KEMA Labs

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On-Line Webinar *June 25, 2020*

Quality assurance on transformers when using green oil (natural esters) as an insulating liquid

CESI

Quality assurance on transformers when using green oil (natural esters) as an insulating liquid

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Member of committees

different working groups in CENELEC / IEC / IEEE – for Transformer and for Bushings

Vice Chairman DKE K321 Transformer

Vice Chairman DKE K451.1 Bushings

Member DKE K451 Insulators

Agenda

1. Where is green oil (natural ester) used as an insulating liquid for transformers
2. Special requirements for the transformer specification
3. Consideration of the environmental conditions for the use of the transformers
4. Quality assurance in the project process
5. Tests
6. Service and maintenance in operation

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Where is green oil used as an insulating liquid for transformers

- Use with oil immersed transformers according to the IEC 60076 series
  - **Distribution Transformer** (already specified for many utilities)
  - **Power Transformer** (specified on request and for special projects)
- Function of the insulating oil
  - **electrical insulation** of the active part (windings, leads, …)
  - Impregnation of the solid **insulation**
  - **Cooling** of windings and iron core (active part)
- more than 30 years projected service life of the transformers

Where is green oil used as an insulating liquid for transformers

- historically use of mineral oil (disadvantage of low flash point)
- for **more than 20 years**, use of **synthetic and natural esters**

Benefits of natural esters:

Quickly biodegradable

Not hazardous to water

Flame retardant

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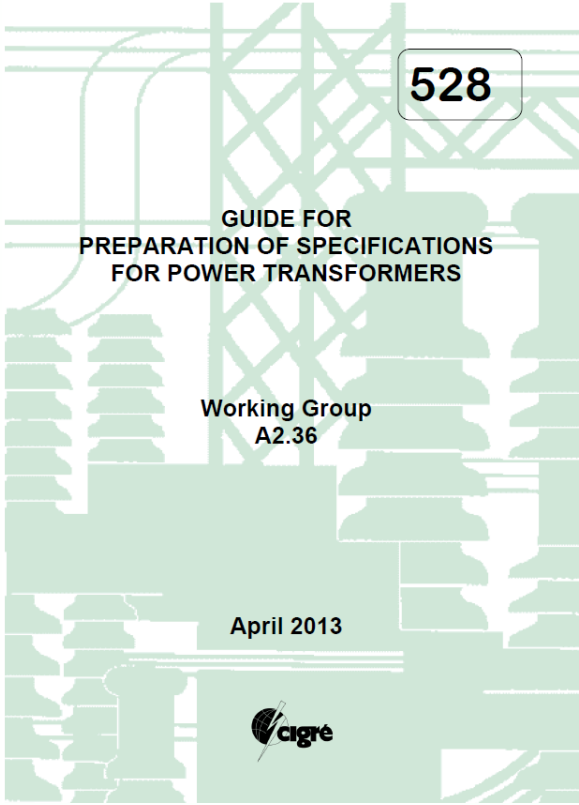
Special requirements for the transformer specification

- Very good overview for specification requirements are given in the **CIGRE publication 528**
  - mainly for **Power Transformer** ➔ also useful for **Distribution Transformer**
- Special attention in the transformer specification to:
  - Specification of the **type of oil**
  - Specification of the **type of cooling** of the transformer
  - Description of **environmental and installation conditions**
  - Range of **ambient temperatures**
  - **protection against oil loss**
  - Fire **safety**



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Consideration of the environmental conditions for the use of the transformers

- where should the transformer be installed and operated
  - **On shore** ➔ possibly in water protection areas
    ➔ near or in residential areas
    ➔ Water power plants
    ➔ mounting on poles
    ➔ use for transport application (trains)
  - **Off shore** ➔ on platforms
    ➔ in wind turbines
- are there special temperature conditions / requirements
  - **Ambient temperature** conditions
  - **Cooling** and cooling conditions

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Quality assurance in the project process

- Manufacturer selection taking into account the oil processes in the manufacturing plant and on-site
  - supplier approval
  - if necessary supplier audit
- **Quality assurance** in the project process
  - Project kick off
  - Design Review
  - Production control (focus on oil processes)
  - Active part inspection
  - FAT
  - Transport
  - Installation and Commissioning

Quality assurance in the project process

- Design Review with special attention to:
  - dielectric strength (with inhomogeneous arrangements, natural esters are slightly worse than mineral oils)
  - selection of the tap changer
  - thermal design / internal and external cooling
  - Use and design of the insulating materials to be impregnated
  - Use of development tests (dielectric, thermal)
  - hermetic design
  - oil filling and preparation during installation

- for **Distribution Transformer** no special requirement ➔ just type testing

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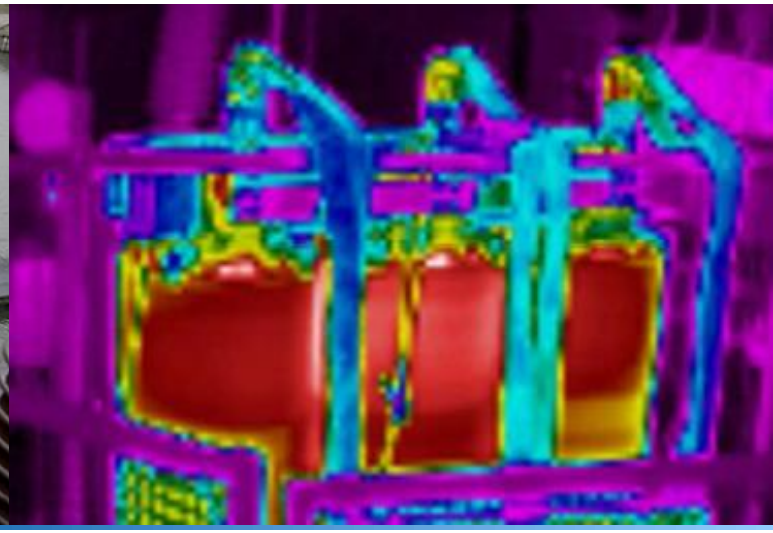
Test

- implementation of development tests (dielectric, thermal)
- Review of the technological processes in the production

- All type and routine tests in accordance with **IEC 60076** must be carried out **without changes**
  - special attention to ➔ dielectric tests
    ➔ temperature rise tests
    ➔ special test like short circuit test





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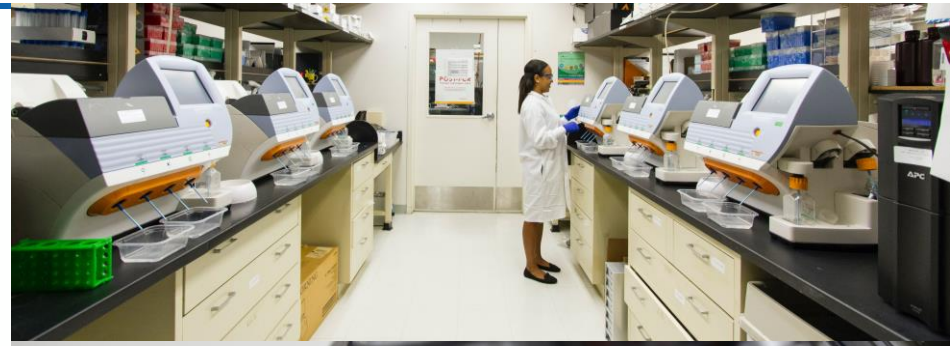
Service and maintenance in operation

- no special requirements for the service and maintenance of transformers

- the usual **oil checks** during maintenance like
  - ➔ **DGA**
  - ➔ **breakdown voltage measurement**
  - ➔ **water content**

  can be used to condition assessment

- the interpretation of the DGA (e.g. according to the Duval triangle) must be slightly adjusted (thermal failure)



Thank you for your attention

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