Fuzzy Logic Based Enhanced Compensation Technique for IPFC Using IGBT Integrated Shunt Model

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Abstract— The interline power flow controller (IPFC) is a flexible ac transmission device that can manage the power flow in multiline transmission systems. IPFC is one of the combined series-series controller in which separate series controllers are employed for series reactive compensation and also for transferring the real power between the lines using DC power link. In this paper, the enhanced power compensation technique for interline power flow controller is achieved using IGBT integrated shunt model. The recent studies related to FACTS devices plays a vital role in the high performance static and other controllers in various power system applications. Especially, the interline power flow controllers has the special feature of multi functionality and dynamic responsible system with respect to the recent power system applications. In comparison with the classic controllers, IPFC provides various satisfactorily dynamic operating points like supply variations and load disturbances. Hence, a fuzzy logic controller id designed in such a way that various dynamic operating points are achieved. The modelling of open and closed loop IPFC systems with IGBT integrated shunt circuit model are done through the MATLAB Simulink, SIM power system tools. The controlling parameters are obtained from the fuzzy logic controllers for the control of interline power flow controllers. Using this technique the high power transfer capability can be enhanced with reduction in power losses which indeed protects the system from the occurrence of various faults.

Key words: IPFC, IGBT, SIM

I. INTRODUCTION

II. INTERLINE POWER FLOW CONTROLLER (IPFC)

IFPC is used to enhance the reliability of power transmission between the lines and for controlling the reactive power in individual lines. In IPFC, two voltage source converters are connected together and the power flow is maintained by using a storage capacitor that acts as a common Dc link between the two lines. Figure-1(a) shows the internal construction of IPFC and the real power flow in either direction of two voltage source converters. This provides a free flow of real power in the device and each converter can generate or absorb the reactive power by its own terminals. The main advantage or the necessity for using IPFC in the transmission line is the stability and controllability achieved in the power flow between the multiline transmission systems. This system provides high power transfer and enhancement in stability and controllability with reduction in power losses which indeed protects the system from the occurrence of various faults. Figure-1(b) describes the single line diagram of internal structure of interline power flow controller with representation of bus voltages and power flow between both terminals.

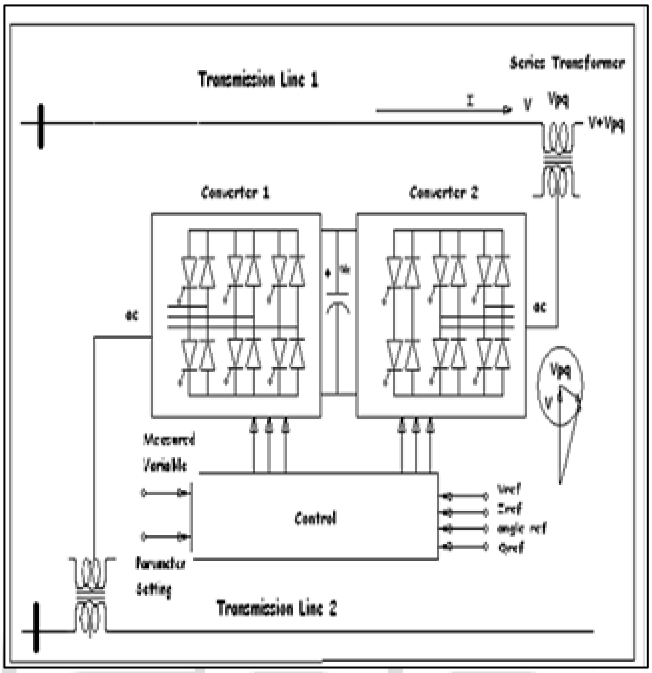

Fig. 1: (a)

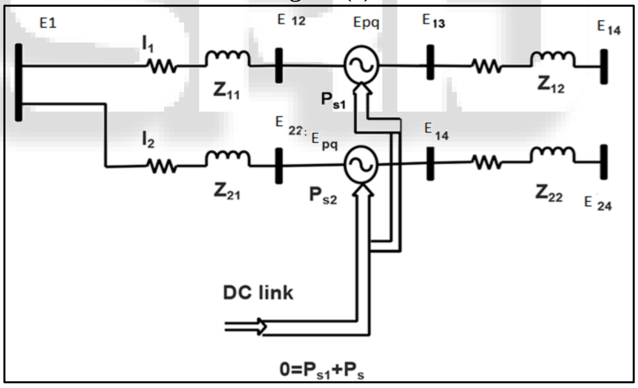

Fig. 1: (b)

III. SIMULATION OF INTERLINE POWER FLOW CONTROLLER

The simulation is done with reference to a single phase system using two transmission lines-one as primary and other as secondary line. The load is selected such a way that one line is overloaded with respect to the other line. The internal circuit is designed with the extension of SSSC's in multiple lines. As an assumption, for two line, four bus system the individual SSSC's are connected in each line. This circuit provides the details of real and reactive powers in the power system with interline power flow controllers.

The analysis of both models has been done and the simulation result shows that IPFC's can manage the power flow in a multi transmission systems, further the device provides high stability and high power transfer capability.

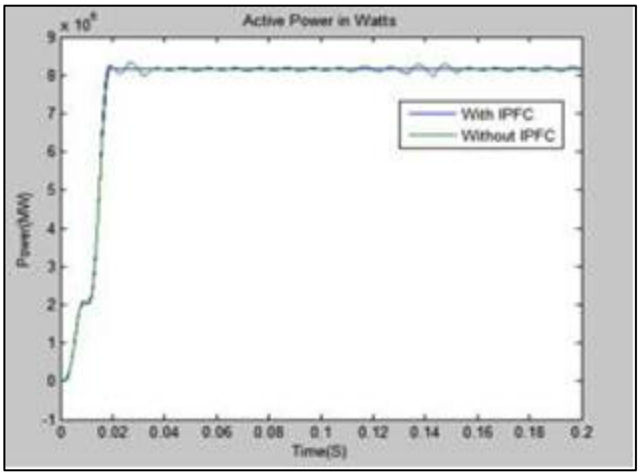

Fig. 2: Primary Transmission Line for Open Loop IPFC

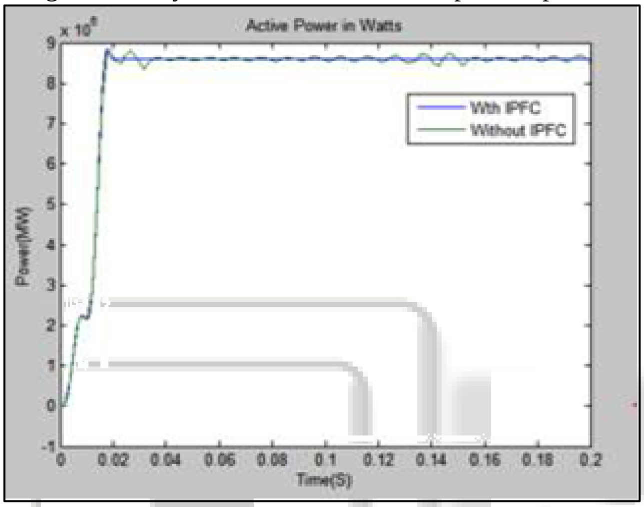

Fig. 3: Secondary transmission line for open loop IPFC

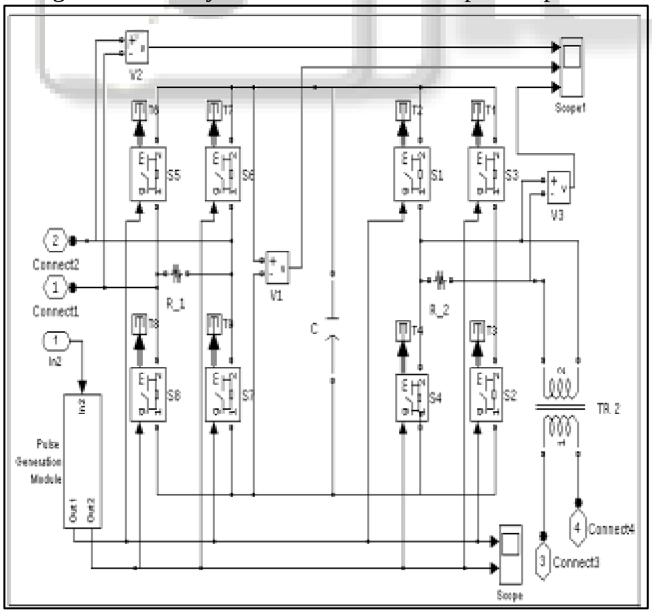
Fig. 4: IPFC system

IV. IGBT INTEGRATED SHUNT MODEL

The enhancement of performance in the power system is achieved by using the static synchronous series compensator which is further extended to interline power flow controller. Voltage dips are one of the various power interruptions that lead to high level disruption in the power systems. The various faults in the power systems can be solved by injecting a small voltage at the supply side of the transmission system. The dynamic energy storage can also be maintained in the DC link, that provides load sensitive protection for substations related to feeder systems. The IPFC integrated shunt model using IGBT's provides enhanced performance in power flow management. IGBT shunted connection offers dynamic energy insertion with lower transition of energy storage in DC link. IPFC provides higher level of protection to the sensitive loads in the distribution feeders from various substation with a common DC link.

V. FUZZY LOGIC CONTROLLER

Fuzzy control is based on fuzzy logic that deals with the relation of human thinking and natural language than the traditional logic systems. FLC is a mathematical system that analyzes analogue input values in terms of logical variables. Fuzzy deals with a partially true state of result involved with concepts that cannot ne expressed as perfect true or perfect false. The input variables in fuzzy system are mapped in sets of membership functions as fuzzy sets known as fuzzification. After the mapping of the membership function and the truth value that control the output variable, the results thus obtained are combined to a convergence of specific output known as defuzzification.

The fuzzy logic controller can work with non-linear and imprecise inputs. It does not need fast processors and it needs only less data storage as membership functions. The power converters are non-linear systems, the reasons for non-linearity is the variable structure within a switching period, saturating inductances and voltage clamping. The PWM switching technique is obtained by using the error and changing error of instantaneous real power technique, so that it makes the system available to track the set reference value. The minimum inference value and centroid defuzzification techniques are used and simulation is performed by using fuzzy tool box in MATLAB simulink model.

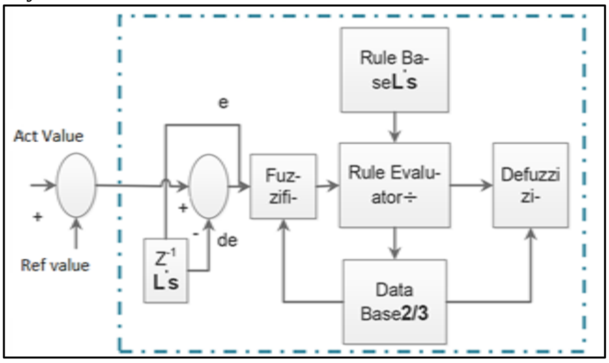

Fig. 5: Basic structure of fuzzy logic controller

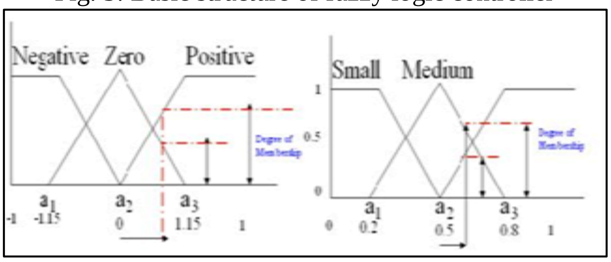

Fig. 6:

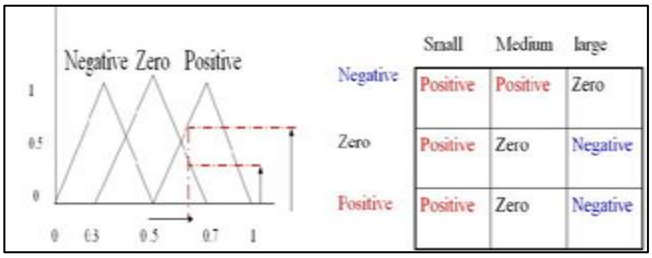

Fig. 7:

VI. SIMULATION RESULTS OF IPFC WITH FLC

The simulation result shows the enhancement in real and reactive power control using IPFC with relevant control methods employing the fuzzy logic controllers. The output shows the improvement of compensation using fuzzy logic controller and IGBT integrated shunted models.

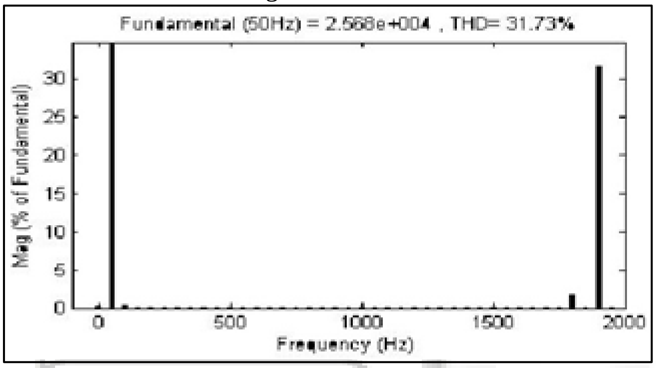

Fig. 8: THD of converter output voltage

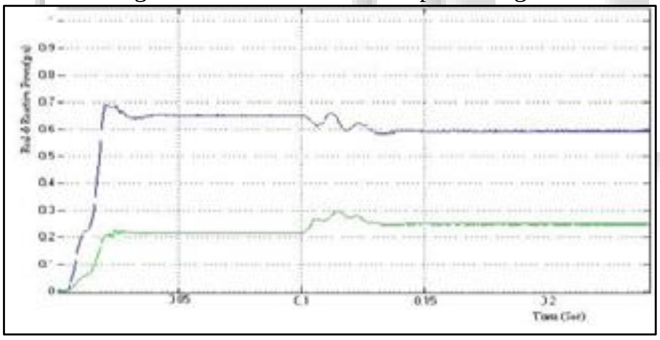

Fig. 9: Real and Reactive power with IPFC

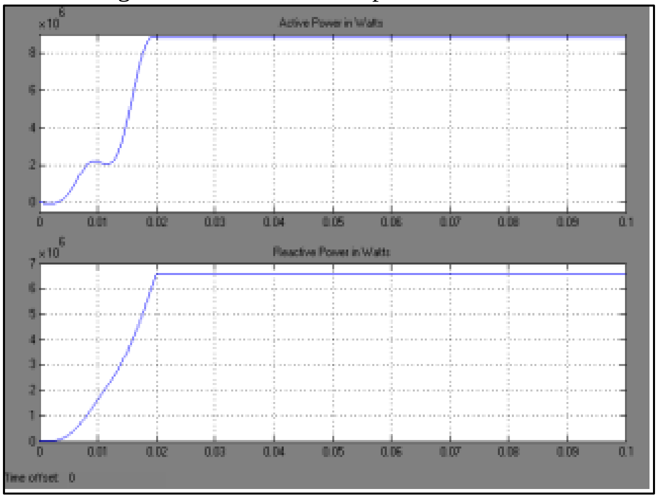

Fig. 10: Active and Reactive Power in Primary Load with IPFC in Open Loop

VII. CONCLUSION

This proposed technique improves the power profile and power factor in the transmission systems. Interline power flow controller is able to balance the real and reactive power flow in the multiple transmission systems. In future research, the multilevel inverters can be employed for further stability and enhancement of power compensation with lesser operating voltage and for easy and better performance.

REFERENCES

[1] Abdoiiah Homaifar, Ed McCormick, Simultaneous Design of Membership Functions and Rule sets for fuzzy controllers using 3(1995). http://dx.doi.org/10.1109/91.388168
[2] C. Fitzer, M. Barnes, and P. Green, “Voltage sag detection technique for a dynamic voltage restorer,” IEEE Transactions on Industry Applications, vol. 40, no. 1, pp. 203–212, 2004.
[3] R. J. Majumder, “Reactive power compensation in single-phase operation of microgrid,” IEEE Transactions on Industrial Electronics, vol. 60, no. 4, pp. 1403–1416, 2013.
[4] N.G. Hingorani, L. Gyugyi “UNDERSTANDING FACTS, Concepts and Technology of FACTS, IEEE Press book, 2000
[5] J.-L. Lin, “A new approach of dead-time compensation for PWM voltage inverters,” IEEE Transactions on Circuits and Systems I: Fundamental Theory and Applications, vol. 49, no. 4, pp. 476–483, 2002.
[6] G.Radhakrishnan, M.Rathika “Application of IPFC Scheme in Power System Transients and Analyzed using Fuzzy Technology” International Journal of Computer Applications Volume25, July 2011
[7] T. T. Earl Cox, Fuzzy Fundamentals, IEEE Spectrum, 10(1992), 58-61. http://dx.doi.org/10.1109/6.158640
[8] A. Saraswathi, S.Sutha, P.Gajalakshmi, R.Ramesh “Fuzzy logic based interlined power flow controller” Applied Mathematical Sciences, Vol. 9, 2015, no. 74, 3651 – 3658.
[9] Subramanian Arumugom, Marimuthu Rajaram “Enhanced High Performance Power Compensation Methodology by IPFC Using PIGBT-IDVR” The Scientific World Journal Volume 2015 (2015), Article ID 634846
[10] Indra Prakash Mishra, Sanjiv Kumar “Control of Active and Reactive Power Flow in Multiple Lines through Interline Power Flow Controller (IPFC)” International Journal of Emerging Technology and Advanced Engineering (ISSN 2250-2459, Volume 2, Issue 11, November 2012)