Ferroresonant Overvoltage Investigation in Wye-Wye Transformers on Transmission System by Using MATLAB

B. Vahidi R. Shariati Nassab S. Ghaghaheh Zadeh E. Abedi
Department of Electrical Engineering
Amirkabir University of Technology
Tehran – Iran
vahidi@aut.ac.ir

Abstract. Ferroresonant overvoltages can be occurred in power systems. In power systems, ferroresonance usually refers to a series resonant condition, as is this case, although there has been some research done on parallel ferroresonant condition. The series circuit is established during fault conditions and its existence is dependent on the configuration of the circuit.
In the present paper for Wye-Wye transformers connections ferroresonance phenomena is investigated and results show effect of different configuration and load.

Key words

Ferroresonance, Transformer, Wye-Wye, MATLAB, Overvoltage

1. Introduction

Ferroresonant overvoltages can be occurred in power systems. In power systems, ferroresonance usually refers to a series resonant condition, as is this case, although there has been some research done on parallel ferroresonant condition [1]-[3]. The series circuit is established during fault conditions and its existence is dependent on the configuration of the circuit [4], [5].
Studies have shown that certain power system configurations will increase a network's susceptibility to ferroresonance. Protection and switching equipment that operates on a single-phase basis may leave sections of a network open circuited, effectively creating a series LC circuit that is excited by the remaining phases. Equipment grounding may also be of concern. For example, ungrounded wye-connected transformers may excite open circuit phases whereas wye-connected transformers disallow it [2].
Transformer loading conditions also have an effect on ferroresonance susceptibility [2].

To limit the damage to the distribution system, sustained overvoltages should be limited to 1.1 pu across transformer windings and 1.25 pu across the metal oxide lightning arresters [6]. For ferroresonant Overvoltages to cause the early demise of the lightning arresters, three conditions need to be meet. First, the right amount of shunt capacitance needs to be connected to the transformer. Second, the transformer needs to be lightly loaded. And finally, a single-Phase fault needs to occur on the system. The first condition is dependent on the configuration of the system. The second two will be determined through the operation of the system [5].

2. Simulation

In order to investigate the ferrorosonant phenomena in power system a network such as fig. 1 is built up in MATLAB 6.5.
A three-phase 250 MVA, 400kV/230kV transformer is connected to the end of a 100km transmission line. A three-phase RLC load is connected to low voltage side of transformer. Single phase switching (phase A) is done for different connection of Wye-Wye transformer and the results are as follows.

For different transformer connection, and for no-load and load conditions simulations are done. The current and voltage of each phase at the beginning of the line is obtained and will be shown in following figures. In this simulation Phase A will be disconnected and ferroresonant condition can be observed on diagrams.
Transformer connections are as follows.
a-Y-Y
b-Yg-Yg

For above connections both no-load, and loaded cases are investigated.

3. Simulation Results

A. Noload Condition for Y-Y Conections

Fig. 2 shows primary currents of transformer at no load condition for single phase switching.

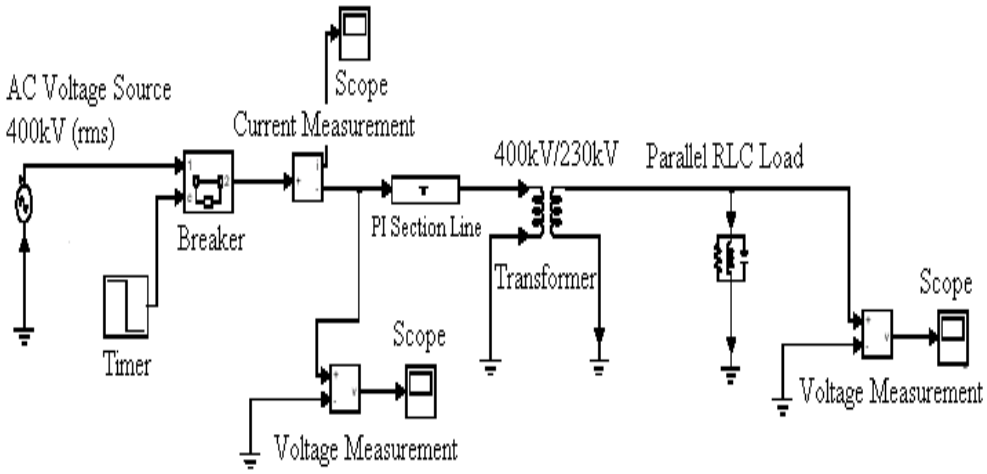

Fig. 1. Simulated circuit on MATLAB

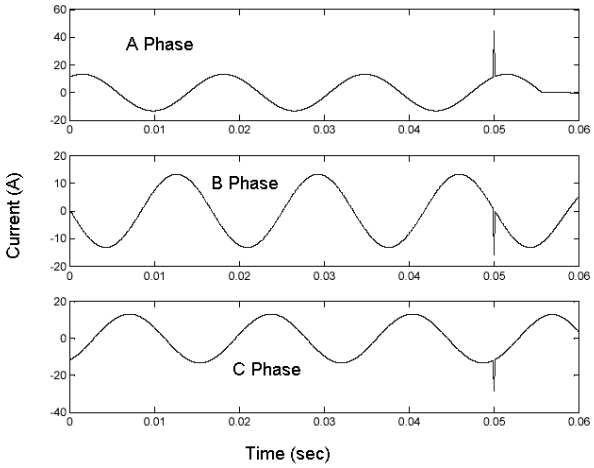

Fig. 2. Primery currtens of transformer.

Fig. 3 shows primary voltages of transformer at no load condition for single phase switching.

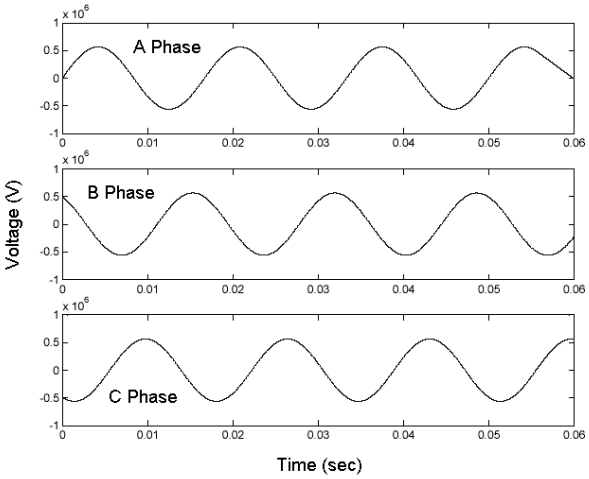

Fig. 3. Primery voltages of transformer.

B. Noload Condition for Y_g-Y_g Conections

Fig. 4 shows primary currents of transformer at no load condition for single phase switching.

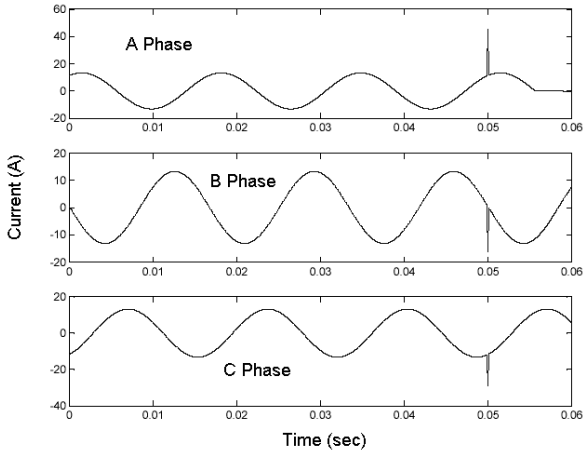

Fig. 4. Primery currtens of transformer.

Fig. 5 shows primary voltages of transformer at no load condition for single phase switching.

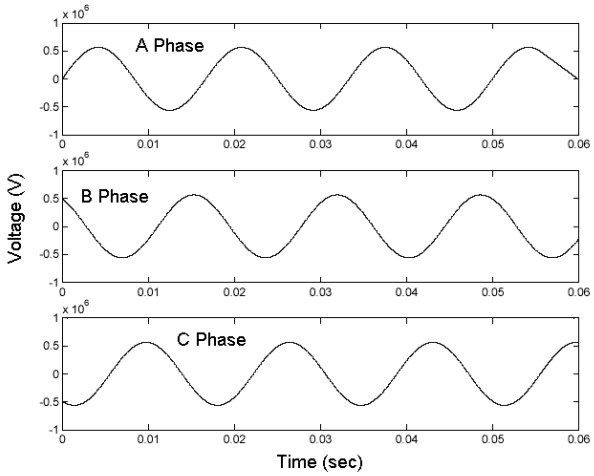

Fig. 5. Primery voltages of transformer.

C. Load Condition for Y-Y Conections

Fig. 6 shows primary currents of transformer at load condition for single phase switching.

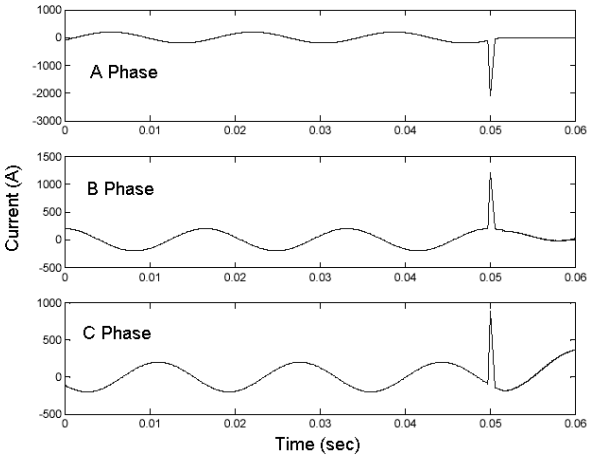

Fig. 6. Primery currtens of transformer.

Fig. 7 shows primary voltages of transformer at load condition for single phase switching.

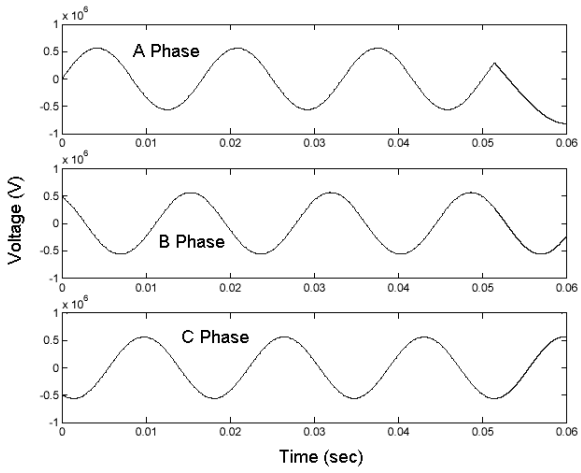

Fig. 7. Primery voltages of transformer.

D. Noload Condition for Y_g-Y_g Conections

Fig. 8 shows primary currents of transformer at load condition for single phase switching.
Fig. 9 shows primary voltages of transformer at load condition for single phase switching.

4. Conclusion

Aim of this paper is using MATLAB for investigating the ferroresonance phenomena.
In the present paper ferroresonant simulation for a network is done on MATLAB for different connections of YY transformer. Results of simulation show that in YY series of transformer load has a small influence on reduction of ferroresonant overvoltages. But in load condition during disconnecting the one phase of is network that lead to ferroresonant will produce overcurrent more than no-load condition.

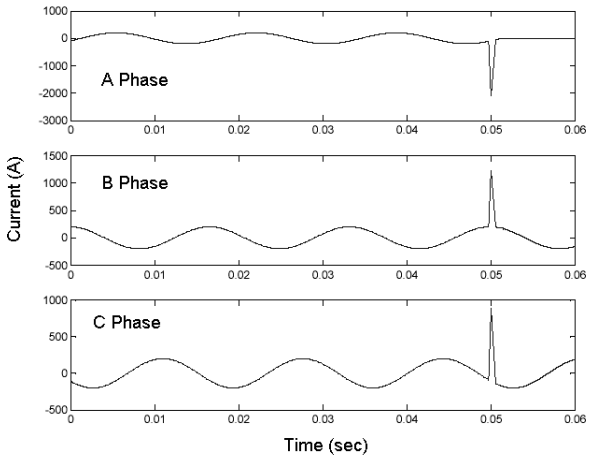

Fig. 8. Primery currtens of transformer.

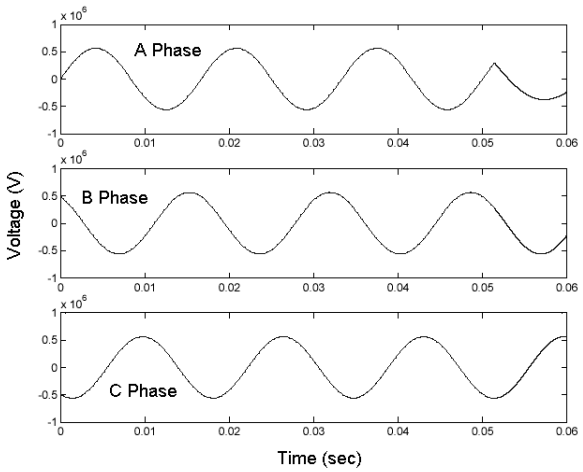

Fig. 9. Primery voltages of transformer.

References

[1] M. R. Iravani and et al, "Modeling and Analysis Guidelines-Part III: The Study of Ferroresonance", IEEE Transactions on Power Delivery, Vol. 15, NO. 1, pp 255-265, January 2000.

[2] O.C.Parks, A. A. Girgis and M. E. Frick, "Simulating Ferroresonance in a Series Compensated Distribution Network", Proceeding of 9th International Conference on Harmonics and Quality of Powers, Vol. 1, Clemson University, USA, 1-4 Oct. 2000, pp 162-167.

[3] D. Shein and S. Zissu, "Domains of Ferroresonance Occurrence in Voltage Transformers with or without Damping Reactors", Proceedings of 18th Convention of Electrical and Electronics Engineer, Isreal, 1995, Paper No. 1.5.2

[4] R. A. Walling and K.D. Barker, "Ferroresonant Overvoltages in Grounded Wye-Wye Padmount Transformers with Low-Loss Silicon-Steel Cores", IEEE Transactions on Power Delivery, Vol. 8, No. 3, pp 1647-1660, July 1993.

[5] L.J. Bohmann, J. Mc Daniel and E. K. Stanek, " Lightning Arrester Failures and Ferroresonance on a Distribution System", IEEE Transactions on Industry Application, Vol. 29, No. 6, pp 1189-1195, Nov./Dec. 1993.

[6] S. Prusty and M. Panda, "Predetermination of Lateral Length to Prevent Overvoltage Problems Due to Open Conductors in Three-Phase Systems", IEE Proceedings, Vol. 132, P.t. C, No.1, pp 49-55, Jan 1985.