West Coast Technical Meeting – Pomona CA, May 24-25, 2016

Siemens Transformer Technology Seminar
Low Partial Discharge Transformers

Siemens AG – Transformers
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Low Partial Discharge
Why highlight Low Partial Discharge

- Working life depends on insulation quality
  - Secure and permanent insulation is needed

- Insulation condition is endangered by Partial Discharges (PD)
  - PD sources are local enhancements of the electric field in the area of inhomogeneities either in gases, liquids or solid media

- Most insulations failures caused by PD
  - Complete breakdown of the insulation is possible
Insulation system
- Organic dielectric materials
  - Insulation liquids
  - Cellulose-based material, such as paper and pressboard

PD mechanism
- PD generates high energy electrons or ions
  - Deterioration of insulation material
  - Chemical decomposition in the insulation material

PD effects
- Degradation of organic material
- PD in the insulation system is the main cause of
  - Electrical aging
  - Failure in insulation system
Current practice and development

PD-Sources in Transformers

Partial discharge can occur in:

- Voids in the solid insulation (paper, polymer etc.)
- Along the interfaces of multi-layer solid insulation systems
- In gas bubbles in liquid insulation
- Around conductors with a high field stress
- A metal object at floating potential
- Free metallic particles in oil

The technical challenge

Our focus is to:

- Minimise PD activity to below the accepted limits of international test standards
- Meet the highest quality requirements
- Meet special PD requirements for customers
Our key factors to reach low PD activity at test voltage level

- Optimised dielectric design
- High material quality
- Manufacturing precision
- Cleanliness in production
- Stable processing

Requirements of the test field

- Low noise PD level in the test field

Benefits for our customer

- No PD at higher voltages leads to more secure operation
- No electrical aging due to PD
  - No deterioration of insulating materials
- No ignition of partial discharge during high voltage fluctuations in the power grid
  - Such as impulse overvoltage and harmonic transients
Optimised dielectric design
- Design analysis
- 3D FEM model
- Field stress limits
- Innovative model studies
- Realistic model simulation in the test field

High material quality
Distributor requirement
- Audits
- Test Report
- Release Report
- Regular check
- Incoming inspection
- Periodic measurements

Manufacturing precision
- Exactly defined work instructions
- Optimal material processing
- Gluing technology
- Visual inspection
- Cleanliness during assembly
Cleanliness in production

- Desert environment incl. Vapour Phase Oven
- Cleanliness of room and air
- Periodic measurements of particle in air

Stable processing

- Desert Climate Zone
- Drying
- Vacuum
- Impregnating time

Results

- Improved cleanliness and dielectric quality of high voltage internal components
- Achieved namely through drying to remove moisture, dry storage and final assembly processes of the active part
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Reference list –
Tested successfully

Medium Power Transformer
120 MVA
132/33 kV
with OLTC
IEC 60076-3 (250pC)

PD Level at test voltage
First unit <25pC
Second unit <15pC

Phase Shifting Transformer
400/400/100 MVA
400/140/49 kV
IEC 60076-3 (250pC)

Contract specification
Guaranteed PD level 1,3xUm/√3
First unit <25pC
Second unit <50pC

Single Phase SVC Transformer
100 MVA
735/√3 / 26 kV
Test voltage phase to ground
750kV
IEEE Std C57.12.00-2010
Guaranteed PD value 500pC

PD Level at test voltage <25pC
HVDC Transformer ± 800 kV
376.6 MVA
525/ 159.8 kV AC
± 800 kV DC
IEC 60076-3; IEC 61378-2

Contract specification:
AC applied 1h: 912 kV; <100pC
AC applied PD level: <50pC

Interconnector Bruchsal
300 / 180 MVA
405 +/- 11% / 115 / 22 kV
Special: Natural Ester Insulation
Liquid KDAF / KNAN
IEC 60076-3

Contract specification:
ACLD < 500 / <10pC
ACLD PD level: <10 / <5pC

Auto Transformer E.On Spar
450/ 450 / 120 MVA
400± 40 / 230 / 30 kV
IEC 60076-3

Contract specification:
ACLD < 100 / <10pC
ACLD PD level: <25 / <5pC
We can offer:

- Optimised dielectric design through the use of 3D FEM modelling
- High material quality ensured through working with our suppliers
- Manufacturing precision
- Cleanliness in production
- Stable processing with advanced drying technology
- Proven results on a range of transformers manufactured for our clients
- Pilot work and model studies