International Journal of Engineering Science Invention

Volume 2 Issue 3 ǁ March. 2013

Analysis of Very Fast Transient over Voltages Intransformer in 400kv Gis By Wavelet

[1]K.prakasam, D.Prabhavathi[2], M.Suryakalavathi[3], Bhumanapally. Ravindhranath Reddy[4]

[1]*Electrical and Electronics Engineering, Siddhartha Institute of Engineering and Technology, JNTU Hyderabad, INDIA*
[2]*Eelectrical and Electronics Engineering, Siddhartha Institute of Engineering and Technology, JNTU, Hyderabad,, INDIA*
[3]*Eelectrical and Electronics Engineering, JNTU college of engineering,, Hyderabad, INDIA*
[4]*Eelectrical and Electronics Engineering, JNTU college of engineering,, Hyderabad, INDIA*

ABSTRACT : In a GIS, Very Fast Transient Over voltages (VFTO) are generated mainly due to switching operations. The switching operation may be of a disconnect or switch or a circuit breaker or an earthling switch. These switching overvoltage levels are possible up to 3.0 p.u, depending on switching configuration .*This paper deals with analysis of vftos in transformer in 400KV GIS ,transformer model is designed in matlab simulink and the vftos generated by the operation of CB are analyzed by Wavelet transform for both open and closing conditions of CB.*

Keywords: *VFTO,GIS,Transformer,Wavelet,Transients,CB,DWT,*

I INTRODUCTION

This paper deals to investigate feasible methods for mitigation of the overvoltage magnitude of VFTOs and suppression of the resonant frequencies amplitude at the power transformer. The proposed method utilizes terminal and capacitance components to suppress VFTOs in GIS. Its advantages are their simplicity and low cost of implementation along with producing minimal changes in the installed GIS. The effectiveness of the proposed method to mitigate overvoltage magnitude and resonant frequencies amplitude of VFTO is presented via simulation. The three pase two winding transformer model is designed and subjected to various switching conditions the simulation work is carried in MATLAB software . The results obtained and are compared between with and without wavelet transform. The result show that the proposed technique is able to offer high accuracy. Application of Wavelet Transform and MLP Neural Network for Ferro resonance Identification.ISTURBANCE due to ferroresonance is a common phenomenon in electric power distribution system operation. Depending on circuit conditions, its effect may be a random over voltage that could be either a short transient for few cycles, a continuous over voltage or even a jump resonance. It causes both phase-to-phase and phase to- ground high sustained oscillating over voltages and over currents with sustained levels of distortion to the current and voltage waveforms, leading to transformer heating together with excessively loud noise due to magneto striction, electrical equipment damage, thermal or insulation breakdown and mal-operation of the protective devices. An additional, very important advantage of gas insulated substations in comparison with the air insulated ones is safety. The safety of gas insulated substations is to be observed exclusively from the environmental protection aspect. In the closed pressure system design of the substation gas leaking is reduced to the standardized rate of 1% per year, while the other design (a hermetically closed system) does not require gas filling. The safety of people exposed to the substation, due to the fact that substations are located in inhabited areas, represents the second type of safety. Beside its unquestionable advantages, GIS also has its disadvantages. One of the main negative phenomena in gas insulated substations is the occurrence of very fast transients – VFT, whereat we differ between the so-called internal and external overvoltage‟s

II. THEORY OF WAVELET ANALYSIS

Wavelets are functions that satisfy certain requirements. The very name wa6elet comes from the requirement that they should integrate to zero, „waving‟ above and below the x-axis. The diminutive connotation of wa6elet suggests the function has to be well localized. Other requirements are technical and needed mostly to insure quick and easy calculation of the direct and inverse wavelet transform. Compared with traditional Fourier method, there are some important differences between them. First Fourier basis functions are localized in frequency but not in time while wavelets are localized in both frequency (viadilation) and time (via translation). Moreover, wavelets can provide multiple resolution in time and frequency. Second, many classes of functions can be represented by wavelets in more compact way. For example, functions with discontinuities and functions with sharp spikes usually take substantially fewer wavelet basis functions than sine-cosine basis functions to achieve a comparable approximation.

There are many types of wavelets [9,10], such as Harr, Daubechies 4, Daubechies 8, Coiflet 3, Symmlet 8 and so on. One can choose between them depending on a particular application. As with the discrete Fourier transform, the wavelet transform has a digitally implement able counterpart, the discrete wavelet transform (DWT). If the „discrete" analysis is pursuing on the discrete time, the DWT is defined as

$$C(j,k) = \sum_{n \in Z} s(n) g_{j,k}(n) \quad (j \in N, k \in Z)$$

where, s(n) is the signal to be analyzed and $g_{i,k}(n)$ is discrete wavelet function, which is defined by

$$g_{j,k}(n) = a_0^{-j/2} g(a_0^{-j} n - k b_0)$$

Select a_0 and b_0 carefully, the family of scaled and shifted mother wavelets constitute an orthonormal basis of $l^2(Z)$ (set of signals of finite energy). When simply choose a_0 = 2and b0=1, a dyadic-orthonormal wavelet transform is obtained. With this choice, there exists an elegant algorithm, the multi resolution signal decomposition (MSD) technique [11], which can decompose a signal into levels with different time and frequency resolution. At each level j, approximation and detail signals Aj, Dj can be built. The words" approximation" and „detail" are justified by the fact that Aj is an approximation of A_{j_1} taking into account the „low frequency" of A_{j_1}, whereas the detail Dj corresponds to the „high frequency" correction. The original signal can be considered as the approximation at level 0.

The coefficients C (j,k) generated by the DWT are something like the „resemblance indexes" between the signal and the wavelet. If the index is large, the resemblance is strong, otherwise it is slight. The signal then can be represented by its DWT coefficients as

$$s(n) = \sum_{j \in N} \sum_{k \in Z} C(j,k) g_{j,k}(n)$$

When fix j and sum on k, a detail Dj is defined as

$$D_j(n) = \sum_{k \in Z} C(j,k) g_{j,k}(n)$$

Then sum on j,the signal is the sum of all the details

$$s(n) = \sum_{j \in N} D_j(n)$$

Take a reference level called J, there are two sorts of details. Those associated with indices j5J correspond to the scales 2j52J, which are the fine details. The others, which correspond are the coarser details. If these latter details are grouped into $A_J = \sum_{j > J} D_j$ which defines an approximation of the signals. Connect the details and an approximation, the equality

$$s = A_J + \sum_{j \le J} D_j$$

which signifies that s is the sum of its approximation A_J and of its fine details. The coefficients produced by DWT, therefore, can be divided into two categories: one is detail coefficient, the other is approximation coefficient. To obtain them, MSD provides an efficient algorithm known as a two channel sub-band coder using quadrature mirror filters [12]. Then the detail part is still represented by wavelets, which can be regarded as series of band-pass filters, whereas the approximation is represented by the dilation and translation of a scaling function, which can be regarded as a low-pass filter.

A. Transients in general

Voltage transients in power systems are caused by switching actions, lightning and faults in the system. Different phenomena create different types of transients. Oscillatory transients are caused mainly by switching phenomena in the network. The most common switching action is capacitor bank switching. The most severe transients are caused by capacitor energizing while capacitor de-energizing only causes a minor transient none synchronized energizing of capacitors is worse than synchronized. Oscillatory transients are characterized by duration,

Magnitude and spectral content there are subclasses of oscillatory transients depending on the dominant frequency .Impulsive transients are caused mainly by lightning strikes. The worst impulsive transients are created when the lightning strikes directly on the power line. However the majority of direct strikes lead to a fault, which shows up as voltage dip at the equipment (monitor or end-user equipment) terminals. Voltage dips are not treated in this paper. Impulsive transients are characterized by rise and decay time. The impulsive transients are divided into subclasses according to their duration Transients in general are rapidly damped when they propagate due to the resistive part of the system. Therefore transients in general are a local phenomenon. Exceptions are transients of relatively low frequency that originate in the transmission or transformer

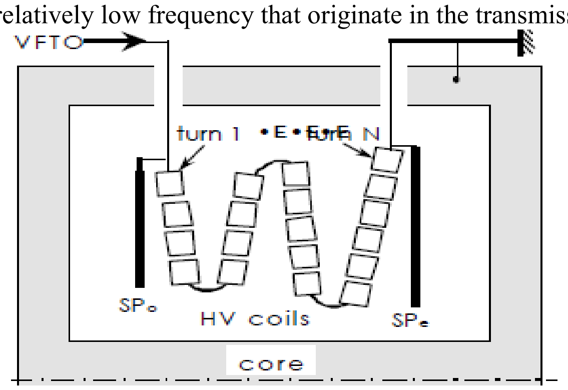

Fig 1 Shell form Transformer winding

The wavelet levels to be selected must best reflect the fault characteristics under various system and fault conditions. In this respect, according to the analyses of different wavelet levels of current waveform and the level 4 (D4) and level 7 (D7) details, are utilized to extract some useful features. This is because the level 4 details generally reflect the dominant non-frequency transient generated by faults. Since level7 details contain most of the fundamental harmonic, which is of 50 Hz in this system, the sum of three phase of them (D9a, D9b, and D9c) have similar characteristics of zero component which can be used to differ phase-to-ground fault and phase-phase fault, two-phase to ground fault and three-phase fault resent wavelet analysis results of other types of fault, which are two-phase fault, two phase to ground fault and three phase fault, respectively

III. PROPOSED SCHEME OF EVALUATION OF VFTOS

A three phase 400 KV GIS has been designed along with transformer using Mat lab simulink of version 7.8 .Three phase circuit breaker is employed to have closing and open conditions. The simulation of the 400kv system is carried for VFTOs .the transient operations are carried by a three phase circuit breaker, with the operating times of 0.001s at the primary of the transformer. for both open and closing conditions of circuit breaker the VFOs are calculated and calculations of vftos obtained. The wavelet levels to be selected must best reflect the fault characteristics under various system and fault conditions. In this respect, according to the analyses of different wavelet levels of current waveform and the level 4 (D4) and level 7 (D7) details, are utilized to extract some useful features. This is because the level 4 details generally reflect the dominant non-frequency transient generated by faults. Since level7 details contain most of the fundamental harmonic, which is of 50 Hz in this system, the sum of three phase of them (D9a, D9b, and D9c) have similar characteristics of zero component which can be used to differ phase-to-ground fault and phase-phase fault, two-phase to ground fault and three-phase fault resent wavelet analysis results of other types of fault, which are two-phase fault, two phase to ground fault and three phase fault, respectively

IV MATLAB SIMULATION METHOD OF ANALYSIS

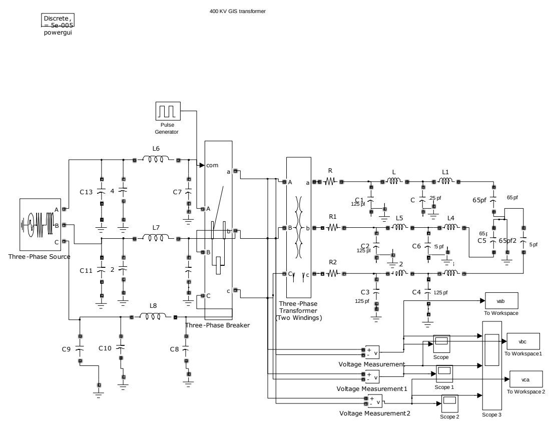

Fig 2-Matlab simulink modeling of 400K V GIS Transformer

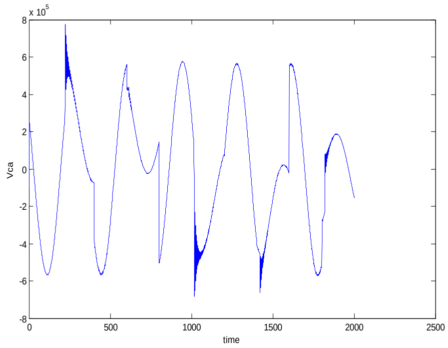

Fig 3 Voltage response at t = 2 cycle

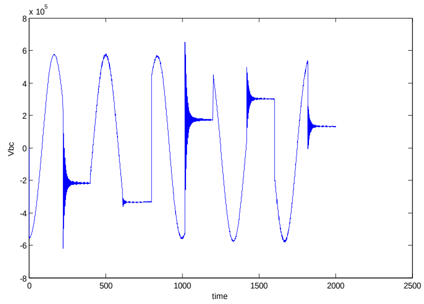

Fig 4 Responses voltage, Breaker current, for t = 0.1s

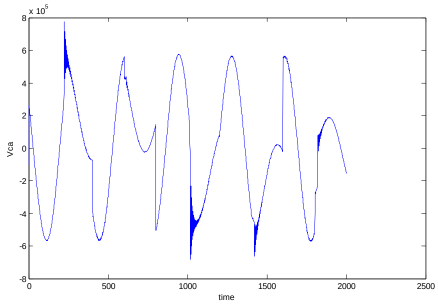

Fig 5 Voltage at t= 0.1s

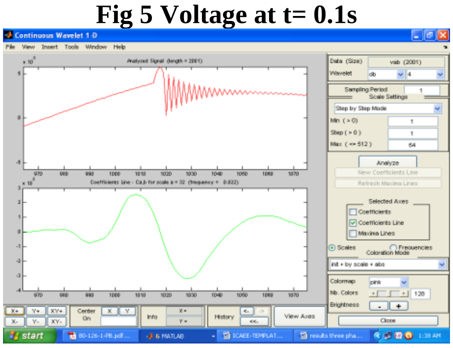

Fig 6 Responce of voltage at t= 1cycle

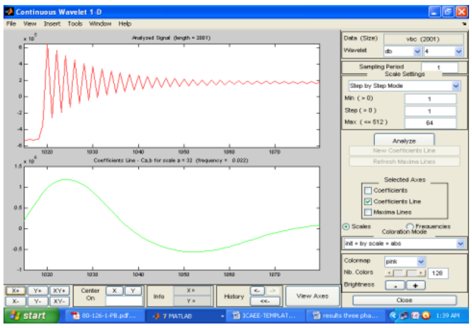

Fig 7 Voltage at t= 2 cycles

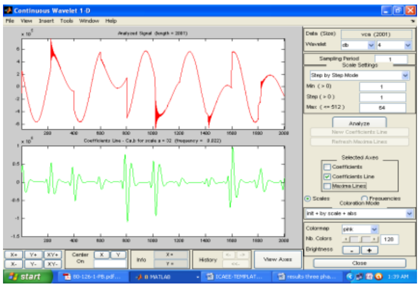

Fig 8 Responce of voltage at t = 2 cycles

S.No	Name of the equipments	Max Peak values of VFTOs
1	Open end	$0.876x10^4V$
2	**Transformer**	**9.12KV**
3	**CB**	**$2.45x10^4V$**

Table-1 maximum peak of the 400KV GIS

The analysis of transformer is done by simulink and wavelet technique for different conditions and the resultant of fast transient over voltages are formulated in figures from 4.1 to 4.6.Fg 41 to 4.3 represents the resultant VFTOs obtained by Matlab simulink model and from 4.4 to 4.6 represents the resultant VFTOs obtained by wavelet technique(DWT).The resultant values are calculated and are given in table 1.

The VFTO is calculated at the primary side of the power transformer, Vtr, and at the open end, Voc. The level and waveshapes of the generated VFTO is shown in Figure3. It is observed that the peak magnitude of the generated VFTO at the primary side of the power transformer is about 2.06 P.u, while it is about 2.63 P.u. at the open end. The trapped charge, which is in the floating section, depends on switch type and load side. For a normal slow speed disconnect or with the maximum trapped charge, it can be about 0.5pu. In the high speed disconnect or the maximum trapped charge could be reach to 1.0 pu [3]. The effect of trapped Charge on the VFTO Levels is shown in table 2. It is noticed that the VFTO at the power transformer terminal increases from about 2.06 to about 4.12 Pu with increasing the trapped charge from 0 to 1pu, respectively. In the same time the VFTO at the open end increases from about 2.36 to about 5.26 Pu with increasing the trapped charge from 0 to 1pu, respectively.table2 indicates effect of trapped charge on VFT

V CONCLUSIONS

The using R-C filter is effectively reduced the VFTO at the transformer, but it has no effect at the open end. When using the resistor switching the peak value of the generated VFTO at transformer is decreased by about 37.9%, while at open end it decreases by about 53.2%. With using the ferrite rings the peak values of the VFTO at transformer is decreased by about 35%, while at the open end it decreased by about 49%. The ferrite rings at any instant can be saturated, due to high frequency and high magnitudes of the VFTO, hence it has no effect on VFTO. With using R-C filter the peak value of the VFTO is reduced by about 37.9%. This method has a problem (results are shown in from fig 3 to 8) that it is protect the transformer only. Due to its complexity (waveform phenomena), GIS modeling for observing specific phenomena is extremely complex. By analyzing simulation results, it can be concluded that such models and simulations allow a more detailed insight into an observed phenomenon. By means of such simulation models it is possible to investigate the influence of individual phenomena on the potential rise of the GIS enclosure. Based on the results of such simulations, further measures for decreasing the potential rise of the GIS enclosure may be suggested. For further investigations of these phenomena, more simulations in programs dealing with electromagnetic fields are to be deployed.

ACKNOWLEDGEMENTS

The authors wish to gratefully acknowledge financial support for this research by
Smt.M.Suryakalavathi .dept of EEE, JNTUH, and her great support for the completion of this work.

REFERENCES

[1]. K. Cornick, et al., "Distribution of very fast transientovervoltages in transformer windings", CIGRE Report, 12-204, 1992.
[2]. Y. Shibuya, et al., "Analysis of very fast transient overvoltage in transformer winding", IEE Proceedings-Generation Transmission and Distribution, vol.144, No.5, 1997, pp.461-468
[3]. Y. Shibuya, et al., "Analysis of Very Fast Transients in Transformer", to be published in IEE Proceedings-Generation Transmission and Distribution.

[4]. Y. Shibuya, et al., "Effects of very fast transient overvoltages on transformer", IEE Proceedings-Generation Transmission and Distribution, vol.146, No.5, 1999, pp.459-464.
[5]. S. Fujita, et al., "Voltage oscillation in transformer Windings affected by very fast transient surges", Transactions of IEE Japan, Vol.120-B, No.5, 2000, pp.766-772.
[6]. J. BAK-JENSEN, B.BAK-JENSEN, S.D. MIKKELSEN: Detection of Faults and Aging Phenomena in Transformers by Transfer FunctionsIEEE Transactions on Power Delivery, Vol. 10, No. 1, Jan. 1995, pp. 308-314
[7]. S. M. ISLAM, G. LEDWICH: Locating TransformerFaults through Sensitivity Analysis of High Frequency Modeling Using Transfer Function Approach, IEEE Int. Symp. on Electrical Insulation, Montréal, 1996, Conference Record pp. 38-41
[8]. Yaswanth Vadrapalli, Urmil B.Parikh, Kalpesh Chauhan," A novel approach to Modeling and Analysis of Very Fast Transients in EHV Gas Insulated Switchgear" SWICON 2011.
[9]. IEEE TF on Very Fast Transient (D.Povh, Chairman), "Modelling and analysis guidelines for very fast Transients", IEEEE Trans. on Power Delivery, vol. 11, no.4, October 1996.
[10]. A.Ecklin, D.Schlicht and A.Plessl, "Overvoltages in GIS caused by the operation of isolators", Surges in high-voltage networks, K.Ragaller (Ed.) 1980.
[11]. N.Fujimoto, H.A.Stuckless and S.A. Boggs,"calculation of disconnector induced overvoltages in gas-insulated substations" Gaseous Dielectrics IV, 1986.
[12]. CIGRE Working Groups 33/13-09, "Very fast transient phenomena associated with gas insulated substations", CIGRE paper No. 3-13, 1988.
[13]. CIGRE Working Group 33.02 Guidelines for representation of networks elements when calculating transients, 1990.
[14]. S.Yanabu et al., "Estimation of fast transient overvoltage in gas-insulated substation", IEEE Trans. on power delivery, vol.5, no.4 1875-1882, October 1990

BIOGRAPHIES OF AUTHOR

1) K.Prakasam, Born in 1973 april 20, his B.tech degree from KSRM College of Engineering SV university in 1997 and M.Tech degree from SV university in the year 2004. He has specialised in Power Systems, High Voltage Engineering and Control Systems. his research interests include Simulation studies on Transients of different power system equipment. He has 16 years of experience. He is presently working as Assoc.Prof and HOD of Dept of EEE, Siddhartha Institute of Engineering and Technolgy, Ibrahimpatnam, Hyderabad

2) D.Prabhavathi Born in 1976 august 27, her B.Tech degree from KSRM college of Engineering, kadapa , SV university, and M.Tech degree from SV iniversity in the year 2003.She has specialised in Power Systems, High Voltage Engineering.She is currently working as Assoc.Prof ,dept of EEE Siddhartha Institute of Engineering and Technolgy, Ibrahimpatnam, Hyderabad Her research interests include Simulation studies on faults identification in UG cable of LT and HT. She has 12 years of experience.

3) Dr. M. Surya Kalavathi, Born on 8th July 1966, Obtained her B.Tech degree from S.V. U. in 1988 and M.Tech from S.V.U. in the year 1992. Obtained her doctoral degree from JNTU, Hyderabad and Post Doctoral from CMU, USA. She is presently the Professor (EEE) in JNTUH College of Engineering, Kukatpally, Hyderabad. Published 16 Research Papers and presently guiding 5 Ph.D. Scholars. She has specialised in Power Systems, High Voltage Engineering and Control Systems. Her research interests include Simulation studies on Transients of different power system equipment. She has 18 years of experience. She has invited for various lectures in institutes.

4) Bhumanapally. Ravindhranath Reddy, Born on 3rd September, 1969. Got his B.Tech in Electrical & Electronics Engineering from the J.N.T.U. College of Engg., Anantapur in the year 1991. Completed his M.Tech in Energy Systems in IPGSR of J.N.T.University Hyderabad in the year 1997. Obtained his doctoral degree from JNTU, Hyderabad .