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A NOVEL LOGIC TO STATOR SINGLE PHASE - TO - GROUND FAULT FOR POWER-FORMER

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ABSTRACT:

The stator single-phase to ground fault is one of the most common fault that a Generator will suffer. If such fault is neglected then there are chances of converting it into phase to phase fault. So there is need to detect and isolate the faulty part from the rest of the system as early as possible. Because of this, protection is very important otherwise there is shortage of power in our system.

The proposed approach detects the ground fault by analyzing the direction, magnitude, and energy of leakage current, which is the difference of zero-sequence current fault component between the neutral and the terminal of Power-former. The aim of the study carried out was realizing 100% coverage of fault detection in internal &external fault protection for the stator winding of Power former.

KEY WORDS: Power former, Leakage Current & Protection against internal& external fault.

INTRODUCTION:

A new concept of rotating machines that enable direct connection of synchronous generators to the transmission network without any intervening step-up transformers is presented by Leijon *et al*. [1]. Such new designed cable-wound high voltage generator is called Power former.This is to be noted that, the star point or neutral point of stator winding of an Generator is grounded through an impedance to limit the ground fault current. Reduced ground fault current causes less damage to the stator core and winding during ground fault. If the ground impedance is made quite high, the ground fault current may become even less than normal rated current of the generator. If so, the sensitivity of phase relays becomes low, even they may fail to trip during fault. For example, a current lower than rated current makes it difficult to operate differential relays for ground fault. In that case, a sensitive ground fault relay is used in addition to the differential protection of a Generator. What type of relaying arrangement will be engaged in stator earth fault protection of Generator depends upon the methods of stator neutral earthing. In the case of resistance neutral earthing the neutral point of stator winding is connected to the ground through a resistor.

Here, one current transformer is connected across the neutral and earth connection of the alternator. Now one protective relay is connected across the current transformer secondary. In alternator can feed the power system in two ways, either it is directly connected to the substation bus bar or it is connected to substation via one star Delta transformer. If the generator is connected directly to the substation bus bars, the relay connected across the CT secondary, would be an inverse time relay because here, relay coordination is required with other fault relays in the system. But when the stator of the alternator is connected to the primary of a star Delta transformer, the fault is restricted in between stator winding and transformer primary winding, therefore no coordination or discrimination is required with other earth fault relays of the system. That is why; in this case instantaneous armature attracted type relay is preferable to be connected across the CT secondary.

It is should be noted that, 100 % of the stator winding cannot be protected in resistance neutral earthing system. How much percentage of stator winding would be protected against earth fault, depends upon the value of earthing resistance and the setting of relay. The resistance grounding of stator winding can also be made by using a distribution transformer instead of connecting a resistor directly to the neutral path of the winding.

Inter turn stator winding fault can easily be detected by stator differential protection or stator earth fault protection. Hence, it is not very essential to provide special protection scheme for inter turn faults occurred in stator winding. This type of faults is generated if the insulation between conductors (with different potential) in the same slot is punctured. This type of fault rapidly changes to earth fault. The high voltage generator contains a large number of conductors per slot in the stator winding hence, in these cases the additional inter turn fault protection of the stator winding may be essential. Moreover in modern practice, inter turn protection is becoming essential for all large generating units. Several methods can be adopted for providing inter turn protection to the stator winding of generator. Cross differential methods is most common among them. In this scheme the winding for each phase is divided into two parallel paths.

Each of the paths is fitted with identical current transformer. The secondary of these current transformers are connected in cross. The current transformer secondary is cross connected because currents at the primary of both CTs are entering unlike the case of differential protection of transformer where current entering from one side and leaving to other side of the transformer. The differential relay along with series stabilizing resistor are connected across the CT secondary loop as shown in the figure. If any inter turn fault occurs in any path of the stator winding, there will be an unbalanced in the CT secondary circuits thereby actuates 87 differential relay.

Many researchers had proposed work on stator single phase to ground fault protection. Different methods are used in this type of protection scheme because this protection saves the total winding from damage. They try to improve Reliability of the system. They uses different protection scheme, different voltage injection schemes, analysis of grounding methods and observation of voltages at different points etc. So Studies on stator single phase to ground fault protection on alternator is very important topic from our power system point of view.

Main reference paper deals with protection of stator line to ground faults. It not only detect stator single phase to ground fault but also give total protection to stator winding. It detects fault by using direction of leakage currents, fault point energy dissipations, magnitude of leakage current. This method is highly sensitive. It gives complete protection to the stator winding. It distinguishes between different types of fault such as internal fault, external fault. In this Paper stator single phase to ground fault protection scheme is basically work on direction of leakage current , magnitude of leakage current and fault point energy dissipation has been developed . Finally results have been complete for proposed scheme. Besides, dynamic simulation tests have been done to verify the principle.

PROPOSED SCHEME:

A Power former energy system is directly connected to the high-voltage network without any step-up transformer. The winding of Power former employs cylindrical conductors such as XLPE cables that result in an even electric field distribution Losses in the step-up transformer and medium voltage bus-work are avoided by elimination of the step-up transformer. The removal of the step-up transformer reduces the number of components in the plant, resulting in reduced maintenance cost and enhanced plant reliability and availability. More compact plant design is also possible. The problem of partial discharge is also eliminated in a Power former energy system.

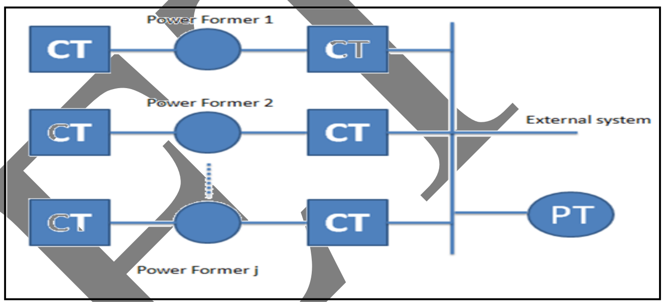

Fig. No.1. Implemented system model

RESULTS FOR INTERNAL STATOR FAULT:

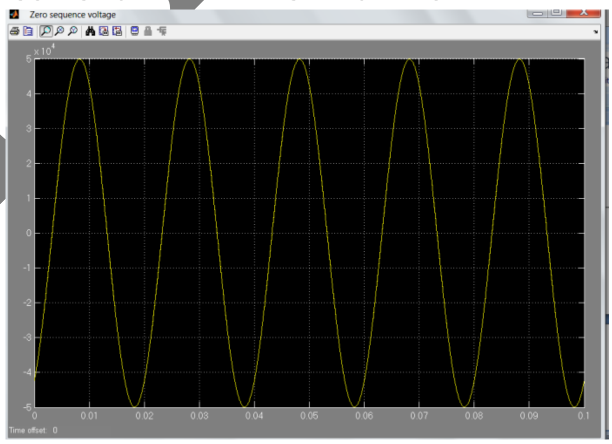

Fig.no.2. zero sequence voltage for internal stator fault

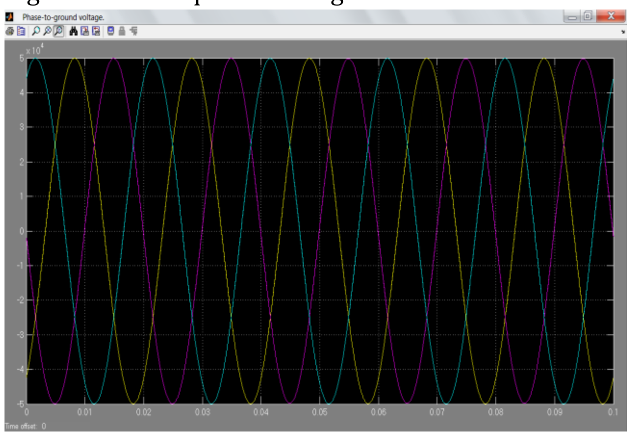

Fig.no.3. phase to ground voltage for internal stator fault

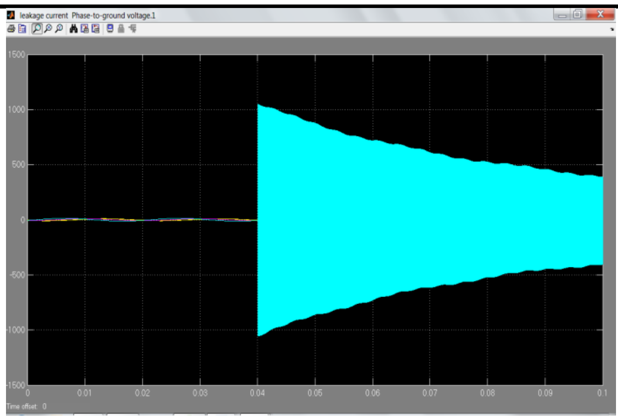

Fig. no.4. leakage current for internal stator fault

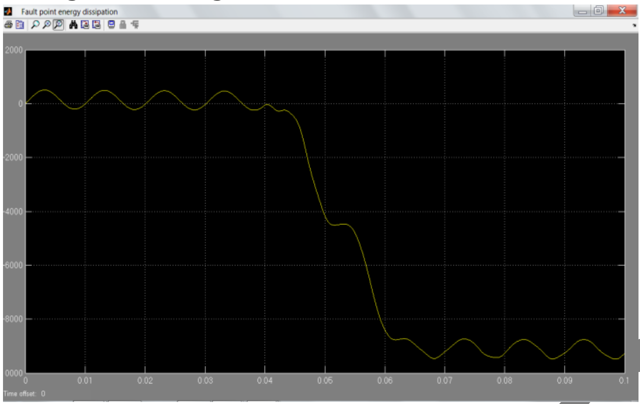

Fig. no. 5. Fault point energy dissipation of powerformer1 in internal stator fault

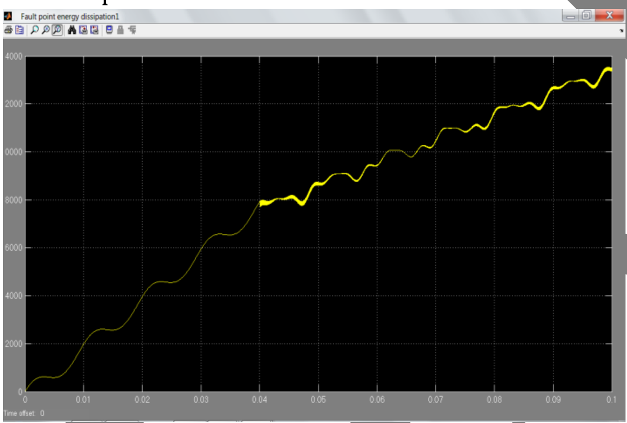

Fig. no. 6. Fault point energy dissipater for powerformer 2 in internal stator fault

Fig. no. 7. Fault point energy dissipater for power former 3 in internal stator fault

RESULTS MATLAB MODELFOR EXTERNAL STATOR FAULT:

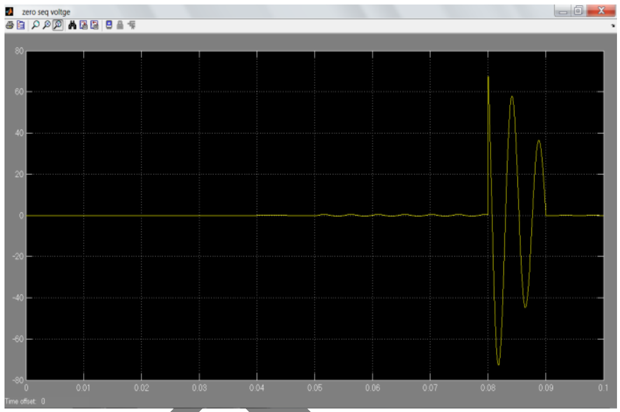

Fig. no.8. zero sequence voltage in external stator fault

Fig. no.9. phase to ground voltage in external stator fault

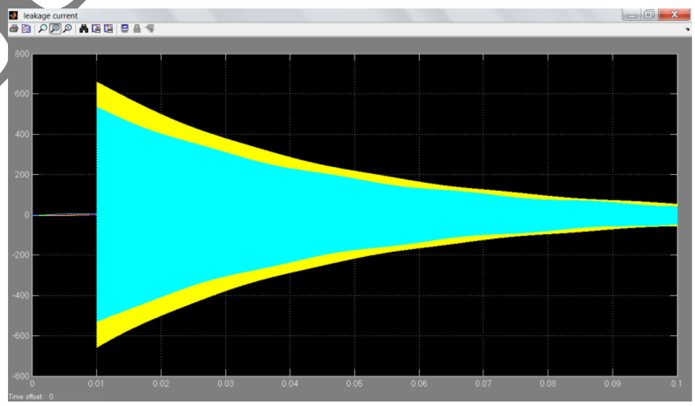

Fig. no.10. leakage current in external stator fault

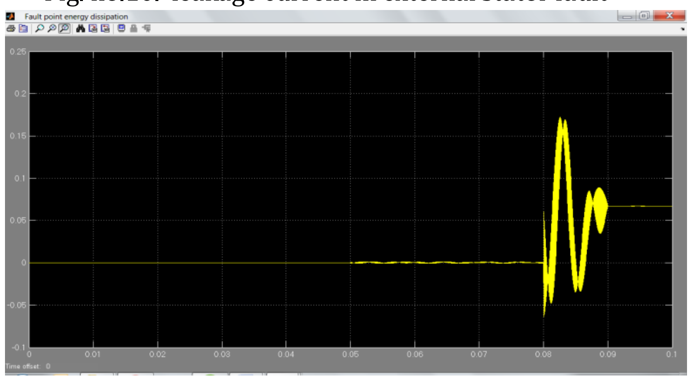

Fig. no.11. Fault point energy dissipater for powerformer 1 in external stator fault

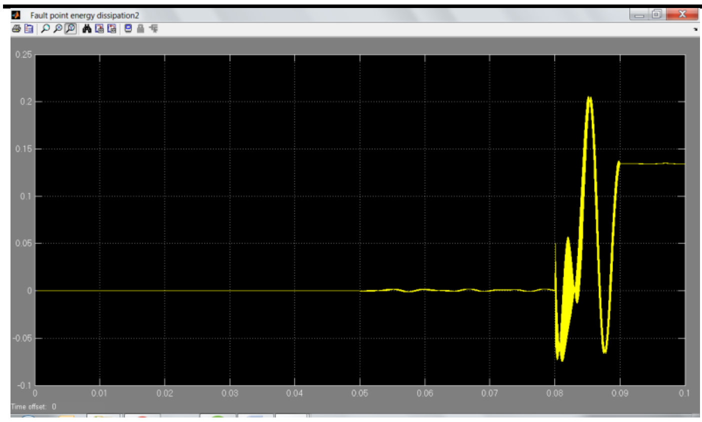

Fig. no. 12. Fault point energy dissipater for powerformer 2 in external stator fault

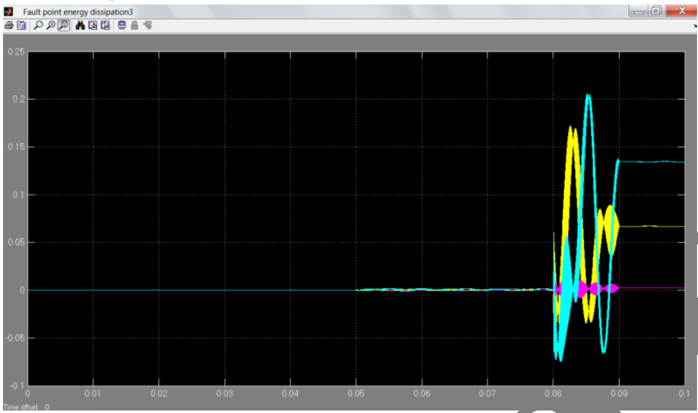

Fig. no.13. Fault point energy dissipater for powerformer 3 in external stator fault

REULTS AND DISCUSSION:

Dynamic measurements were carried out for demonstration of to find out the effectiveness of the implemented scheme. As Power former was not available at the laboratory results are demonstrated using mat lab simulink environment. Moreover conventional generator model is taken for taking the implementation scheme. Parts of the parameters of two generator models are as follows:

1. 15MVA, 0.4kva generator 1 Cg1=0.069 μF
2. 15MVA, 0.4kva generator 1 Cg1=0.069 μF

3) System frequency is 50 Hz;
4) Generator grounding method is ungrounded;
5) The following faults were simulated, including those which could not be detected by traditional protection schemes:
   a) Fault resistance Rg : 5 Ω, 1 kΩ, 2 kΩ, 3 kΩ, 4 kΩ, 5 kΩ;
   b) Internal single-phase fault when 6.5%, 20%, 46.5% of the stator winding are shorted;
   c) Different external faults.

The phase-to-earth capacitance of the generator model itself is not large enough to simulate Powerformer, Therefore, the internal single-phase-to-ground fault within the Powerformer can result in high leakage current. Additionally, Powerformers are connected directly to the transmission net- work without any intervening step-up transformer, which could have a high zero-sequence voltage. Powerformers, therefore, are able to operate relays delivering signals during faults with sufficient magnitude. The differences of fault point energy dissipation between Powerformers and conventional generators are obvious. Therefore, the faulty Powerformer can be easily detected.

CONCLUSION:

The methods implemented traditionally resulted in low sensitivity and reliability for detecting and isolating the stator single phase to ground fault in parallel operation of powerformers. Implemented technique in this paper is based on the direction of the leakage currents, fault point energy dissipation; magnitude of leakage currents is successfully implemented for overcoming low sensitivity and reliability.

REFERENCES:

1) IEEE Guide for AC Generator Protection, IEEE Std C37.102TM , 2006.
2) IEEE Guide for Generator Ground Protection, IEEE Std C37.101TM ,2006.
3) N. Tai, X. Yin, and D. Chen, "*Analysis of stator ground protection schemes for hydro-generator of three-gorges power plant based on zero sequence voltage,*" in Proc. IEEE Winter Meeting, vol. 3, Singapore, Jan. 2000, pp. 1888–1893.
4) R. M. Rifaat, *"Utilizing third harmonic 100% stator ground fault protection, a cogeneration experience,"* in Proc. IEEE Conf. Ind. Appl., 2000, vol. 5, pp. 3254–3259.
5) M. Fulczyk, "*Voltage 3rd harmonic in generator stator winding at changes in generator load conditions,"* in Proc. Electric Mach. Drives Conf., 2003,vol. 3, pp. 1476–1482.
6) M. Fulczyk and R. Mydlikowski, "*Influence of generator load conditions on voltage 3rd harmonics in generator stator winding,*" in Proc. IEEE Power Eng. Soc. General Meeting, 2005, vol. 2, pp. 18–30.
7) N. Tai, X. Yin, Z. Zhang, and D. Chen, "*Research of subharmonic injection schemes for hydro-generator stator ground protection,*" in Proc. IEEE Winter Meeting, Singapore, Jan. 2000, pp. 1928–1932.
8) Z. Xiangjun, Y. Xianggen, L. Gan, S. Sheng, and C. Deshu, "*Improvementof subharmonic injection schemes for huge hydro-generator stator ground fault*

protection," Power Syst. Technol., vol. 2, pp. 707–710, 2002.

9) M. Touma-Holmberg and K. Srivastava, "*Double winding, high-voltage cable wound generator: Steady-state and fault analysis,*" IEEE Trans. Energy Conversion, vol. 19, no. 2, pp. 245–250, Jun. 2004.
10) S. G. Johansson and B. Larsson*, "Short-circuit tests on a high-voltage, cable-wound hydropower generator*," IEEE Trans. Energy Conversion,vol. 19, no. 1, pp. 28–33,
11) Y. Gao, X. Lin, Q. Tian, and P. Liu, "*Novel identification method of stator single phase-to-ground fault for cable-wound generators,"* IEEE Trans. Energy Conversion, vol. 23, no. 2, pp. 349–357, Jun. 2008.
12) Q. Tian, Z. Liu, and X. Lin, *"A new approach to winding capacitance divid- ing method for the generator with considerable winding distributed capac- itance,"* in Proc. Electr. Util. Deregulation Restructuring Power Technol., pp. 1672–1677, Apr. 6–9, 2008.
13) M. Leijon, S. G. Johansson, F. Owman, S. Alfredson, T. Karlsson, S. Lindahl, C. Parkegren, and S. Thoren, *"Powerformer Tm- experiences form the application of extruded solid dielectric cables in the stator wind ing of rotating machines,"* in Proc. Power Eng. Soc. Winter Meeting, Jan. 23–27, 2000, vol. 1, pp. 736–744.