

Alternative Technologies

SC A2 Question 2.4:

Are there any applications for which alternative transformer technologies are not well suited and what can be done to develop new types of alternative transformer for these applications?

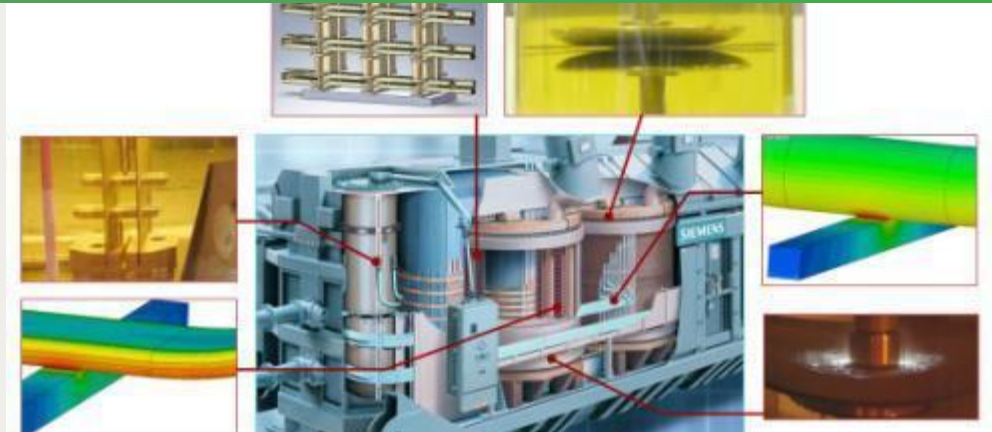
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How to deal with the challenges? What is critical in a transformer design?

Transformer design challenges

1. Higher viscosity, differences in other thermal parameters (e.g. high pour point of natural ester)
2. Impregnation behavior of solid insulation
3. Compatibility with materials commonly used in transformers
4. Higher electrostatic charging tendency (ECT)
5. Lower dielectric strength of ester in comparison to mineral oil



Solutions from Siemens Energy

1. Tailored cooling design
2. Adapted procedure for impregnation and filling
3. Compatibility tests of materials
4. Adjusted liquid flow velocities
5. Design adjustments (e.g. distances between windings and grounded elements or lead arrangements have to be modified)



Streaming model test setup (ECT)

What is the difference?

What are the main technical figures of esters?

We can deliver the different performance levels of esters

Property of insulation fluid	Mineral oil (e.g. IEC 60296)	Synthetic ester (e.g. IEC 61099)	Natural ester (e.g. IEC 62770)
Kinematic viscosity at 20°C (mm ² /s)	22	70	78
Kinematic viscosity at 100°C (mm ² /s)	≈ 2	≈ 5	≈ 8
Fire point (°C)	≈ 170	>300	>350
Flash point (°C)	≈ 160	>250	>300
Dielectric constant	2,2	3,2	3,1
Pour point (°C)	> -50	> -60	> -21
Water saturation at 20°C (ppm)	55	2600	1100
Biodegradation (%)	<10	80 - 95	95 - 100
Fire hazard classification	O	K	K
Oxidation stability	+	+	-
Dielectric properties	Well known	Design modification necessary	Design modification necessary

Group Discussion Meeting

Please see Paper ID – 11022 Design of innovative resilient transformers for maximum operating flexibility

Known high-end materials, e.g.

- Aramid (Nomex)
- Synthetic ester (Midel 7131)

- adjusted design tools and
- experienced workforce over the whole process chain

offers a new generation of transformers for high-end applications.

Group Discussion Meeting



Paper ID – 11022 **Session 2022**
Study Committee – A2
PS2 - Beyond the mineral oil-immersed transformers and reactors

Design of innovative resilient transformers for maximum operating flexibility

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