Electricity Transmission

Silicon Oil Research

LCNI
October 2019

nationalgrid

Silicon Oil Research

- Driver
- Research Projects Started by NGET
- Outcomes to date
- Further Information and Getting involved
- Q&A

01

Driver

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Frequent issues with XLPE 132 kV Terminations

Driver: Multiple large scale replacements in the UK and World wide over the last 30 years

- Operating Environment of CSE is not well understood
- Silicon oil is frequently used but not well understood
- Impacts of electrical design & contaminants was not well understood
- Specifications for cable accessories appear to be limited

NGET wanted to understand the assets and materials in more detail to inform our specifications and practices – leading to a large research programme focused on silicon oil

Electricity Transmission

02

Research Projects

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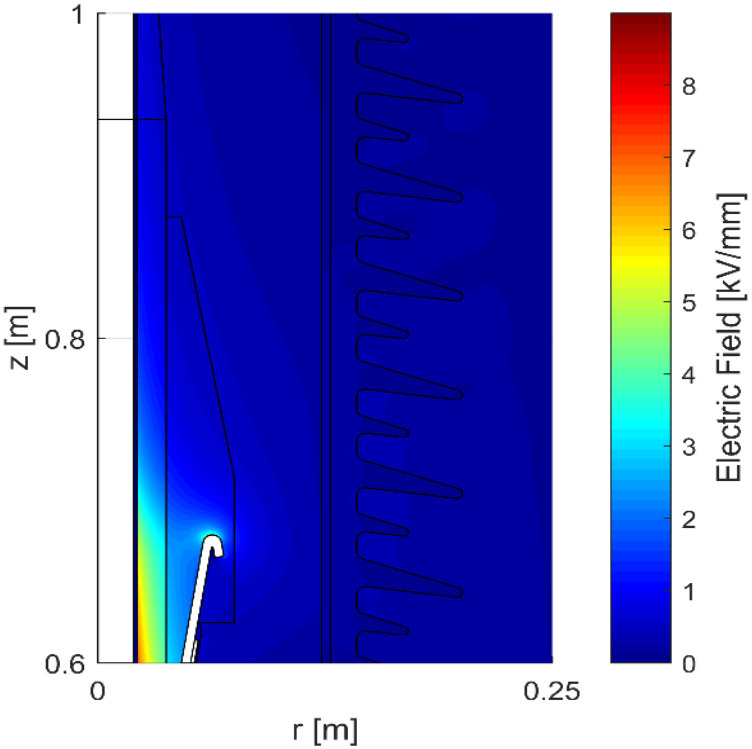
Liquids for Cable Sealing Ends (LiCaSE)

Aim: To inform cable system specifications for oil filled XLPE CSEs

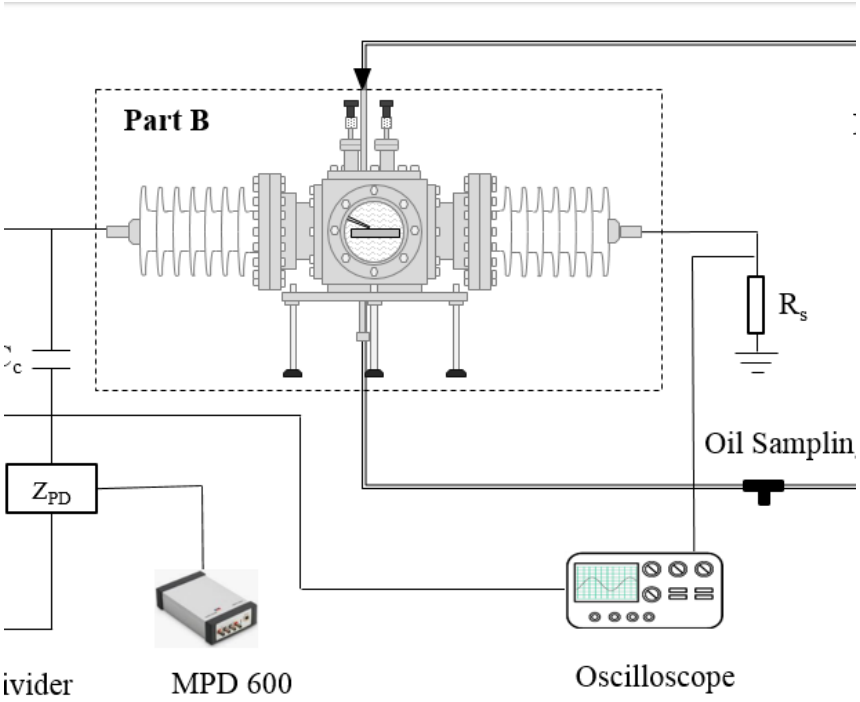
- Understand the operating environment of the CSE in more detail through detailed modelling.
- Investigate chemical interactions within cable sealing ends and identify possible degradation modes.
- Evaluate different oil types and rank performance.
- Identify methods of detecting poor quality oil on site.



Electrical Characterisation of Silicon Oil (ECOSO)

Aim: To understand the partial discharge characteristics of silicon oil and solid insulation.

- Investigate and understand PD in silicon oil
- Investigate the impact of stress cone materials on the PD
- Understand the tracking process along
- Understand DGA development in the oils
- To better inform condition monitoring practices



03

Outcomes to date

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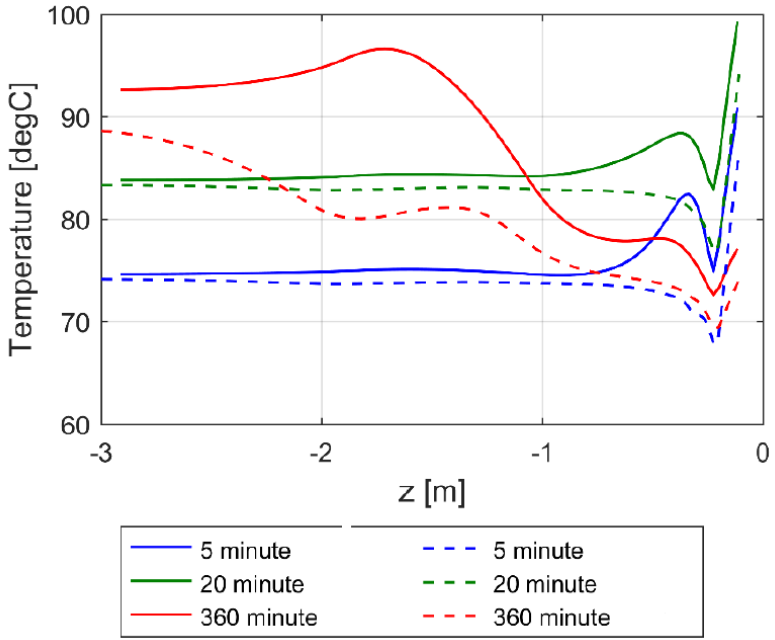
LiCaSE - COMSOL Modelling of terminations

Aim: to determine the normal operating temperatures & electric fields

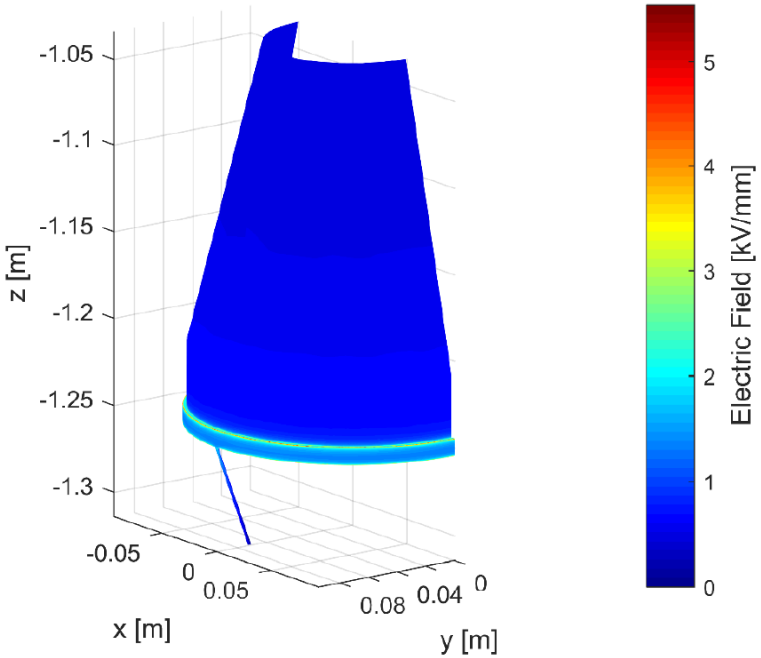
- Significant temperature rise only occurs under emergency rating scenario
- Worst case the CSE will reach 95ºC; could be higher with a different ambient and direct sunlight
- Under full load – internal temperatures only ready around 60 ºC
- Under ‘typical load 30%’ the temperatures are around 30-40 ºC internal temperature



LiCaSE - COMSOL Modelling of terminations

Aim: to determine the normal operating temperatures & electric fields

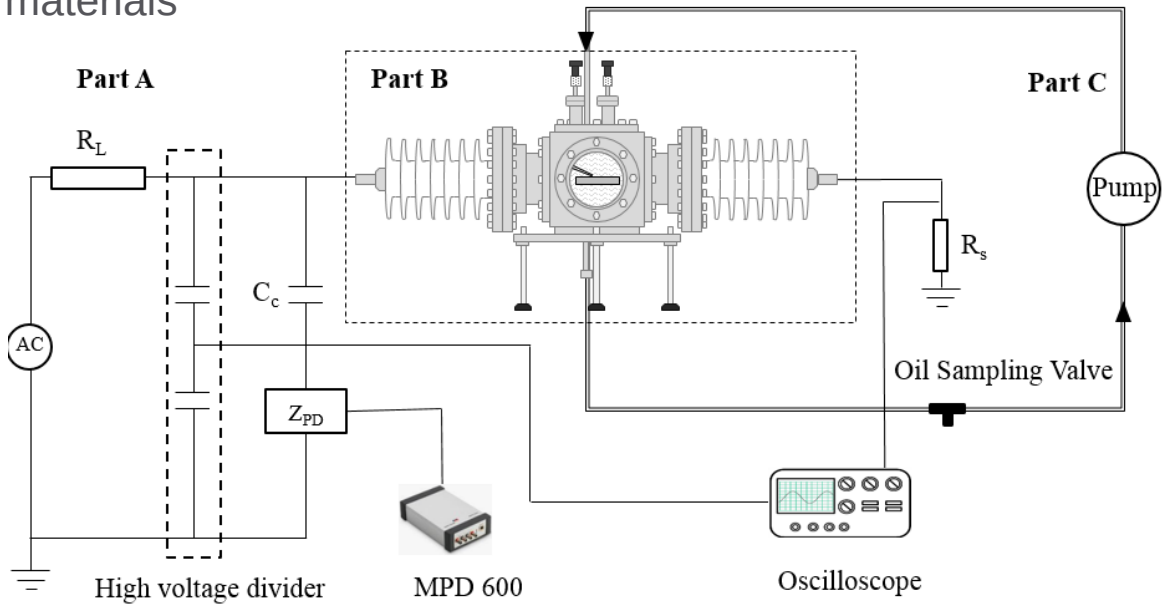
- Different designs have different peak electric fields
- Low stress design typically operate around 1 kV/mm
- High stress designs also exist – which may have inferior performance.
  - *Debris collection*
  - *Increased probability of PD / Tracking initiation*



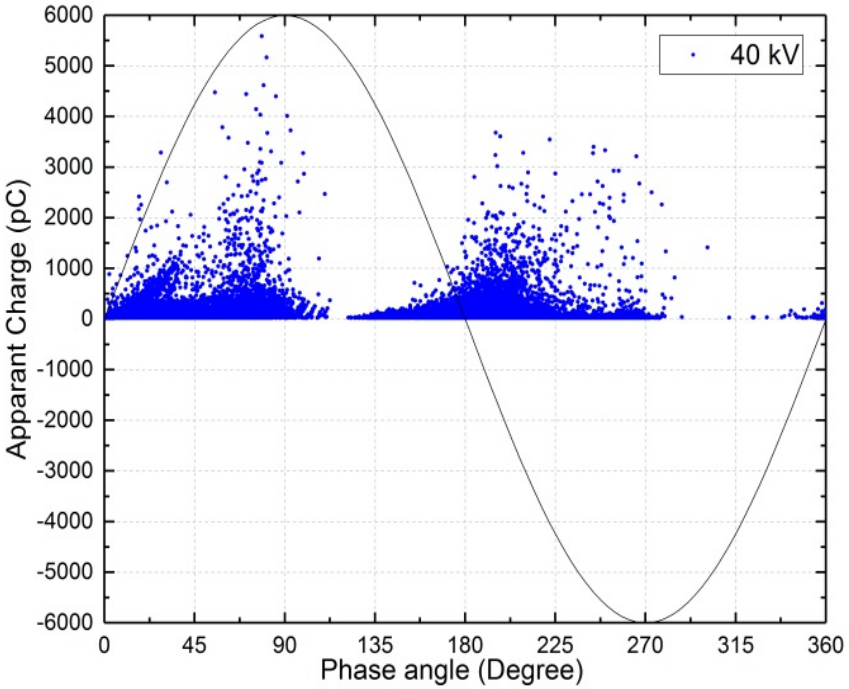
ECOSO - PD testing of Silicon Oil

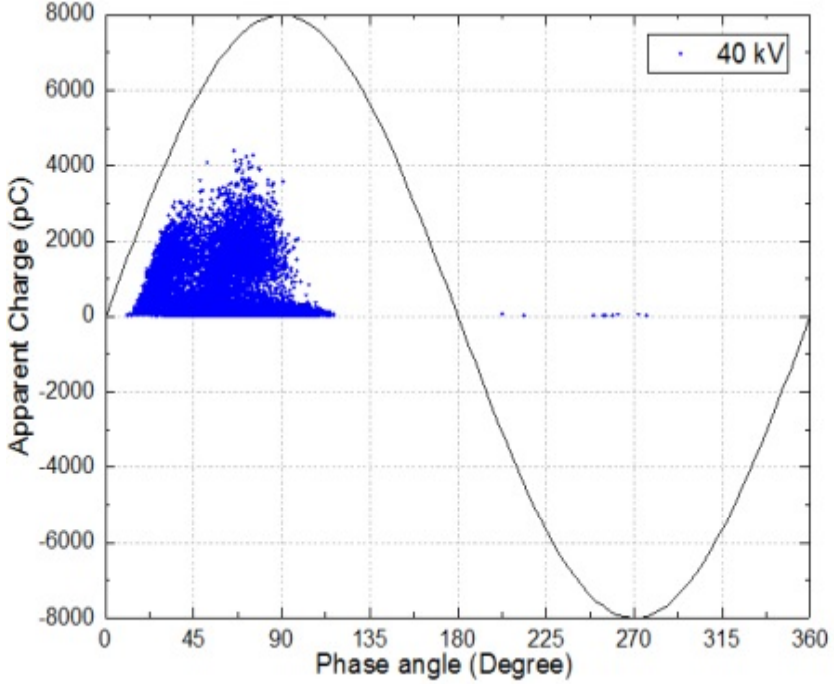
Aim: To understand the behaviour of PD in silicon oil

- PD testing of the Oils in isolation
- Then introduce solid insulation materials

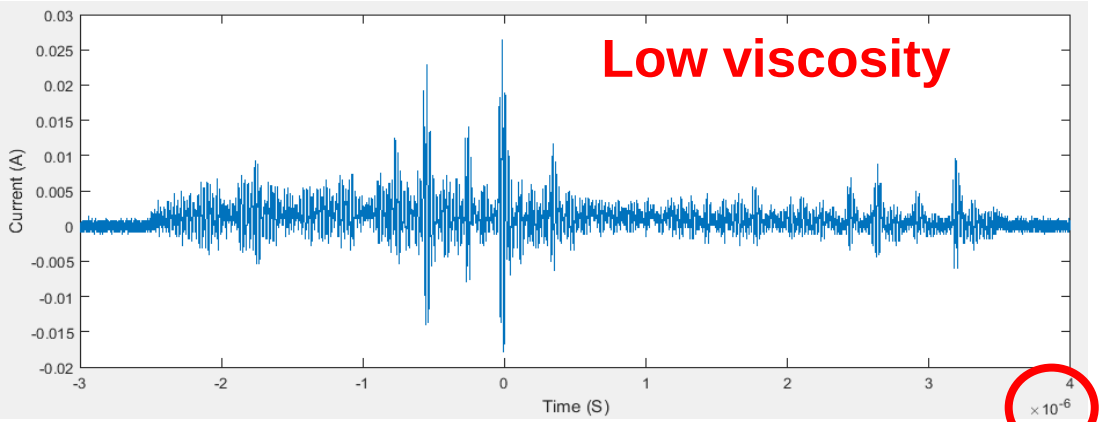


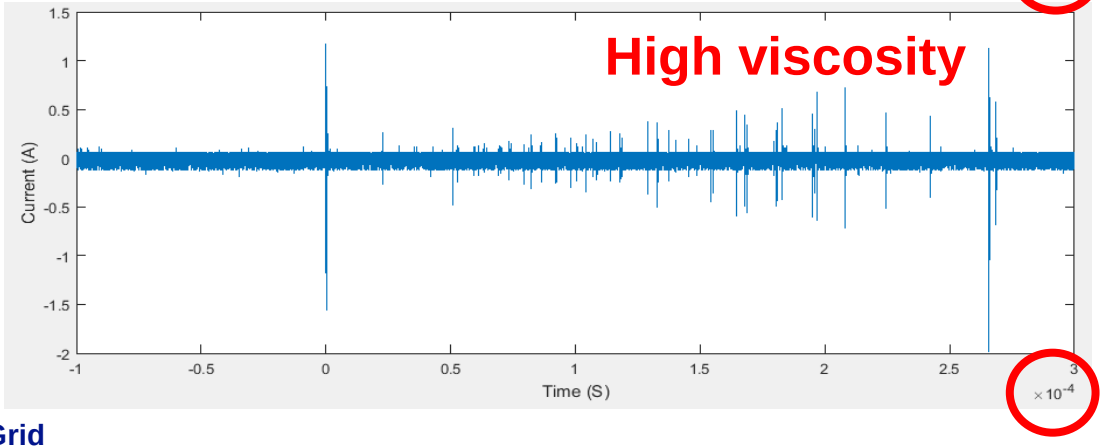
Which one is PD?

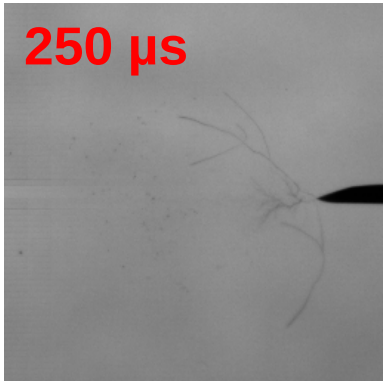




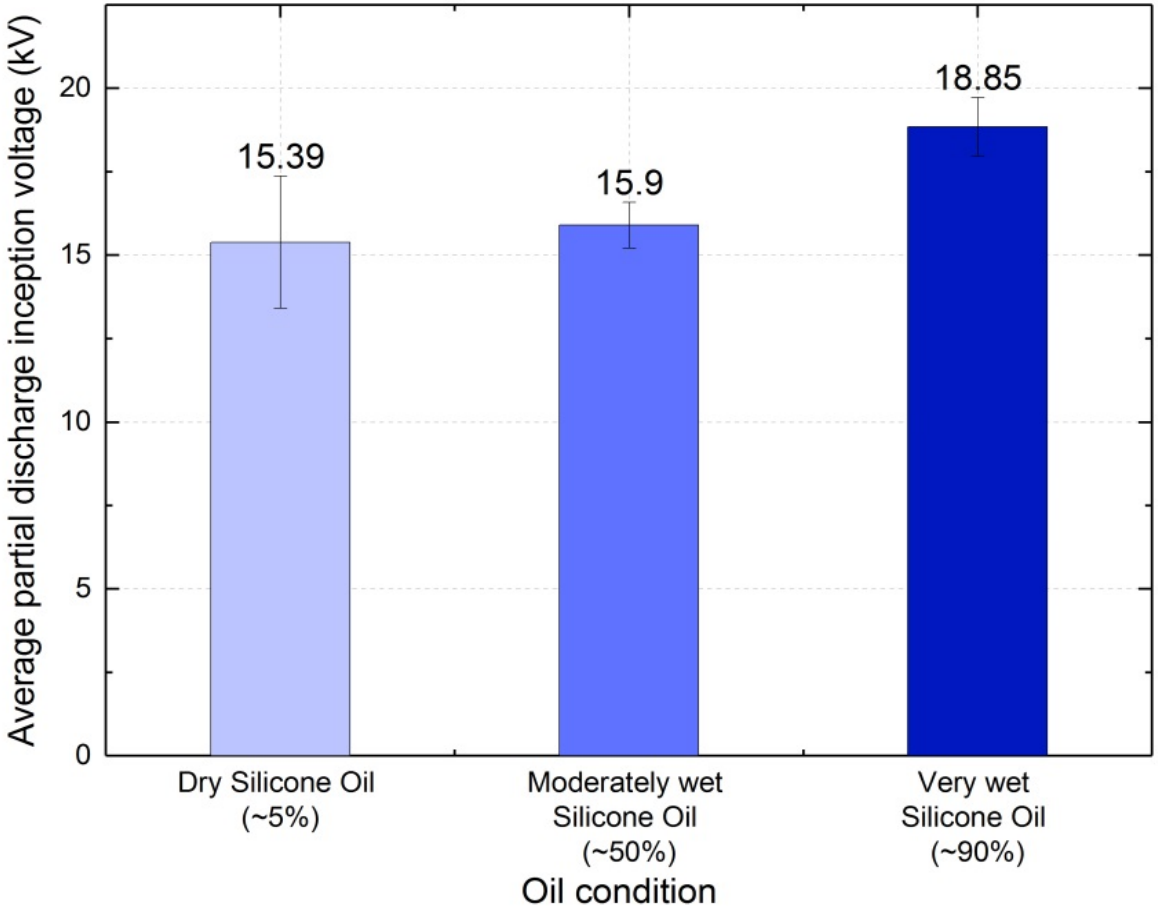
Viscosity impacts the PD pattern



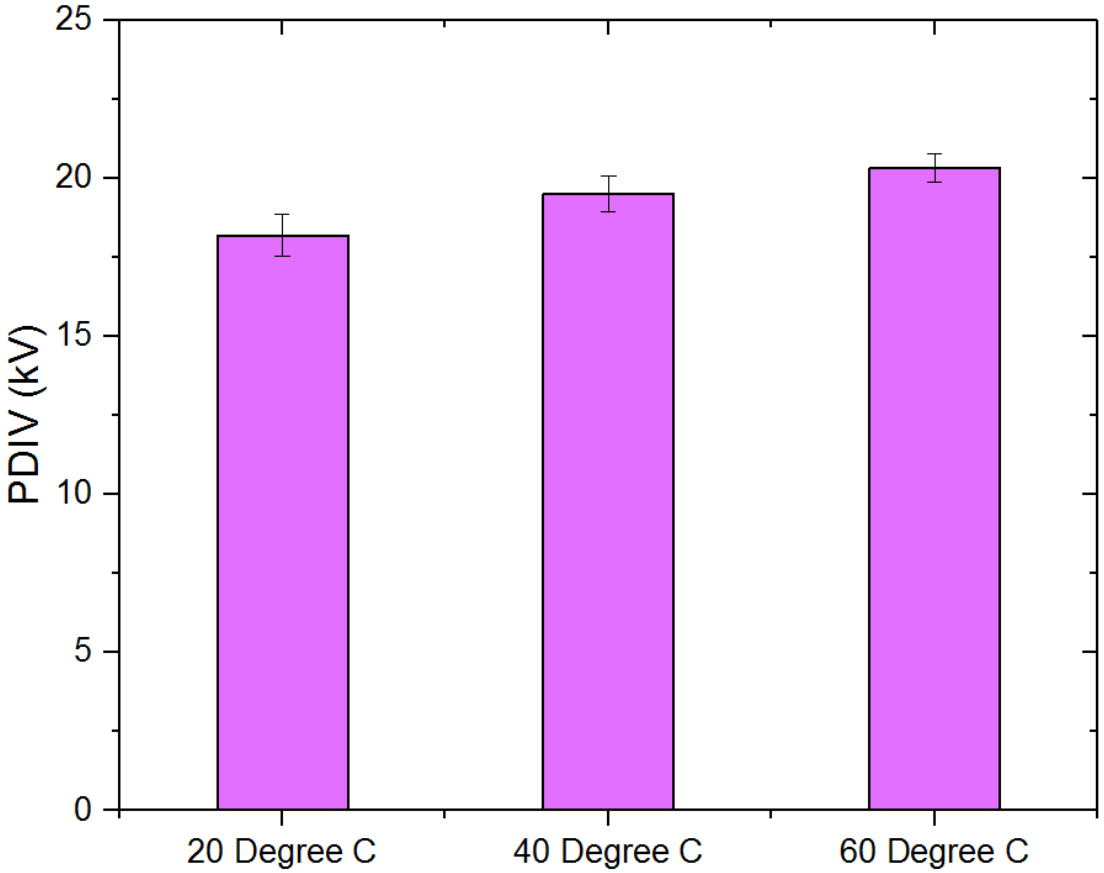




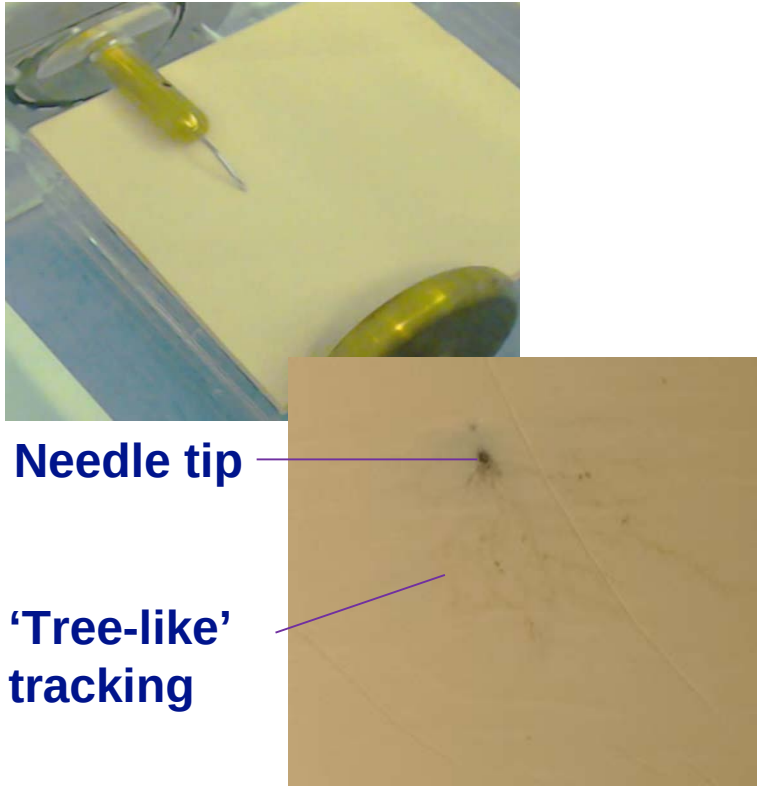
Moisture increases PDIV



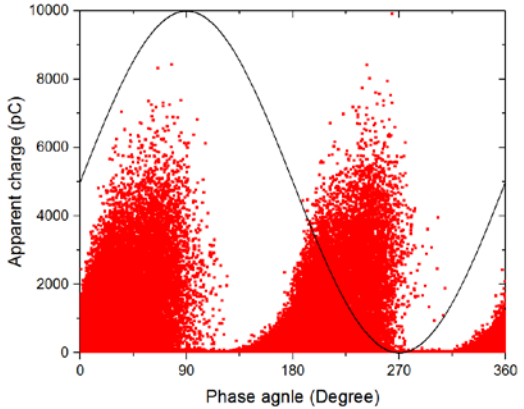
Temperature also increased PDIV slightly



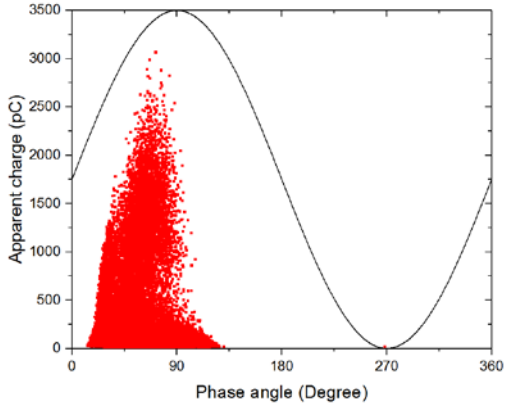
PD Characteristics of Silicon Oil & Solid Insulation



Preliminary results

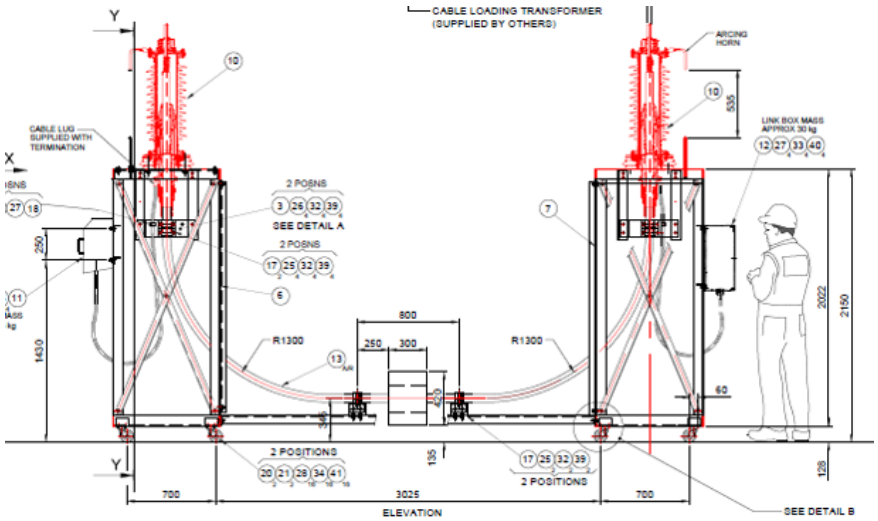


With EPR sheet



Without sheet

What's Next?


CABLE LOADING TRANSFORMER
(SUPPLIED BY OTHERS)
ARCING HORN
CABLE LUG SUPPLIED WITH TERMINATION
LINK BOX MASS APPROX 30 kg
2 POSNS
SEE DETAIL A
R1300
R1300
800
250
300
535
2022
2150
1430
250
60
135
128
2 POSITIONS
2 POSITIONS
700
3025
700
ELEVATION
SEE DETAIL B

What to find out more?

Further information can be found here:

ECOSO:

https://www.smarternetworks.org/project/nia_ngto009

LiCaSE:

https://www.smarternetworks.org/project/nia_ngto010

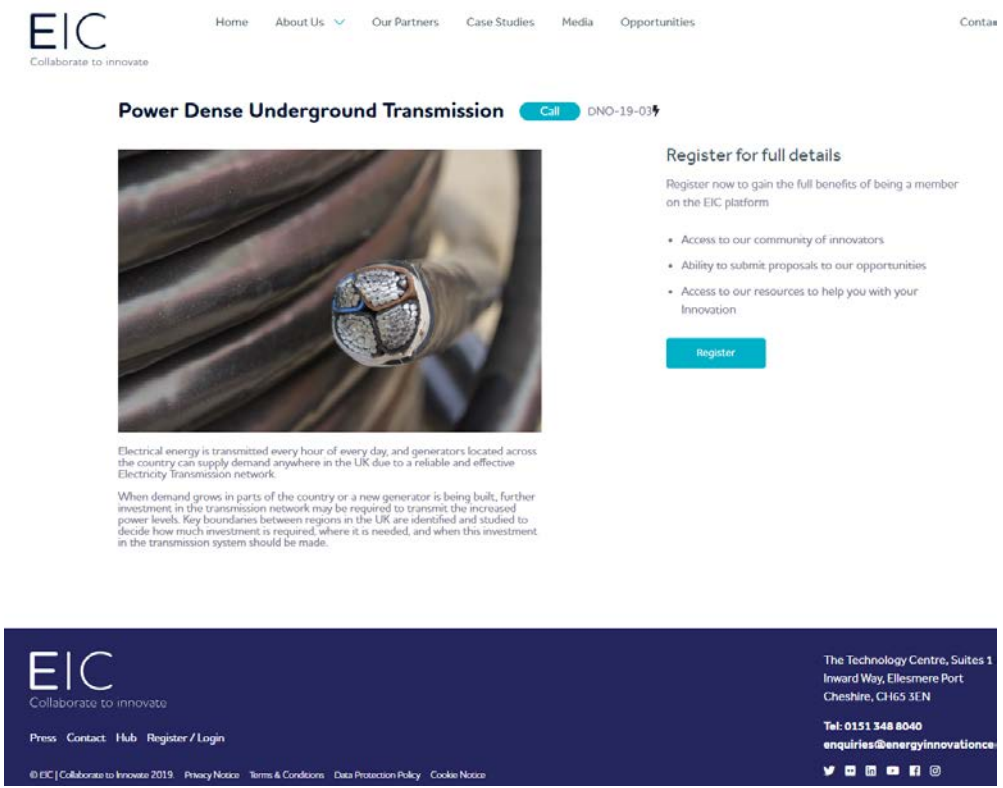
Novel O-Ring Designs (NORD) – Investigating the performance of CSE O-rings

https://www.smarternetworks.org/project/nia_ngto032

- 3 Papers are also currently under review for publication

Want to get involved in Innovation?

- Go to: www.ukeic.com



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04

Q&A

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