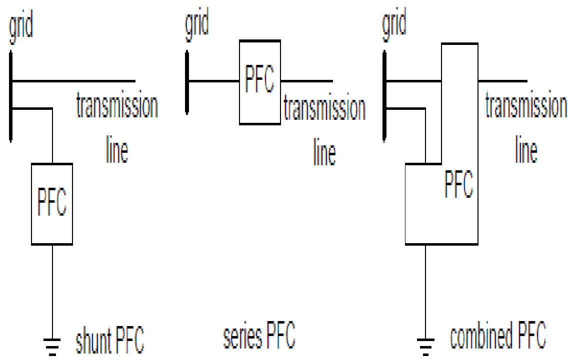

Fig 1 Simplified diagram of shunt, series and combined devices

A shunt device is a device that connects between the grid and the ground. Shunt devices generate or absorb reactive power at the point of connection there by controlling the voltage magnitude. Because the bus voltage magnitude can only be varied within certain limits, controlling the power flow in this way is limited and shunt devices mainly serve other purposes. A device that is connected in series with the transmission line is referred to as a 'series device'. Series devices influence the impedance of transmission lines. The principle is to change (reduce or increase) the line impedance by inserting a reactor or capacitor. To compensate for the inductive voltage drop, a capacitor can be inserted in the line to reduce the line impedance. By increasing the inductive impedance of the line, series devices are also used to limit the current flowing through certain lines to prevent overheating. The new concept presented in this thesis is called 'Distributed Power Flow Controller (DPFC)'. It is a combined FACTS device, which has taken a UPFC as its starting point. The DPFC has the same control capability as the UPFC; independent adjustment of the line impedance, the transmission angle and the bus voltage. The DPFC eliminates the common DC link that is used to connect the shunt and series converter back-to- back within the UPFC. By employing the Distributed FACTS concept as the series converter of the DPFC, the cost is greatly reduced due to the small rating of the components in the series converters. Also, the reliability of the DPFC is improved because of the redundancy provided by the multiple series converters. The below figure mentions the changed working of a DPFC control with the other FACTS devices.

II. DPFC

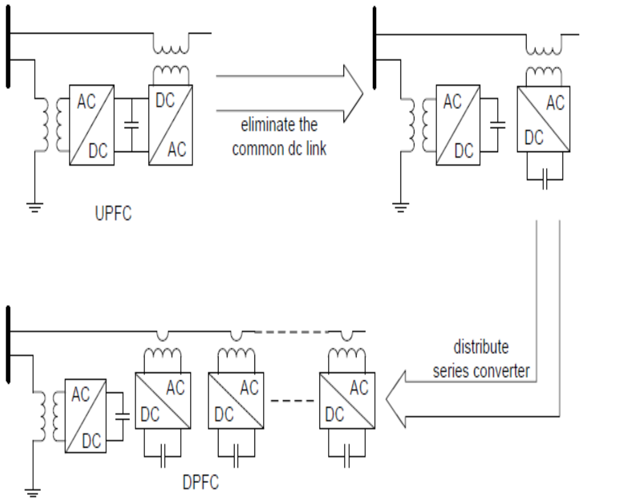

Fig 2 Evolution of DPFC from UPFC

A. DPFC CONTROL

To control multiple converters, a DPFC consists of three types of controllers: central control, shunt control and series control,

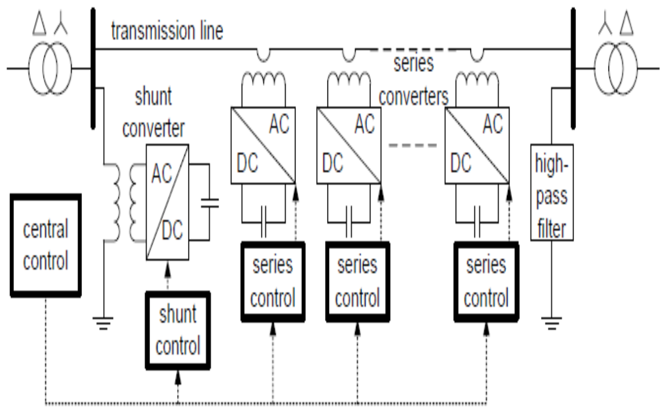

Fig 3 DPFC with series shunt and centralized controllers

The DPFC can be considered a UPFC that employs the D-FACTS concept and the concept of exchanging power through the 3rd harmonic. In this way, the DPFC inherits all their advantages High controllability, high reliability, low cost.

B. Genetic algorithms

Genetic algorithm is a mathematical model of natural evolution for searching of optimal solutions. In engineering many problems are faced where it is not possible to find exact solution from given data and relations hence an optimization technique is needed the genetic algorithm helps in quickly searching the solution even in very large domain.

The basic of genetic algorithm is based on the rule of survival of the fittest, here the initial arbitrarily selected values of variables is evolved and promoted on the basis of their survival on fitness function, and the evolution is performed by selection, crossover and mutation as happened with natural process.

The algorithm is required following preprocessing:

1. Define the limits of variable.
2. Convert the variable to binary string.
3. Form a fitness function which minimize when solution found.

The evolution usually starts from a population of randomly generated individuals and happens in generations. In each generation, the fitness of every individual in the population is evaluated, multiple individuals are stochastically selected from the current population (based on their fitness), and modified (recombined and possibly randomly mutated) to form a new population. The new population is then used in the next iteration of the algorithm. Commonly, the algorithm terminates when either a maximum number of generations has been produced, or a satisfactory fitness level has been reached for the population. If the algorithm has terminated due to a maximum number of generations, a satisfactory solution may or may not have been reached. The fitness function is defined over the genetic representation and measures the quality of the represented solution. The fitness function is always problem dependent. If the variables values not evolving towards solution in may be directed to local minima to avoid such conditions a mutation (random variation in variables binary string) could be performed generally mutation is performed after 100 to 1000 Crossovers. Simple generational genetic algorithm procedure:

1. Choose the initial population of individuals
2. Evaluate the fitness of each individual in that population
3. Repeat on this generation until termination (time limit, sufficient

III. PROPOSED WORK

In proposed system five series compensators are used and each has capability of injecting the 0.1 voltage (PU), hence the number of variable for the given system is six, the initial population for the genes is selected to eight, the mutation to crossover ratio is selected to 0.001 and the goal tolerance is set to 1 percent. The genetic algorithm is used to calculate the optimum values for Vse, i∠θi (where Vse, I represents the voltage generated by ith series compensator and θi is the angle of generated voltage) which gives the required Vo ∠θo, the calculation and controlling is performed from central unit where the signals are generated from all other units and are controlled and monitored by the genetic algorithm at the centre

A. SIMULATION

The model of transmission system is simulated using MATLAB. The Model of simulated network contains a 500KV power source which supplies the power to a 100 MVA load through a 500km. long transmission line, for controlling five SSSC (20MVA) controllers are placed at some intervals of line and a STATCOM of 100MVA is placed near the source.

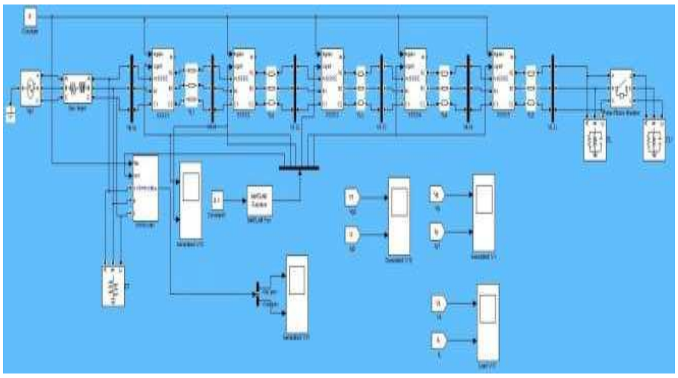

Fig 4 Diagram of the Simulated Model designed in Simulink.

IV. RESULTS

The load is switched from 100MVA to 200MVA at t = 2 sec. and switched back to 100MVA at t = 3 sec.

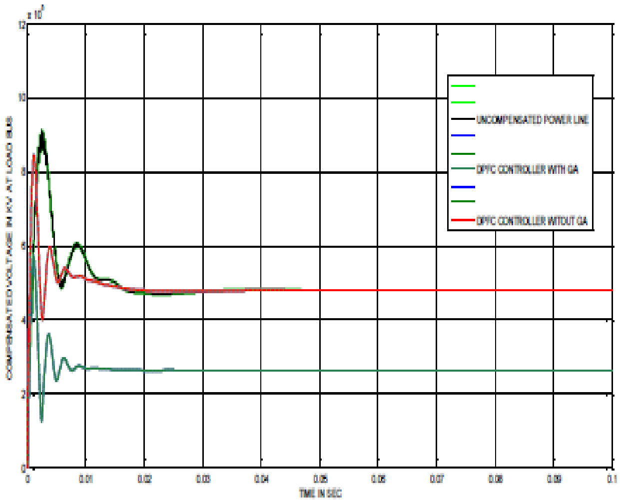

Fig 5 Voltage comparison plot at generator bus

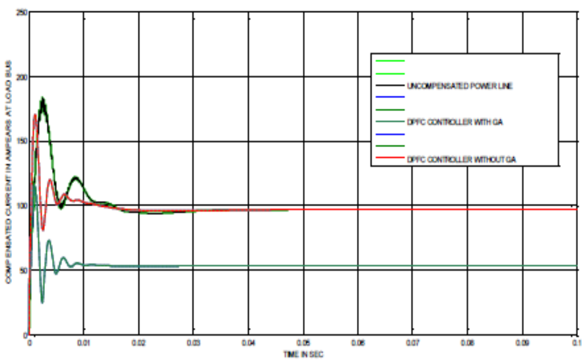

Fig 6 Current comparison plot at generator bus

(i) The genetic algorithm is coded in such a way that the inputs from the FACT devices are controlled and monitored due to their evaluation. The evaluation is done in such a way that the necessary voltage to be injected by FACT device is controlled at load ends which ultimately improves voltage regulation of the whole system

(ii) The scope at the generator side measures the reactive power to be injected by the FACT in the form of voltage control. In the figure mentioned below it can be seen that there is an exponential rise in Q (reactive power) without genetic algorithm control, while with the genetic algorithm control there is an exponential decay in the reactive power.

(iii) This decline of reactive power decreases the injected voltage from 550 kv to 270 kv at load end as shown in Figure 5-2.

(iv) In the Figure 5-2 voltage comparison plot of uncompensated power line and compensated power line is shown. Here uncompensated lines are prone to voltage flickers (fluctuations), where from the graph it is clearly deduced that the compensated power lines are not having fluctuation of voltages.

(viii) As the generator bus voltage fluctuations are reduced and system become more stable by compensated controllers behavior is also understand by the current comparison plot as shown in Figure 5-3.

V. CONCLUSION

The aim of the paper is to use the genetic algorithm as Centralized controller for the improvement of the performance of DPFC & the simulation results shows that the proposed algorithm works well and improves the load regulation and fluctuations. The work can be easily carried properly even with failure of one of the series converters.

VI. FUTURE SCOPE

It is aimed that the future of power system network will not be unidirectional else it will be bidirectional depending upon the consumption of power .so the need of distributed power system is nessacary in the formation of smart grid and electric vehicles system which is the near stable future for power system. Hence these places will need more optimization in their work were work can be ahead carried above the approaches of genetic algorithms.

REFERENCES

[1] Ahmad Jamshidi, Masoud Barakati S., and Mohammad Moradi Ghahderijani, “Power Quality Improvement and Mitigation Case Study Using Distributed Power Flow Controller,” in Proc. IEEE Industrial Electronics (ISIE), May2012.
[2] Kumar Arun, and G. Priya, “Power System Stability Enhancement using FACTS Controllers,” in Proc. IEEE Industrial Electronics, 2012.
[3] Tang Ye, Hu Wei, Huang Yang, Xu Fei, Min Rui, “Coordinated control of multi-FACTS to enhance the small disturbance stability of the power system”, IEEE PES ISGT ASIA 2012.
[4] Singh Bindeshwar, Sharma N. K.,Tiwari A. N, Verma K. S., and Singh Deependra, “Enhancement of Voltage Stability by Coordinated Control of Multiple FACTS Controllers in Multi-Machine Power System Environments”, in Proc. IEEE 2011
[5] Zhihui Yuan, Haan Sjoerd W. H. de, Ferreira Jan Braham, and Cvoric Dalibor, “A FACTS Device: Distributed Power-Flow Controller (DPFC),” IEEE Trans. Power Electron., vol. 25, no. 10, Oct.2010.
[6] Yuan Z., Haan S.W.H. de, Ferreira J.A., “Control

Scheme to Improve DPFC Performance during Series Converter Failures", in proc. IEEE 2010.
[7] Zhihui Y., Haan S. W. H. de, and Ferreira B, "Dpfc control during shunt converter failure," in Proc. IEEE Energy Convers. Congr. Expo. (ECCE), pp. 2727–2732, 2009.
[8] Nguyen T.T. and Wagh S. R., "Model Predictive Control of FACTS Devices for Power System Transient Stability", IEEE T&D Asia 2009.
[9] Du W., Wang H. F. and Dunn R., "Power System Oscillation Stability and Control by FACTS and ESS – A Survey", in Proc. IEEE 2009.
[10] Zhihui Yuan, Haan Sjoerd W.H. de, Ferreira Braham, "Utilizing Distributed Power Flow Controller (DPFC) for Power Oscillation Damping" in Proc. IEEE Energy Convers. Congr. Expo. (ECCE), pp. 2727–2732, 2009.
[11] Zhihui Y., Haan S.W. H. de, and Ferreira B., "Utilizing distributed power flow controller (DPFC) for power oscillation damping," in Proc. IEEE Power Energy Soc. Gen. Meet. (PES), 2009, pp. 1–5
[12] Huber L., Irving B. T., and Jovanovic M. M., "Review and stability analysis of pll-based interleaving control of dcm/ccm boundary boost pfc converters," IEEE Trans. Power Electron., vol. 24, no. 8, pp. 1992–1999, Aug. 2009.
[13] Davidson C. C. and Preville G. de. "The future of high power electronics in Transmission and Distribution power systems". In: Power Electronics and Applications, European Conference on, 2009.
[14] Farhangi H.. "The path of the smart grid". Power and Energy Magazine, IEEE, 2009.
[15] Sozer Y. and Torrey D. A., "Modeling and control of utility interactive inverters," IEEE Trans. Power Electron., vol. 24, no. 11, pp. 2475–2483, Nov. 2009.

UditVeer Singh Rajput has done his BE in ELECTRICAL &ELECTRONICS ENGINEERING and completed his MTECH in control system, He is an Asst.proffessor in CORPORATE INSTITUTE OF SCIENCE AND TECHNOLOGY BHOPAL and he has published paper in power system technologies and has a wide area of specialization in circuit theory and control system

Syed waseem Ali has done his BE in ELECTRICAL AND ELECTRONICS ENGINEERING and completed his MTECH in INTEGRATED POWER SYSTEM from VNIT Nagpur, He is an Asst.proffessor in CORPORATE INSTITUTE OF SCIENCE AND TECHNOLOGY BHOPAL and he has wide area of specialization in Academics in powersystem, power electronics, drives and instrumentation

Santosh Kumar Tembhare is Assistant Professor, Department of Electrical & Electronics, Corporate Institute of Science & Technology Bhopal, Madhya Pradesh; India.He did B.E. in Electrical & Electronics, M.Tech. in Power Systems from UIT RGPV Bhopal.His area of research includes Power Syste[redacted]m and Control system.He has about half decade of teaching experience.

