



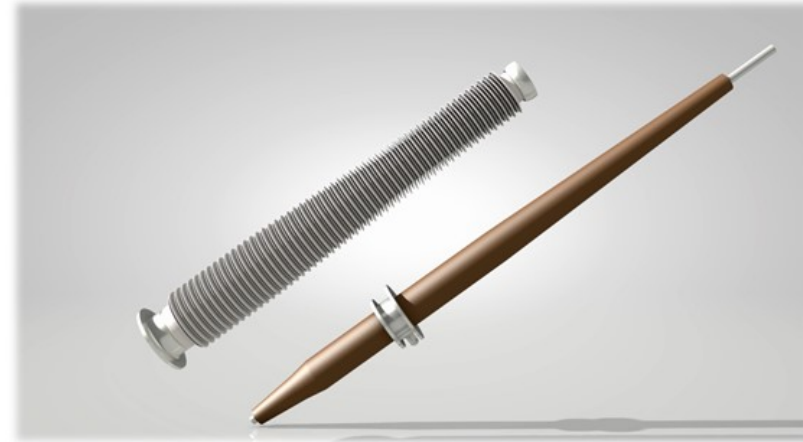
Lars Jonsson, CIGRE-IEC Colloquium, May 9 - 2016

Development of dry-insulated 800 kV ac transformer bushings

Introduction

Primary components

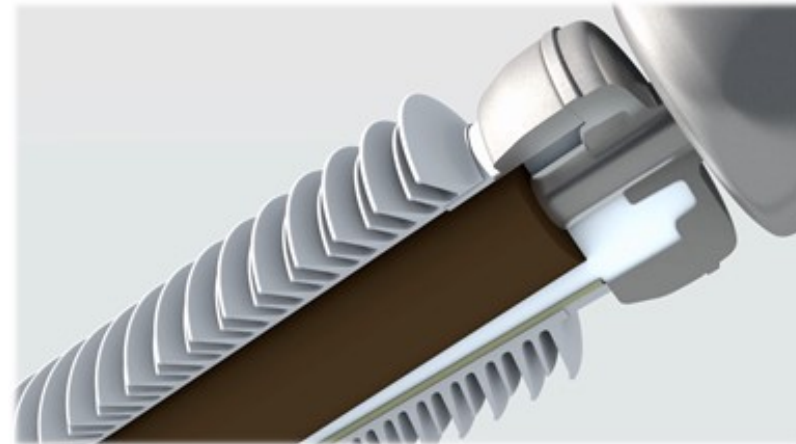
- Outer insulation
- Inner insulation
- Mounting flange
- Conductor arrangements



Concept selection

The reason for using dry technology

- Reduced risk of fire
- Seals the transformer and reduces the down-time in the event failures
- Mechanically rigid and lower weight



Concept selection

The reason for using composite insulation

- Non shattering
- Non flammable
- Hydrophobic surface
- Increased seismic withstand



Concept selection

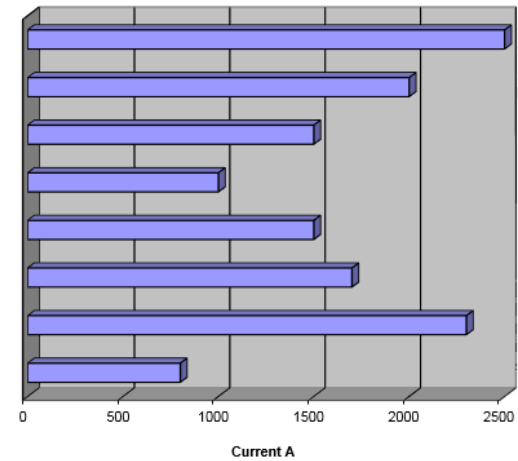
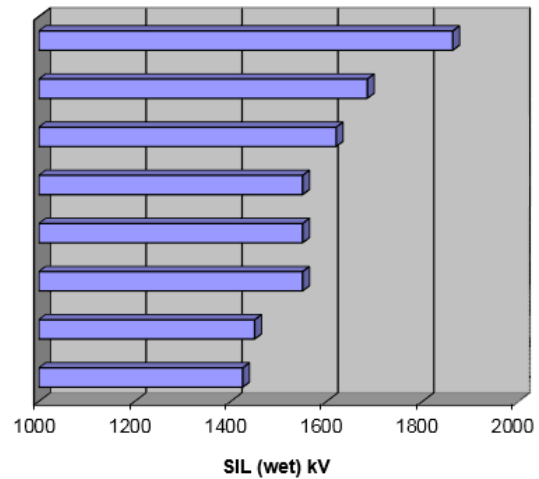
The reason for interchangeability

- Ageing infrastructure
- A growing concern for safety, environment and availability
- Connection details
- Shield arrangement



Primary system data

735 – 800 kV grids



Project challenges

Heat dissipation

- Heat conductivity
- Dissipation factor
- Thermal stability
- Overload

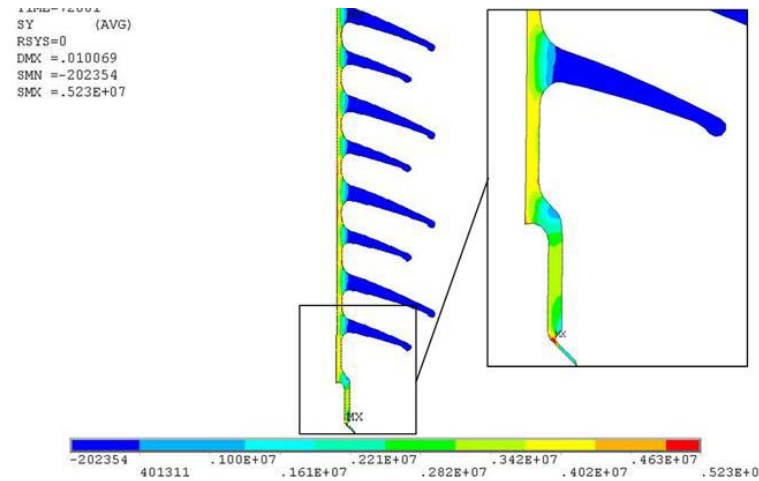
$$P_{loss} = 2 \cdot \pi \cdot f \cdot C_1 \cdot u^2 \cdot \tan \delta$$

$$P_{loss} = R \cdot I^2$$

Project challenges

Thermal engineering

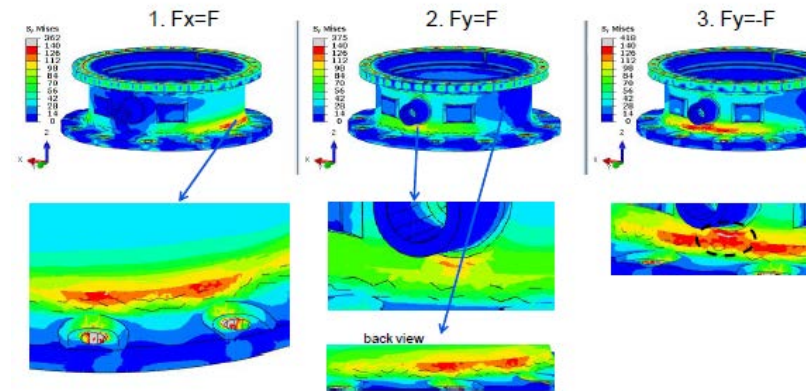
- Temperature cycling requirements
- Variations with temperature
- Gradients in core
- Simulations



Project challenges

Mechanical engineering

- Non linear
- Seismic load
- Mechanical testing



Project challenges

Production engineering

- Winding
 - Foil placement
 - Compensation
- Impregnation and curing
 - 2000 kg of epoxy
 - Partial discharges
- Machining
 - Tolerances



Verifications

Type testing

- IEC and IEEE
 - Power-frequency voltage withstand
 - 1 minute, wet
 - Long duration
 - Dry lightning Impulse voltage withstand
 - Switching impulse voltage withstand
 - Thermal stability
 - Temperature rise
 - Cantilever load withstand
 - Tightness
 - External pressure



Outlook

- Steep increase in the demand – several utility specifications are being changed
- Several upgrading projects

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