

Functions influenced by ageing

SC D1 Materials and Emerging Test Techniques

PS1, Q1.13 - Which functions are influenced by ageing of liquid insulation systems? What are the possibilities to verify these functions? Are alternative methods to measure ageing mirroring the functional properties?

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Summary

- There are multiple functions influenced by aging of insulation systems. Various impacts depend on physical properties of degrading materials.
- Aging can be influenced by impact of multiple materials combined within insulation system. **It is important to look at the insulation system as a whole and not individual materials only.**
- Various evaluation methods allow for observing changing material properties.
- **Aging evaluations may not be limited to thermal aging but include exposure to dielectric stress (voltage endurance) or mechanical stress (mechanical cycling).**

Functions influenced by aging

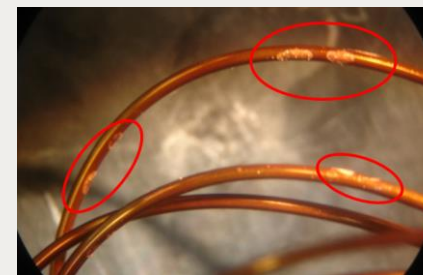
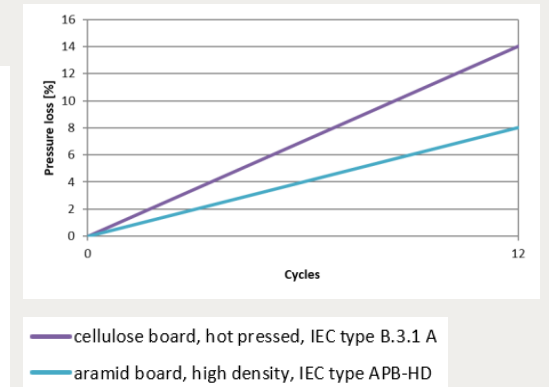
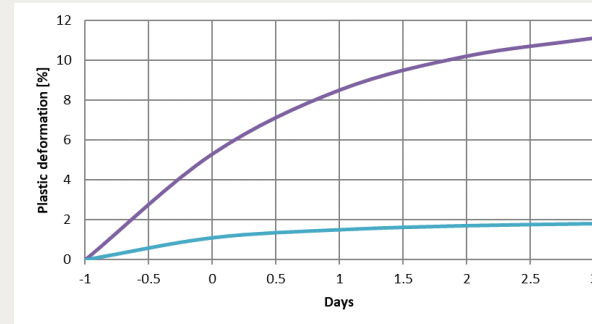
Mechanical strength

- Assumed to be the key property affected by aging of solid insulation (evaluated by DPv for cellulose or tensile strength for other materials),
- Directly impacting life of the equipment (mechanical withstand).

Other properties:

- Plastic deformation (clamping blocks, clamping plates),
- Dielectric strength (enamels, films),
- Elongation (films, papers),
- Elasticity (gaskets),
- Bonding strength (adhesives, epoxies),
- Viscosity (liquids),
- Moisture absorption (cellulose).

Group Discussion Meeting



Aging of insulation systems

Proper evaluation of insulation system shall

- include adequate combination of materials (specific solid and specific liquid),
- model real operating conditions (temperature profile within insulation, moisture content, pressure, oxygen access, etc.),
- if needed, focus on other properties than just mechanical strength of material.

Example considerations

- Moisture may be low at the beginning of aging but may be generated in the system later as a product of cellulose degradation.
- In aramid-based systems the moisture content may be low all the time as there is not contact of cellulose with hot conductors.
- Liquids have normally limited contact with conductor temperatures. Their bulk temperature is typically much lower than hot spot in windings. Aging at graded temperatures is an option.
- Aging in esters changes environment for all aging materials vs. aging in mineral oil.

Group Discussion Meeting

