

NAME :	Radoslaw Szewczyk	GROUP REF. :	A2
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There seem to be conflicting opinions concerning the use of some alternative transformer technologies at higher temperatures, especially ester-immersed transformers. What is the experience of using alternative transformer technologies at higher temperatures? What further work is needed on this subject?

Answer

There is a good record of experience at the industry with various applications of transformers designed for higher temperature operation. These transformers historically used various types of alternative liquids, incl. esters. Today, developments continue on new types of advanced liquids.

Continued research is needed for adopting the new liquid solutions but comprehensive evaluation of insulation systems. New solid insulation components are also under development for matching the increasing temperatures allowed by new insulating liquids.

Clean, sustainable, reliable, and resilient energy is not an option today, but this transition process is not at all easy. Some steps are hard because renewable energy is intermittent, difficult, and costly to storage. International HV grids operators are facing with these difficulties because some studies demonstrated that is not possible to integrate more than 10% from distributed energy (solar and wind) into a traditional power system. Anyway, some other steps in the respect of the clean transition energy paradigm are currently fully available.

Use of insulating materials with high thermal performances, low-flammable, environmentally sustainable as recognized by IEC 60076-14 can provide reliable and cheap solutions to overcome and to support:

- unpredictable energy peak demands
- weight and dimension limits for fast deployable transformers, to be used in case of emergency or on construction sites
- fire accidents
- transformer life extension.

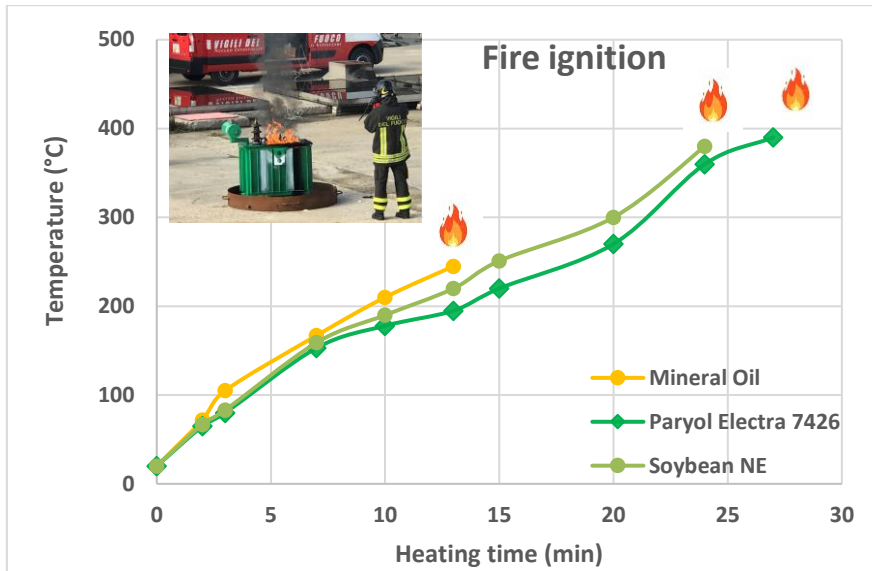
Overloadable resilient area station power transformers (AST*) with esters have been implemented several years ago in US, with no concerns observed for their operation.

**AST - typically medium power transformers to transform the transmission line voltage (e.g. 132 kV) to a local area distribution network voltage (e.g. 11 to 33 kV); power rating in the range of 10 to 93 MVA*

As is always the case whenever new technologies are presenting on the market some conflicting opinions raise. This is a largely understandable attitude in a justifiably conservative and cautious world such as the electrical industry because the use of traditional insulation materials like cellulosic paper and mineral oils boast almost a century of experience.

For this reason, DuPont and A&A Fratelli has developed and tested a new insulation system, composed by Nomex® 910 (a paper combining thermally upgraded cellulose and aramid) and Paryol Electra 7426 (high-oleic sunflower natural ester). DuPont and A&A Fratelli didn't limit their new proposal by coupling the insulation materials in according to IEC 60076-14 standard. The thermal evaluation study demonstrating the superior thermal class has been carried out following IEEE Std C57.100 and results were validated and certified by a 3rd party certification entity (Underwriters Laboratory) to ensure the highest quality of the generated test data.

Also, the low flammability of the Paryol Electra 7426 has been tested by the Italian Firefighters Brigade simulating a fire in a small distribution transformer, as in the figure here below. Mineral oil burns completely after 13 minutes until final consumption. Instead, Paryol Electra 7426 after 28 minutes had just a flash, but fire was extinguished immediately afterwards.



Additionally, the superior oxidation stability properties which extend the life endurance, and the no-gassing behavior has been demonstrated as reported in paper No. 10772 from this conference. What makes the difference in comparison to other natural esters is the composition of high-oleic sunflower poor of poly-unsaturated fatty acids.

Compatibility issues with other materials (metals, solid insulation, polymers, paints, etc.) has been also checked and no contraindications has been found out.

Paryol Electra 7426 has been successfully approved by the main OLTC manufacturer for use in power transformers and in furnace transformers.

Despite these supporting researches and developments and the wide application of natural esters, also in HV transformers by some TSOs, the current prudent policy prescribes to select a superior voltage class for some ancillary transformer equipment like bushings or OLTC. Future works should be addressed to check and verify these worries.