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Question 2.04
Is testing under high temperature representative enough for the determination of thermal index of insulating materials? Are the acceleration factors used for high temperature accelerated tests for different insulation systems well documented? How shall the change of properties and chemical characteristics of the insulating liquid itself be considered under such conditions? **Can diagnostics as DGA be transposed from old insulation systems to new ones?** How can dielectric performance (e.g. withstand voltages) of an insulation system/design be qualified? Where are standards for performance and compatibility lacking?

Answer

Proper DGA analysis requires developing adequate interpretation guidelines for specific insulation system. But, depending on materials used in new insulation system, existing guidelines can be successfully used for evaluation of equipment performance.

For example, existing DGA interpretation tools can be applicable to hybrid insulation systems with aramid insulation.

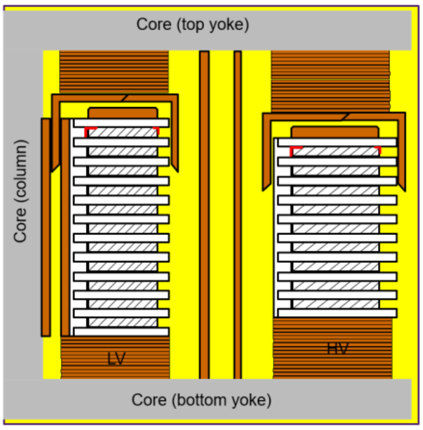

Fig. 1 – Typical configuration of hybrid insulation system: aramid paper used for conductor insulation and aramid pressboard used in vicinity of windings.

Aramid insulation does not generate tracers typical for cellulose (CO, CO2, furans). But DGA can still be performed to observe gassing from conventional components of the insulation system:

- liquid,
- cellulose based parts of hybrid insulation system.

Condition of equipment may be assessed based on these more sensitive components (with adjusted criteria for gas concentration). If oil is overheated or exposed to dielectric discharges, this would be indicated in gasses generated from oil. If any of the sensitive cellulose components is exposed to excessive temperatures, the cellulose would generate gasses typical for the level of overheating observed.

The interpretation tools need to be adjusted for lower gas generation from cellulose in hybrid systems, because there is less cellulose in direct contact with windings. The Fig. 2 illustrates the case of prototype transformers containing aramid insulation on conductors. Lower CO and CO_2 generation is naturally observed after factory temperature rise tests.

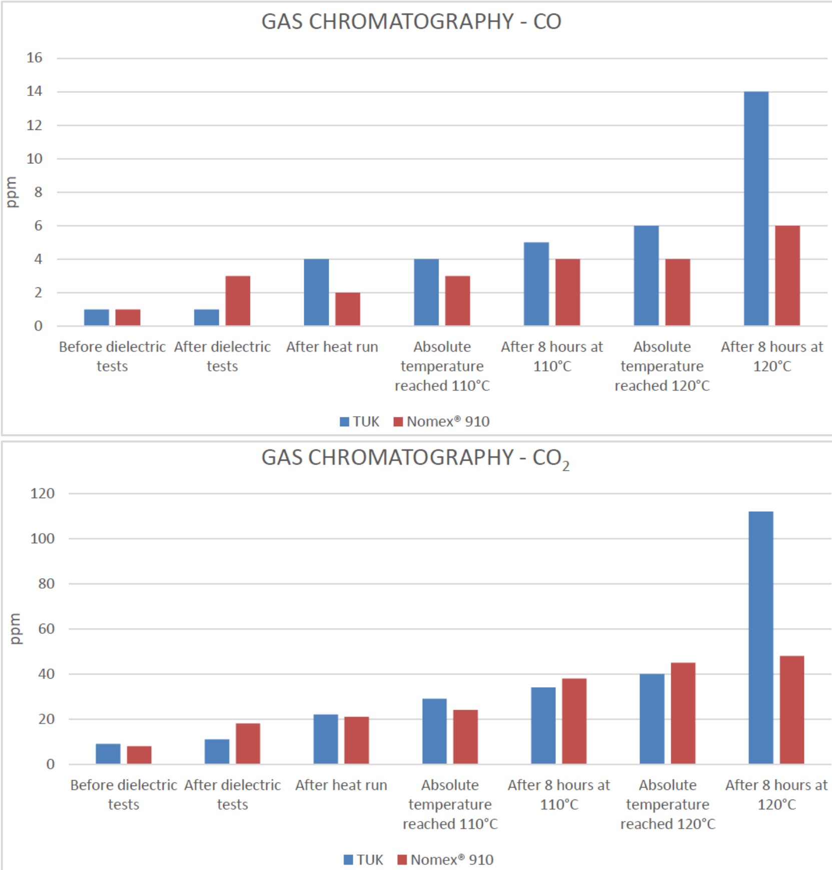

Fig. 2 – Illustration of lower gas generation from insulation system with aramid

For addressing the need for proper DGA interpretation tools for aramid-based insulation systems, a research program is in place. The aim is developing chemical markers for identification of thermal faults in aramid insulation.

Temperature range: 170 – 300 – 500 – 700°C

Type of analysis before/after aging:

- Dissolved gas analysis (DGA),
- Gas chromatography mass spectroscopy (GC-MS),
- Suspended particles investigation (analytical ferrography),
- Liquid physical chemical analysis.

Fig. 3 – Test equipment developed for thermal fault modelling in liquid immersed system with aramid insulation: vessel with powerful water-cooling system + paper wrapped heating resistance

More details on this research can be found in publication D1 11027 from this conference: “Thermal faults simulation for aramid insulation in liquid immersed power transformers” by R. Szewczyk et al.