NAME :	Radoslaw Szewczyk	GROUP REF. :	D1
COUNTRY :	Poland	PREF. SUBJECT :	PS2
REGISTRATION NUMBER :	5024	QUESTION N° :	Q 2.04

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

Accelerated aging of insulation systems under high temperature is representative for the determination of thermal index of insulating materials. There is a long experience in thermal evaluation of dry-type or liquid immersed insulation systems and standard references for it exist. Various methods are defined for different types of insulation materials and various insulation systems.

For example, evaluation of liquid immersed insulation systems is covered by IEEE Std. C57.100. The system evaluation is based on comparative testing vs. Industry Proven Systems, in order to establish Relative Thermal Index (RTI) for the candidate insulation system. The accelerated aging at elevated temperatures is based on Arrhenius law, and the insulation life at lower temperatures can be extrapolated from established formulas.

The choice of proper evaluation method may be necessary for different applications and equipment types:

- Complete equipment (transformer) model – the most precise method evaluating actual design of the equipment but limited to that specific design. Actual stresses on insulation components may be different in different designs, hence the method might not be representative for other designs vs. the evaluated one.
- Sealed tube – the most simplified and practical aging model; allowing effective long term insulation evaluation in given environment and with other materials included,
- Dual temperature cell – more advanced model allowing for separating temperatures for solid insulation (insulated heating element) and liquid (bulk liquid temperature).

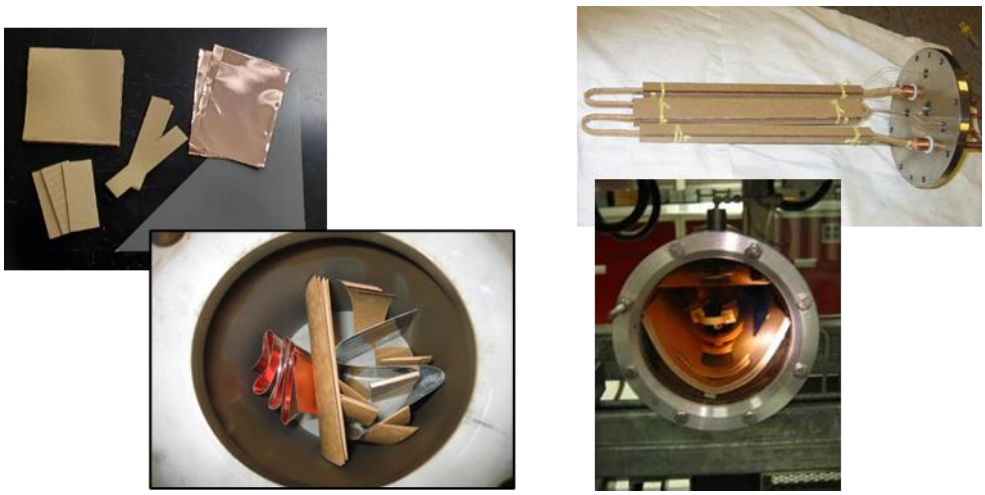

Fig. 1 – Various cells for accelerated insulation system aging: sealed tube with collection of materials representing insulation system (left) vs. dual-temperature cell with a model of insulated conductor and pressboard components adjacent to it (right)

Recently, we completed a 3rd party certification process of new insulation system. This confirms the trust at the industry and validity of established methods for ensuring proper insulation system performance. This is a first ever insulation system certified by UL for liquid immersed transformers.

It must be noted that majority of thermal evaluation methods focus on solid insulation materials, while liquids are considered only an environment for aging of that solid insulation. Procedures for evaluating liquids alone or for evaluating liquid aging as part of insulation systems are still missing. This includes:

- Understanding of long-term thermal aging behavior of liquids,
- Guidelines for accelerated aging tests,
- Criteria for end-of-life determination.

We proposed developing CIGRE guidelines for aging and evaluation of liquids in 2014, but the topic was considered too complex at that time (too many factors to consider). Now, an active IEEE Working Group investigates aging factors for various liquids, mainly esters.