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HOW WILL LARGE SCALE PV CHANGE THE USAGE OF POWER TRANSFORMERS?

The grid was originally set up to transfer energy from large fossil fuelled generators to load centres. Now, large scale PV is being placed inland where land is cheap and solar insolation is best. However, the infrastructure in this area is not very extensive. How does the utility make the best use out of their existing power transformers, while protecting these publicly owned assets and preventing unnecessary costs to the community?

Dr. Dan Martin, Australasian Transformer Innovation Centre, the University of Queensland

In 2016 the NSW utility Essential Energy approached us to discuss how they could allow a generator to connect PV solar to a mid-life zone substation. Although they could install new transformers, the utility has a responsibility to minimise costs to the community by seeking innovative engineering solutions which would result in savings.

The first step of this project was to model the effects a solar farm would have on the residual life of paper insulation. A challenge faced by many distribution utilities is that quite often monitoring is not very extensive. Consequently, load models are applied to calculate winding temperature, and then oil tests are used to estimate the residual insulation life. At the time, the ageing models developed were used in-house. The IEC 60076/7 transformer loading guide has since been updated, in 2018, reflecting this new understanding, which gave us the confidence and satisfaction to continue to develop.

The Queensland utility Ergon Energy approached us as they had a similar need in their use of power transformers. Several large scale PV generators have been installed in Western Queensland, where generation is exported to the National Electricity Market via the subtransmission network. Understanding the relationship between loading and life remaining will help the utility optimise the use of public assets while ensuring value for money to the community.

In our work we looked at changes in dissolved gases which could indicate unexpected over-temperature, and also tracked the increase in oil furan content. A model was set up to calculate the average winding temperature from the change in furan concentration, and then this average temperature was compared to the long-term load to check for consistency.

Experience of running motors powered by an inverter has shown that power discharge can occur in the insulation, caused by the fast rise time of the inverter’s output, and repetition rate. To verify that a similar effect is not occurring from the fast rise time of the inverter used in a PV farm, the dissolved gas content of the transformer oil is also being tracked and evaluated.

An important part of any project is the dissemination of knowledge and findings, which the industry can use to update their policies to reflect. Included in our communications strategy was to present at the 20th Anniversary TechCon Aus-NZ conference. This gave the opportunity to discuss this work with industry experts, network with other stakeholders, and update the project direction based on this input.

As Australia transitions to a renewables-dominant future the industry will undoubtedly innovate to adapt the grid. Our mission is to help this transition by working in partnership with our sponsoring organisations.

Dr. Martin presents “Assessing and mitigating the impact of large-scale solar and wind farm inverters on power transformers – a preliminary investigation” at the 20th Anniversary TechCon Aus-NZ conference, Sydney, April 2019.

EFFECTS OF POWER QUALITY ON INSULATION

The effects of power quality on insulation can be divided into two areas: one is on further heating, and the other is on electrical activity. Harmonics are known to increase eddy currents and stray losses in transformers, which may heat up the transformer further than expected. Currently, there are investigations into high frequency harmonics to determine effects on insulation, where these harmonics have a frequency higher than those typically measured by a utility.
MASTER CLASS:
POWER TRANSFORMER INSULATION

The Australasian Transformer Innovation Centre (TIC) University of Queensland, is proud to announce its first CPD master class.

Power transformers are the most expensive plant in a high voltage substation. The purchase price of power transformers ranges from $10k to $7m. The heart of a power transformer is the insulation. The insulation condition has major impact on the life and reliability of a power transformer.

However, the material science of cellulose insulation and insulation electric design principles are often the least understood area for those who specify, procure, operate, maintain and manage power transformers.

LEARNING OUTCOMES
To understand the function(s) of pressboard and paper in power transformers. To become acquainted with the key insulation components of power transformers. To get to know the characteristics and challenges of cellulose insulation with regard to:
1. cellulose insulation manufacturing
2. insulation electric design principles
3. transformer windings sizing (drying), static winding clamping and oil impregnation
4. operation: aging phenomena

Learn about transformer secret killers, know and assess the key parameters which determine the end-of-life of transformers.
To be exposed to:
• Alternatives to paper and oil.
• Making things easy. Non-uniform insulation and centre entry.
• Understanding how the test requirements set what insulation is needed.

To be acquainted with dielectric withstand, partial discharge inception and breakdown in transformers including:
1. Breakdown Behaviour – Initiation, Propagation, Breakdown
2. Insulation Co-ordination and Waveshape (BL, SIL vs AC)
3. Puncture and Creep Breakdown

Understand winding types and their application. Learn about dielectric dimensioning:
• Major Insulation (between windings and to earth)
• Minor Insulation (within windings)

Understand the differences between mineral oil and esters:
• Implications for power transformer insulation design
• Thermal behaviour
• Moisture interaction
• Benefits and risks

Be acquainted with dynamic short circuit behaviour in transformers and insulation response.

*Note the detailed course program/learning outcomes for each city will be shown on the TIC website.

TARGET AUDIENCE
The course will deliver theoretical background information with “hands on” practical experiences suited to procurement, asset strategies, operations and maintenance managers, and engineers in generation, transmission and distribution, renewables, manufacturing, mining, industrial and infrastructure organisations.

COURSE DATES/PRENSETERs
Brisbane 17-18 October 2019 Christoph Krause, Michael O’Brien
Sydney 21-22 October 2019 Christoph Krause, Rob Milledge
Melbourne 24-25 October 2019 Christoph Krause, Deepak Maini, Arun M athur, Bijay Lal

The Melbourne course includes a factory tour of Wilson’s world class manufacturing facilities. This tour will demonstrate the key aspects of transformer designs, construction, testing and quality pertaining to transformer insulation.

PRESENTERS
This master class will be presented by experts in both cellulose insulation and power transformer design: Christoph Krause (ABB), Michael O’Brien (GE Grid Solutions), Rob Milledge (ABB Australia), Deepak Maini (Wilson Transformer Company), Arun Mathur (Wilson Transformer Company), Bijay Lal (Wilson Transformer Company).

PRICING
TIC MEMBERS
PLATINUM Member $1,322
NON TIC MEMBERS
One Attendee $1,678
Three or more Attendees
(10% Discount) $1,510

Notes
All prices are exclusive of GST.
TIC Members using complimentary attendance are requested to register by sending an email to: m.warach@uq.edu.au

ONLINE REGISTRATION/COURSE PROGRAMS/COURSE VENUE & DETAILS
Please visit http://www.tee.uq.edu.au/ tic-cpd

Photo courtesy Weidmann
Transformer Cleanbar Assembly

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