electricity north west

Bringing energy to your door

Oil regeneration

Research carried out by Electricity North West suggests that oil regeneration could extend the life of a transformer by approximately ten years.

Electricity North West has pioneered a new, environmentally friendly approach to regenerating oil which extends the life of our power equipment and keeps costs down for customers across the region.

As the only network operator with a dedicated oil reprocessing plant in the UK, we already recycle 1.5 million litres of oil every year which is used to insulate and cool transformers.

Now, as part of a groundbreaking innovation project, we have improved the oil recycling process and are using it to extend the life of high voltage transformers which provide power to thousands of local homes and businesses.

Background

Oil is a natural material which ages due to operating environment and transformer properties. The oil affects the insulation in the transformer and the insulation affects the oil, hence the condition of the oil impacts the expected life of the transformer. The condition of the oil can be measured by sampling and analysis.

Aged oil demonstrates higher concentration of oxidation and acids. By removing the ageing products, the oil regeneration process significantly improves the condition of the oil, rendering it as close to new as possible. By regenerating the oil in this way, we can extend the life of a transformer by several years.

The process is performed while a transformer is in service to achieve maximum effectiveness, with minimum impact on site operations.

Our oil regeneration projects

Oil Regeneration

November 2011 – December 2014

Funded under the Innovation Funding Incentive (IFI), this project investigated transformer oil regeneration as an alternative transformer management option. The technique offered the greatest opportunity to improve the transformer's health index and thereby extended the operational life of the transformer.

Combined Online Transformer Monitoring

September 2014 – September 2022

This Network Innovation Allowance (NIA) project aims to validate the ten-year life extension through the analysis of data collected from transformers that have undergone oil regeneration.

Optimising Oil Regeneration

February 2016 – February 2022

This NIA project builds on the above research and will identify the optimum window for oil regeneration in the life cycle of a transformer.

These projects will allow us to develop our understanding of the effects of life extension on transformer failure modes and maintenance requirements.

Method

Oil regeneration is conducted in two stages. The first stage consists of the traditional cleaning process which is already widely used in the industry. But this approach provides only short-term benefits of around one to two years.

Our approach is to carry out a second stage cleaning process at a high temperature which improves the extraction of the ageing products from the oil and the insulation.

Early attempts revealed that where the oil regeneration process was completed too quickly, the core of the transformer was not raised enough and the results were temporary. In the months following the oil regeneration, the oil condition returned to its pre-regeneration levels, leading us to conclude that the process required modification and the core temperature increased and maintained at 65-85°C. Figure 1 shows the results of dissolved gas analysis (DGA) for early oil regeneration attempts.

To achieve this higher temperature we 'lagged' the transformer to prevent heat loss. The brown areas in Figure 2 show where the lagging was applied.

Using the new process with the higher temperature produced the DGA results shown in Figure 3.

Figure 1: Unsuccessful oil regeneration

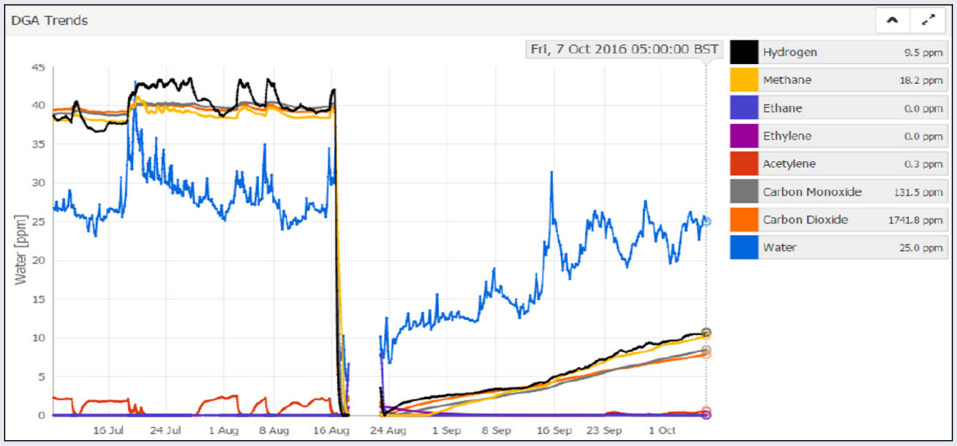


Figure 2: Lagging of the transformer

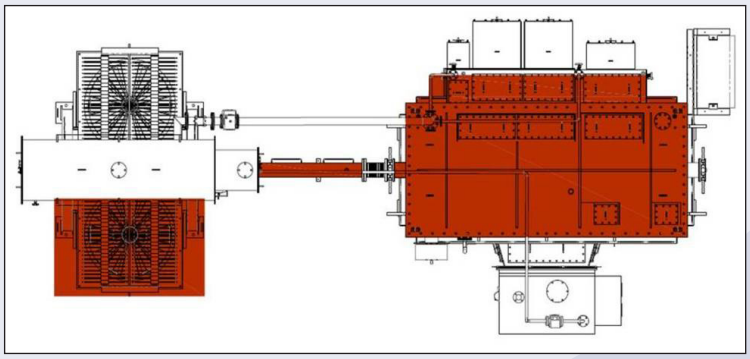
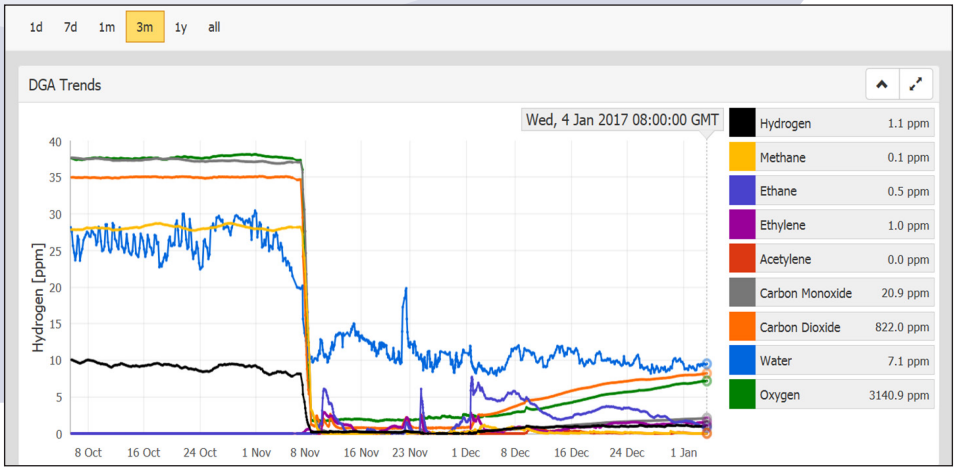


Figure 3: Successful oil regeneration



Continuing analysis of the transformer revealed that the DGA trends remained at low levels which validated the success of the oil regeneration process.

As part of our Combined Online Transformer Monitoring project, we will validate the data and calibrate the life extension results. This will be done once online data has been recorded for a significant time period to ensure the results are reliable and consistent.

To help with the data analysis we have developed a visualisation tool which produces reports on the condition of our transformers. This report consists of high level red, amber and green status management reporting and provides the ability to analyse more in-depth data. The reports can provide a transformer fleet overview, a high level short-term action check list, a summary of fleet condition and exception reporting, and site specific details.

Our Optimising Oil Regeneration project builds on the above research and explores the best time to carry out oil regeneration. This will determine whether carrying out the process earlier, rather than at end-of-life, can reduce the rate of degradation and further extend the life of a transformer.

To achieve this we will monitor twin transformers at 13 sites at various stages of their lives. At each site, the oil will be regenerated on only one of the transformers so we can compare the oil condition and subsequent life extension over time.

The outputs of these projects will allow us to optimise our asset management strategy for transformers.

Figure 4: Fleet overview

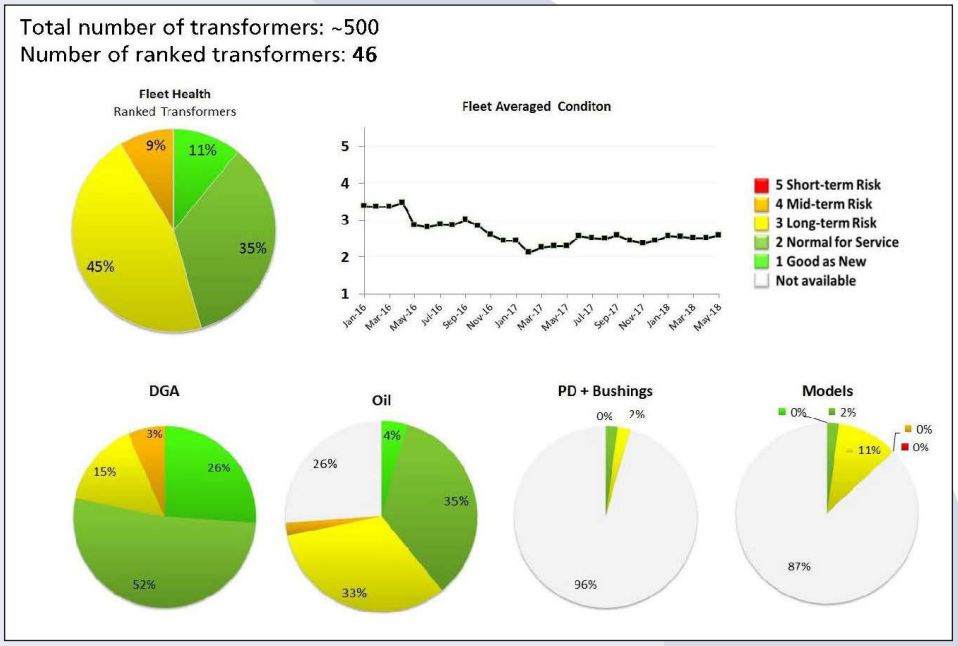


Figure 5: Summary of fleet condition and exception reporting

Activity required	Transformer	May 2018 Condition	Previous condition	Comments	Monitoring system status
	Hazel-Grove T1	4.30	4.30	Signs of significant oil aging mainly due to Acidity and CO. Oil treatment should be planned.	
	Carleton T11	4.19	-	High Acetylene but stable. Moisture level is elevated. DGA and Oil quality analysis required for initial reference and C2H2 cross check.	
	Chorley South T12	4.08	⇩ 4.10	Although the online monitoring is not showing any critical condition, as expected after oil treatment in 2016, there are suspicious oil quality data from the last oil sampling that requires to be checked. It is necessary to repeat oil sampling for moisture content and BDV ASAP.	
	Newton Heath T11	3.31	⇧ 3.28	There are signs of oil aging. Oil regeneration could be planned but not urgent. Moderate moisture content in oil leading to low BDV.	
	Castelton T11	3.27	⇧ 3.22	There are signs of oil aging. Oil regeneration could be planned but not urgent. It is necessary to repeat DGA analysis in lab because of suspicious Acetylene concentration likely due to bad oil sampling.	
	Tardy Gate T12	3.19	⇧ 3.17	Moderate moisture content in oil decreased BDV. Moisture in oil from lab is different from online data. It is necessary to repeat oil sampling for moisture content and BDV.	
	Hindley Green T12	3.19	3.19	High Hydrogen concentration may be sign of PD. Lab DGA results require update (the last DGA results dated by 17/11/2016). Oil quality test required.	
	Barton Dock Road T12	3.18	⇧ 3.14	There is relatively low breakdown voltage obtained in lab that affects insulation strength. Sample is suspicious because it was taken right during/after oil regen. It needs to update DGA and Oil Quality results.	
	Portwood T12	3.17	⇧ 3.13	Signs of oil aging. No action required.	
	Egremont T1	3.17	⇩ 4.16	Elevated moisture concentration both in oil and cellulose insulation. The results are obtained by models calculation.	

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