Study Committee A2

Power Transformers and Reactors

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Evaluation and Implementation of HV Dry-Type Shunt Reactors into a 420kV Transmission Grid

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Introduction and Summary

The paper presents different steps and considerations to qualify dry-type air-core HV reactors for the use in the German 420kV transmission grid of TenneT.

The main interfaces of HV shunt reactor are: necessary civil work, primary connection and breaker, monitoring and control equipment.

Especially the design of the necessary civil construction is significantly influenced by either using oil-immersed or dry-type reactors. The absence of oil, the presence of a magnetic stray field, the lower weight and the fact that air-core dry-type shunts are arranged as a bank of single-phase units impacts the design of the necessary foundations.

Additional topics which are important from an asset management point of view are, required spare units, transportation efforts and necessary time to put a shunt reactor bank back into service in case of an outage or after maintenance.

Typical layout of a 420kV Air-Core Dry-Type Shunt Reactor Bank

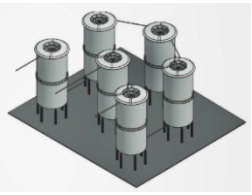

Figure 1 – Typical arrangement of a 420kV Dry-Type Shunt Reactor

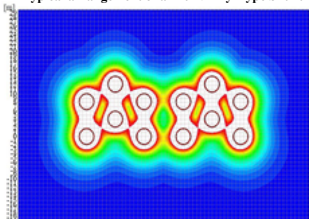

Figure 2 – Magnet field distribution around two 420kV 120MVA Dry-Type Shunt Reactors

Differences in operation compared to oil-immersed units

- Maintenance: Special care should be taken regarding grounding of the units under maintenance.
- Protection: Typical differential protection is only necessary for multi-column installations
- Switching: It's essential that the windings of each column of an arrangement, having two or more columns connected in series, is insulated for the full BIL
- Losses: When designing air-core shunt reactors to about the same losses as oil-immersed units they are running at vey low temperatures which is having a positive impact on the expected thermal live time of the units.

Spare units and replacements

The modular approach of dry-type air-core HV shunt reactors provides faster delivery for spare units, lower costs for spare units and lower down times in case of a failure.

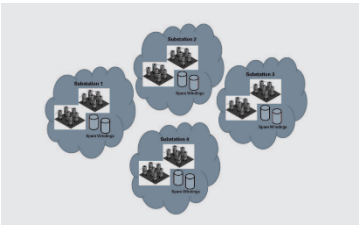

Figure 3 - Substations each having two 420kV shunt reactor banks

Limitations when using transmission class Air-Core Dry-Type Shunts

- Applications where variability is needed
- Existing (liquid-immersed) installations
- Maritime/Offshore Environment due to the windings being more exposed to the environment compared to oil-immersed shunt reactors
- Indoor applications
- Very low sound requirements which would require external housing
- Voltages above 550kV

Conclusion

The conducted studies have shown, that air-core dry-type reactors are a viable alternative solution for transmission class shunt reactor projects. There are important differences to oil-immersed shunt reactors when executing such projects using dry-type air-core reactors. Transport, handling and erection are simplified. However, the station layout planning requires a careful consideration of the effects of the stray magnetic field. Topics such as reactor switching, protection and maintenance need to be attended at well.

Due to the various simplifications the total costs of the station is decreasing. This is especially true for greenfield projects. The modular concept has advantages in spare and replacement management and results in reduced outage times. The limitations of air-core dry type shunt applications were also outlined at the end of the paper.