Modelling and Analysing Very Fast Transient Overvoltage under Trapped Charges Impact in Gas Insulated Substations

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Abstract-- Very fast transient overvoltages (VFTO) are a unique phenomenon in a GIS caused by disconnector operations. These transients have a duration measured in nanoseconds and a frequency greater than several Megahertz. This project examines the magnitudes of transient overvoltage using computer modelling of electrical networks. In the present paper, we present the simulation results of the VFTO at the GIS under the effect of trapped charges in different locations. The model enables the software to recognise the impact of trapped charges on the high voltage system at varying locations in a substation. The project will use the software ATP-EMTP to model a comprehensive GIS system.

BACKGROUND & MAIN RESULTS

As the contacts of the disconnector approach, the electric field between them will increase during closing until sparking happens. Due to the slow operating speed, the first strike will almost certainly happen at the each other of the power frequency voltage. The current will then flow through the spark, charging the capacitive load to the source voltage. Rapidly, the potential difference between the contacts decreases and the spark eventually dies [1]. The behaviour that occurs during the opening phase is almost the exact opposite of the process described above. Electromagnetic Interference (EMI), flashovers, and insulation ageing issues can occur due to VFTO. Components such as bus ducts, elbows, closed disconnectors, closed switches, and closed breakers are represented as loss-free distributed parameters transmission lines in VFTO studies [3]. Capacitance is also represented by a spacer and an open disconnector. The value of VFTO can reach roughly 3 p.u in the GIS under operating conditions[2]. The trapped charges can affect the propagation and magnitude of very fast transient overvoltages (VFTOs) in GIS systems. The trapped charges can act as a voltage source and raise the voltage in the system, which could damage equipment or cause the system to stop working. Additionally, the trapped charges can affect the insulation resistance and dielectric strength of the system, reducing the overall performance of the GIS.

In order to investigate the VFTO in GIS from a 400 kV substation, some study cases for a single-bus GIS arrangement have been identified. The model includes two scenarios, each with a distinct impact. The research examines the highest voltage values at various system locations for each design. Then, it compares their results to determine the system's peak voltage. In addition, the equipment's capabilities and the potential application of mitigation techniques, if necessary. Future work will refine the simulation model and compare the recorded transients during disconnector switching operations.

CONCLUSIONS

The simulation tests show that values of VFTO rise when adding the effect of the trapped charges with a few nanoseconds of rising time. The results will indicate the most undesirable highest peak value under trapped charge impact. By identifying which components have the highest peak value, closer attention must be paid to monitoring and protecting these components.

REFERENCES

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