EcoStruxure Transformer Expert

Graphical representation of DGA results through the ETE package

Presented by: Presenter’s Name

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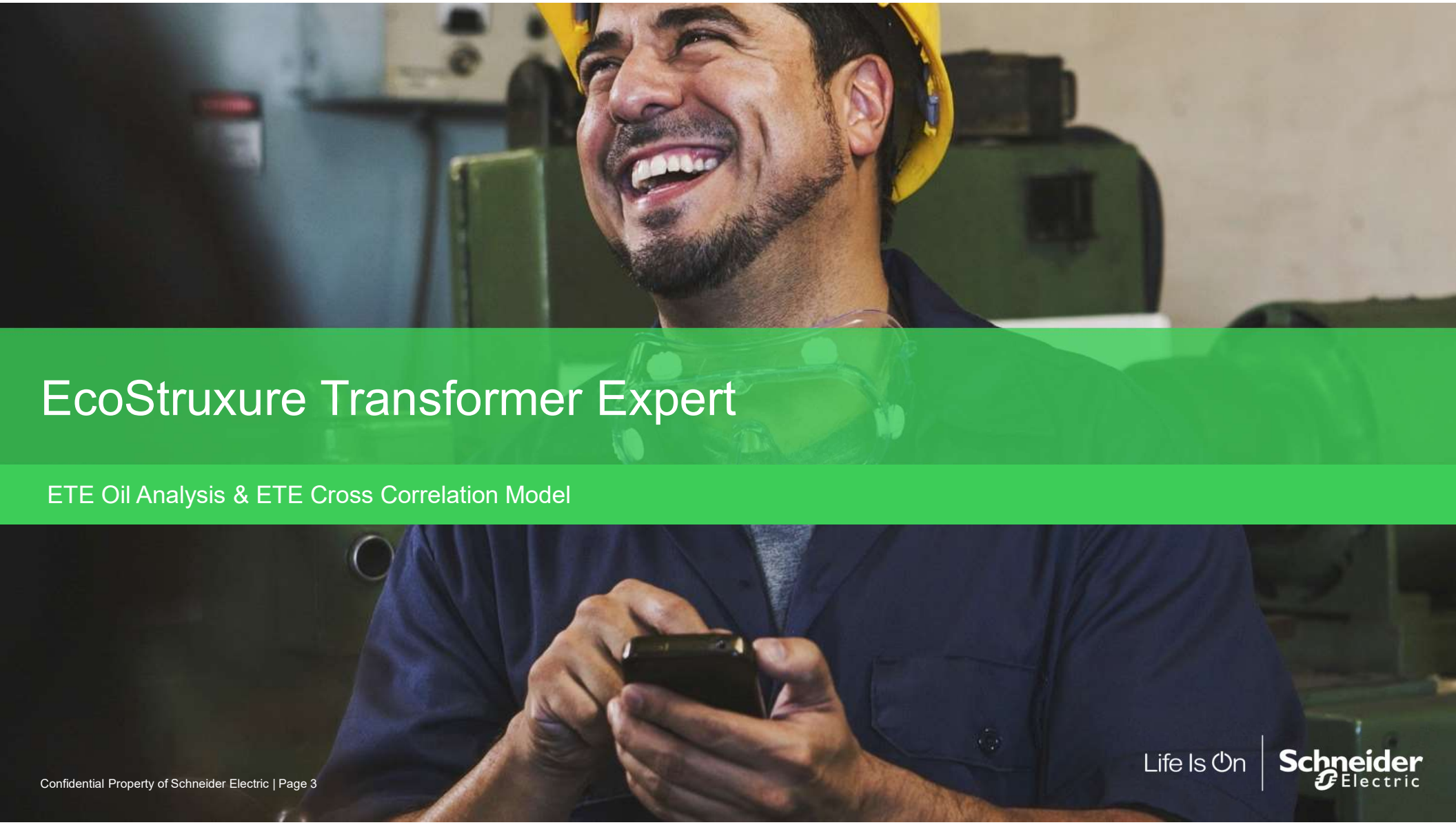

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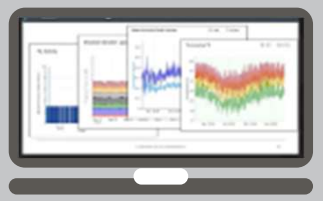
ETE Oil Analysis & ETE Cross Correlation Model

Schneider Electric: EcoStruxure Transformer Expert

How to monitor your transformers risks



Continue to perform **oil sampling** and testing.

Install innovative sensors to record data online.

ETE analyses and correlates data in a single view to anticipate irreversible trends.

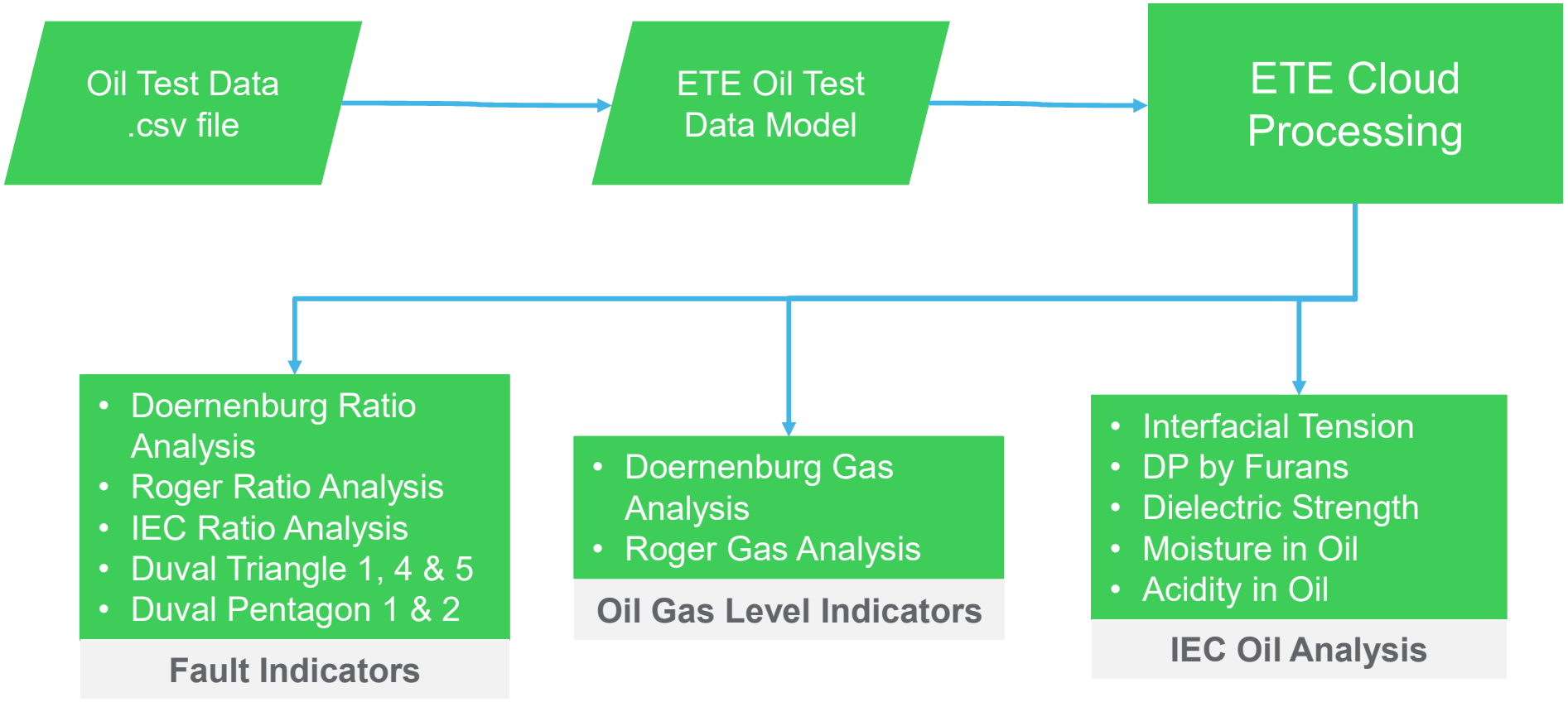
ETE Oil Analysis & Insight Interaction Architecture

An ETE software model that enhances the data platform available for ETE Insight analysis

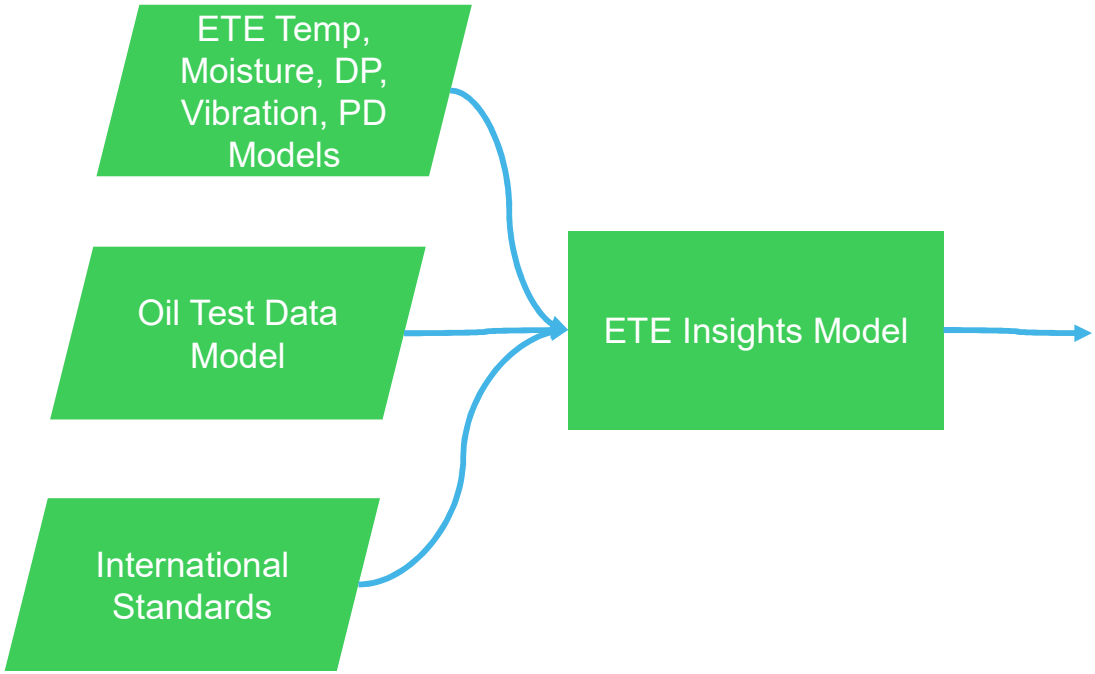
Objective

- A low cost central repository for oil test data
- Make use of all readily available data to drive better analysis of Tx status
- All data mapped against well accepted International standards
- Deliver a single site for oil test data collection
- Provides easy access to oil test data via unlimited cloud based access for corporate users
- Secure password protected data
- Easy & automated upload process using oil test laboratory format (.csv file)

Offline Oil Test Data Model



Oil Test Data & ETE Insights Cross Correlation Model



CONCERN	CONDITION INDEX	DATE OF EVENT
High CO2/CO : 2.97 D	Solid Insulation D	24-Nov-2021

Threshold: < 3.0

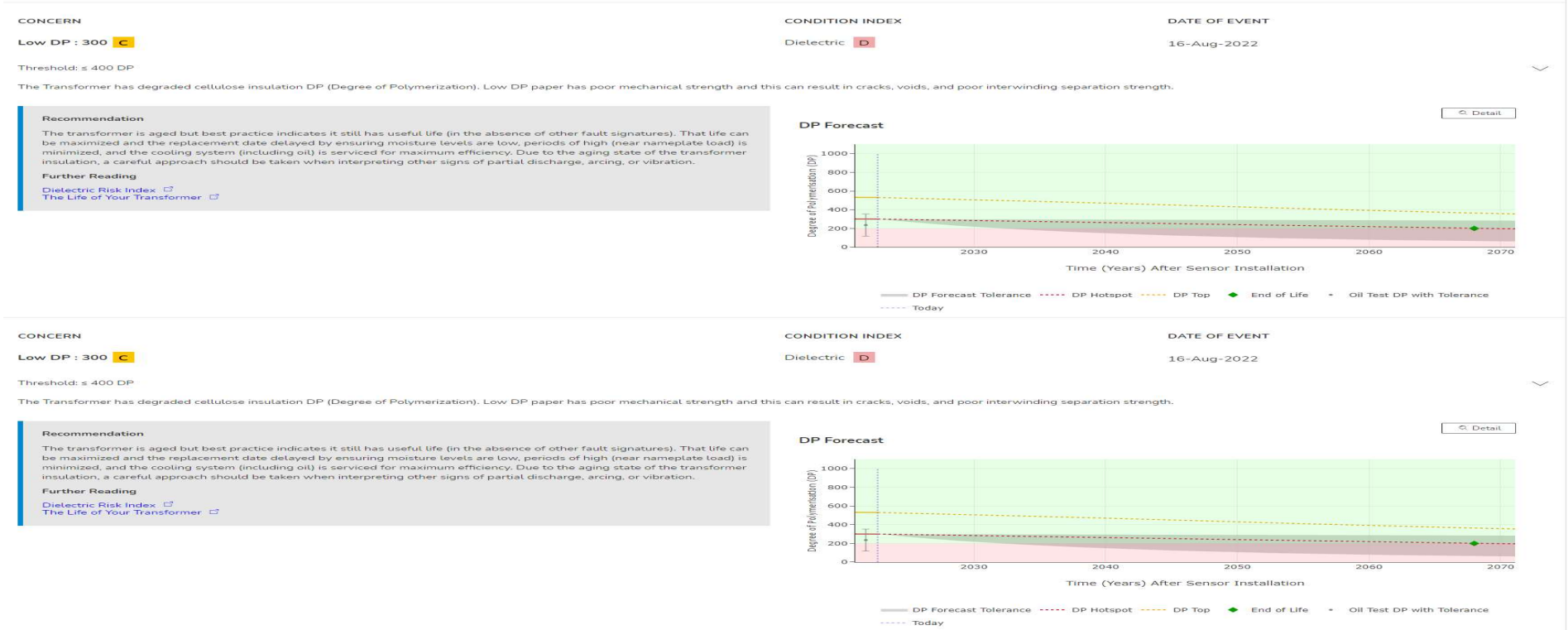
The transformer is generating significant gas associated with low temperature (< 150°C) aging, possibly in a concentrated location. This could be due to a fault, excessively high operating temperatures, or corona affecting the cellulose insulation.

CONCERN	DGA ANALYSIS	DATE OF EVENT
Thermal Fault < 700 °C		16-Dec-2021

Rogers analysis indicates that a medium temperature thermal fault exists in the transformer. This type of fault is very dangerous and likely indicates that power current is involved.

Oil Test Data & ETE Insights Cross Correlation Model

Below is an example of how ETE provides comprehensive insights and recommendations to avoid transformer failure.



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Oil Test Data Output - International Standards

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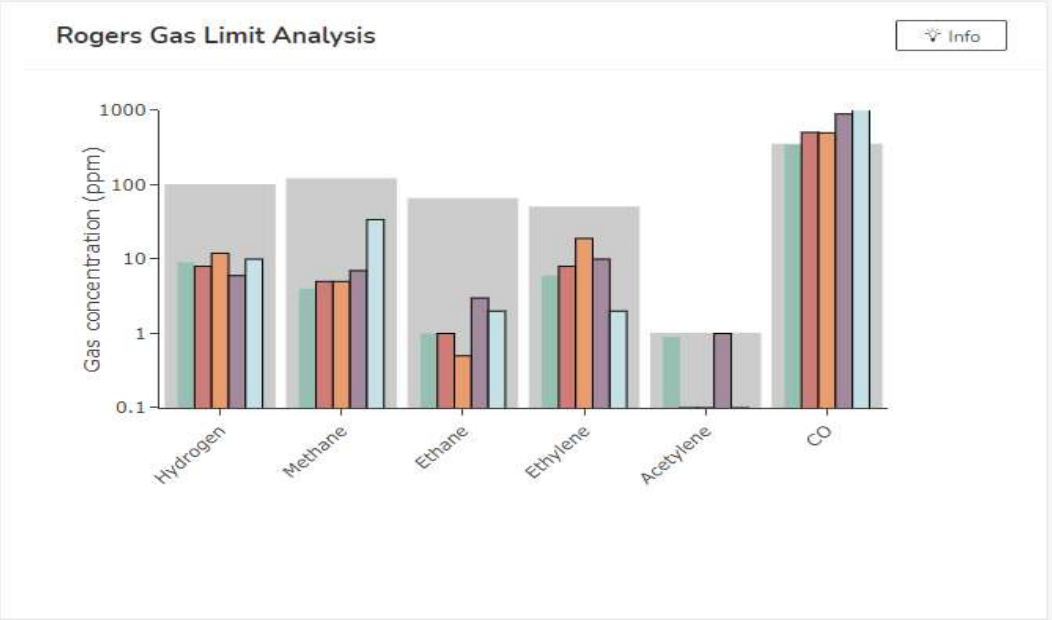
Roger Gas Limit Analysis

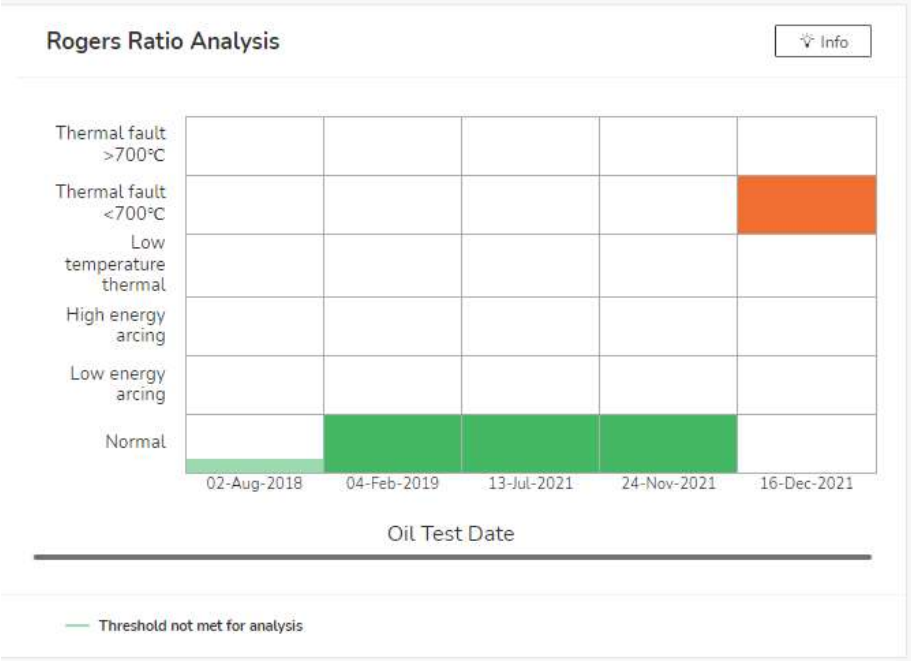
The ETE platform generated graph from the concentration of H_2, Methane, Ethane, Ethylene, Acetylene and CO in each oil test.



- Only applicable if at least one of the gases is at a concentration above the benchmark value.
- If there are no gases meeting this requirement, the analysis is not applicable.
- The background grey bars show the benchmark value of each gas.

Roger Ratio Analysis

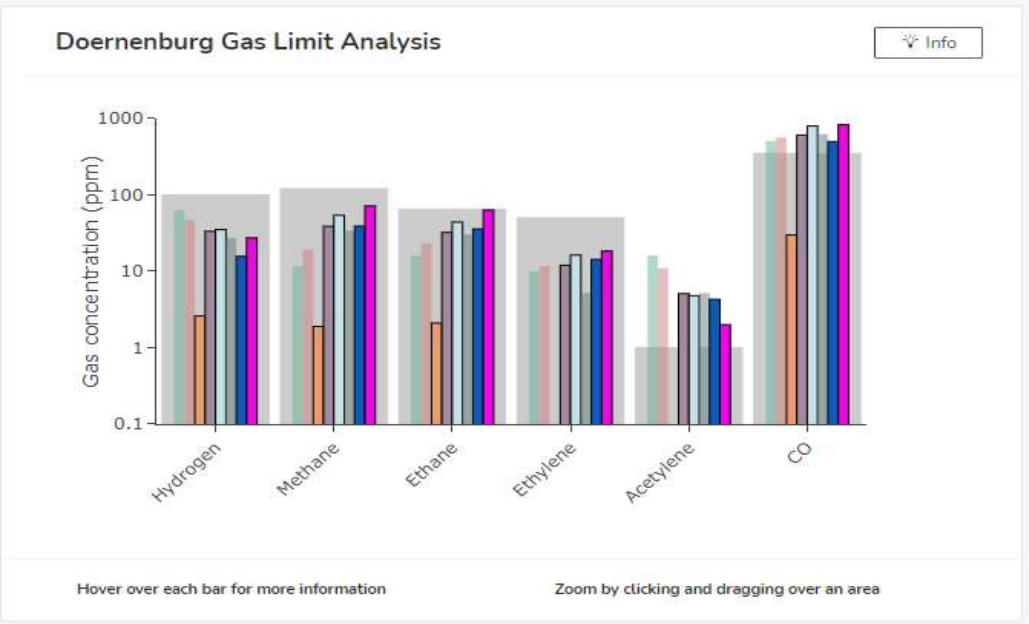
Using Roger Ratio Analysis, ETE provides insights into potential faults in the transformer.



- The severity of the fault is represented by colour.
- If the required threshold is not met for the analysis, the results will be shown as a thin green line.
- Please note these graphs provide an analysis using IEC & IEE standards. The limitations described in the relevant standards apply.

Doernenburg Gas Limit Analysis

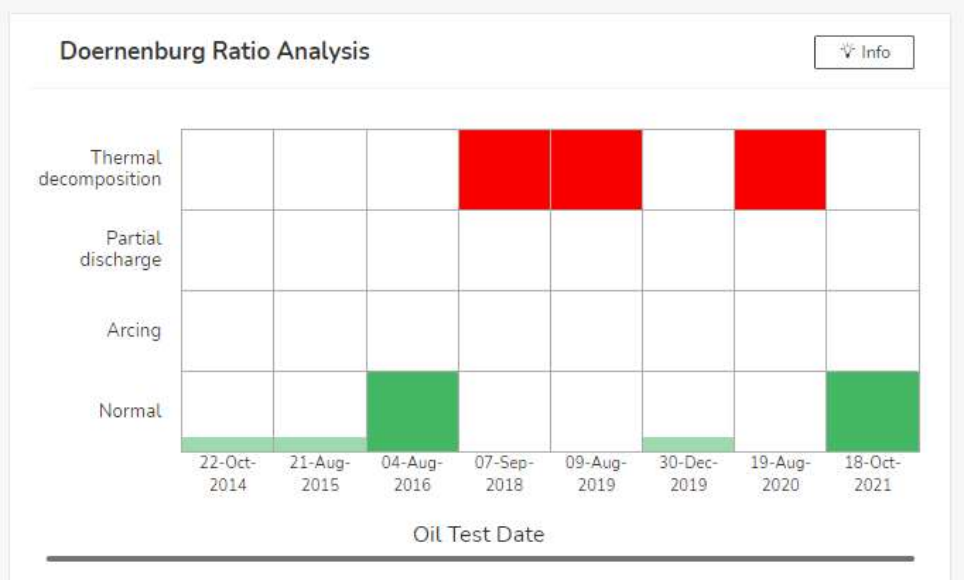
The ETE platform generated graph from the concentration of H_2, Methane, Ethane, Ethylene, Acetylene and CO in each oil test.



- Applicable regardless of gas concentration level.
- If a gas concentration is under the benchmark value, it is diagnosed as ‘normal’.
- The background grey bars show the benchmark value of each gas.

Doernenburg Ratio Analysis

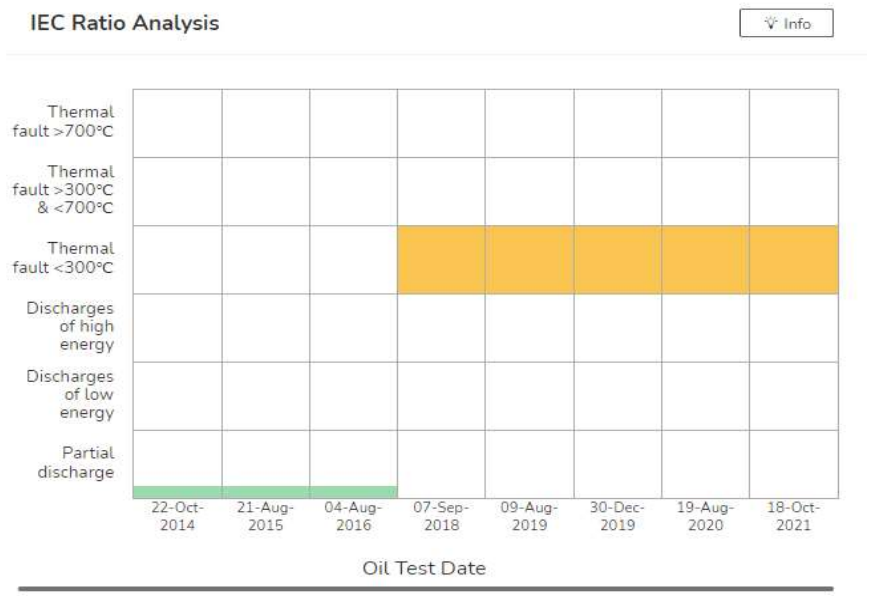
Using Doernenburg Ratio Analysis, ETE provides an indication of potential faults in the transformer.



- The severity of the fault is represented by colour.
- If the required threshold is not met for the analysis, the results will be shown as a thin green line.
- Please note these graphs provide an analysis using IEC & IEE standards. The limitations described in the relevant standards apply.

IEC Ratio Analysis

The ETE platform uses the three commonly analysed gas ratios of C_2H_2/C_2H_4, CH_4/H_2 and C_2H_4/C_2H_6 to plot this graph.



- The severity of the fault is represented by colour.
- If the required threshold is not met for the analysis, the results will be shown as a thin green line.
- Please note these graphs provide an analysis using IEC & IEE standards. The limitations described in the relevant standards apply.

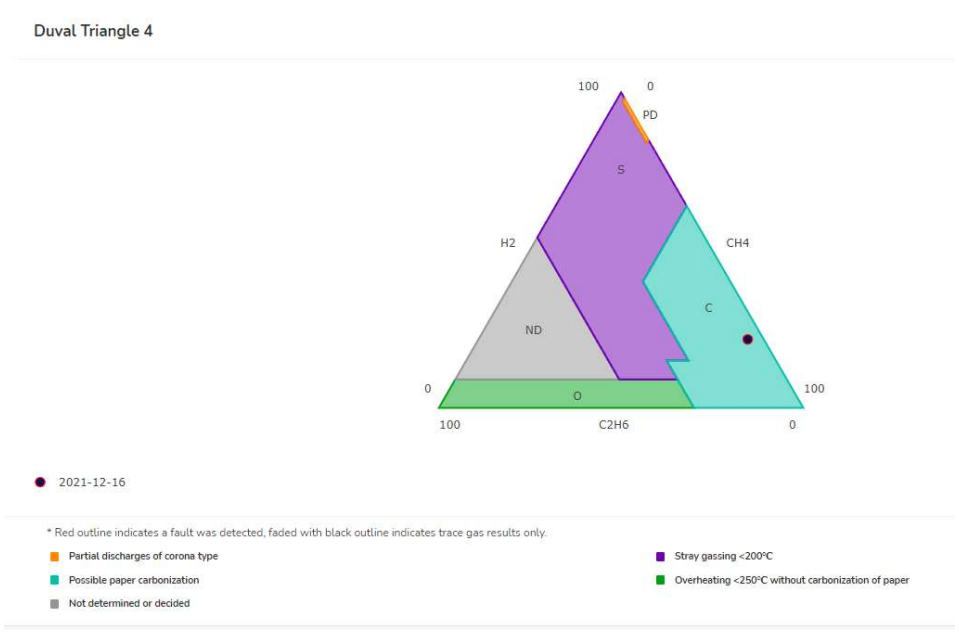
Duval Triangle Method

The ETE platform provides a range of graphical representations to support the interpretation of DGA results, including the Duval Triangle method, which assists in diagnosing faults.

- Based on three key gases of CH_4, C_2H_4 and C_2H_2.
- Gas concentrations are calculated and then plotted along each side of the triangle.
- The triangle is subdivided into fault zones. The fault zone in which the point is located indicates the likely fault diagnosis.
- Should only be used in conjunction with other tests as this method cannot identify a normal condition (i.e., no fault).

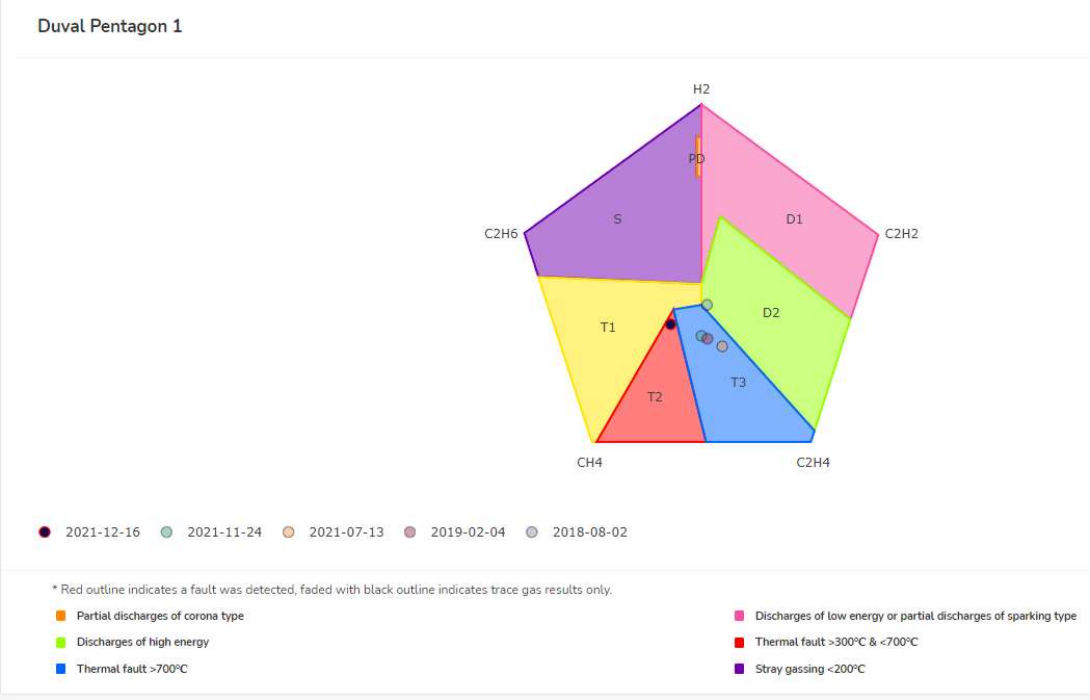
Duval Triangle Method

Duval Triangle 4 & 5 are used in the same manner, assisting customers in obtaining more detailed information about sub-types of thermal faults.



Duval Pentagon Method

This method is another graphical representation to support the interpretation of DGA results.



- Uses all five hydrocarbon gases H_2, C_2H_6, CH_4, C_2H_4 and C_2H_2.
- Six basic types of fault can be detected.
- Should only be used in conjunction with other tests as this method cannot identify a normal condition (i.e., no fault).
- Duval Pentagon 2 can be used to obtain more information on thermal faults.

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ETE Oil Analysis

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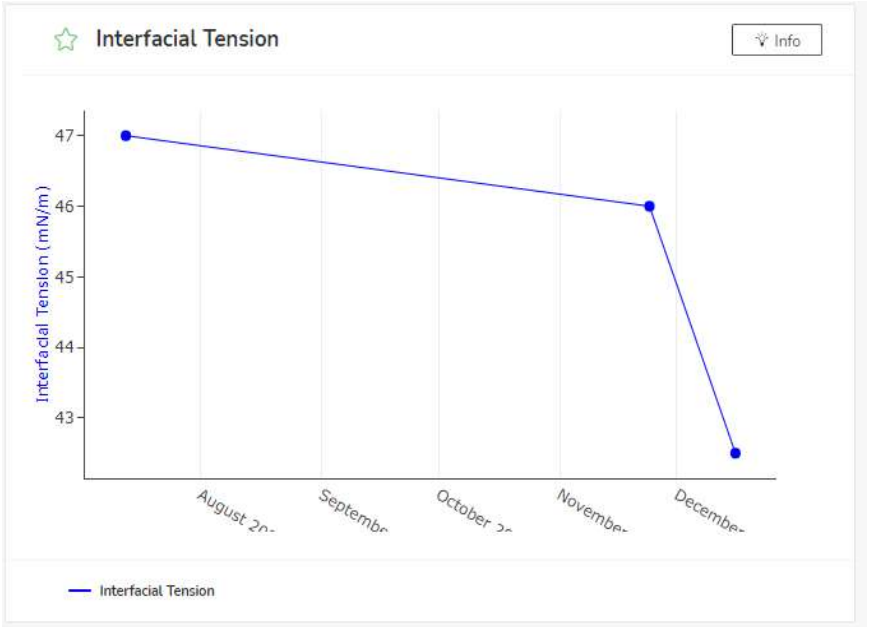
Oil Quality Graphs

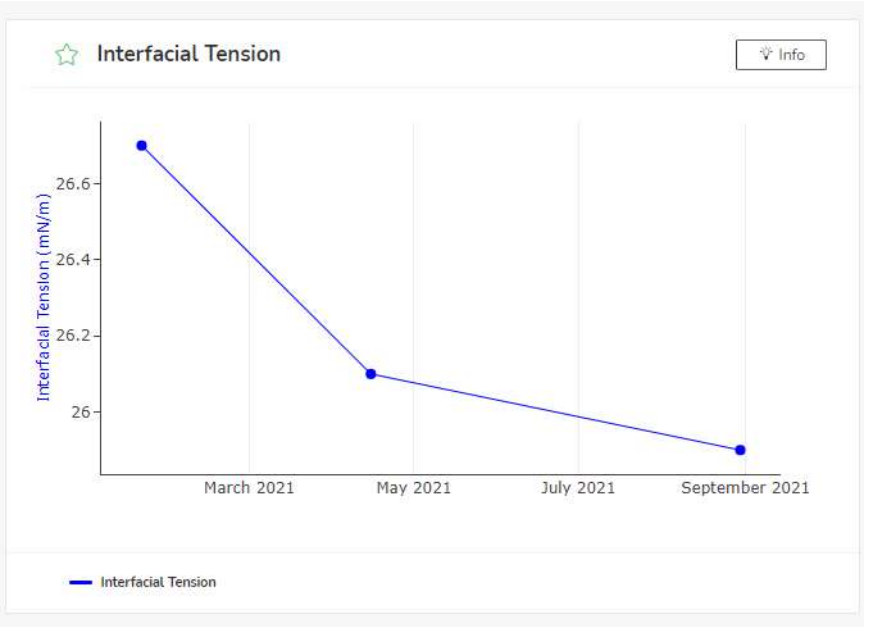
ETE uses oil quality test results imported by the customer to create five types of graphs.

- Interfacial Tension
- Dielectric Strength
- Acidity in Oil
- Depolymerization by Furans
- Moisture in Oil

Interfacial Tension

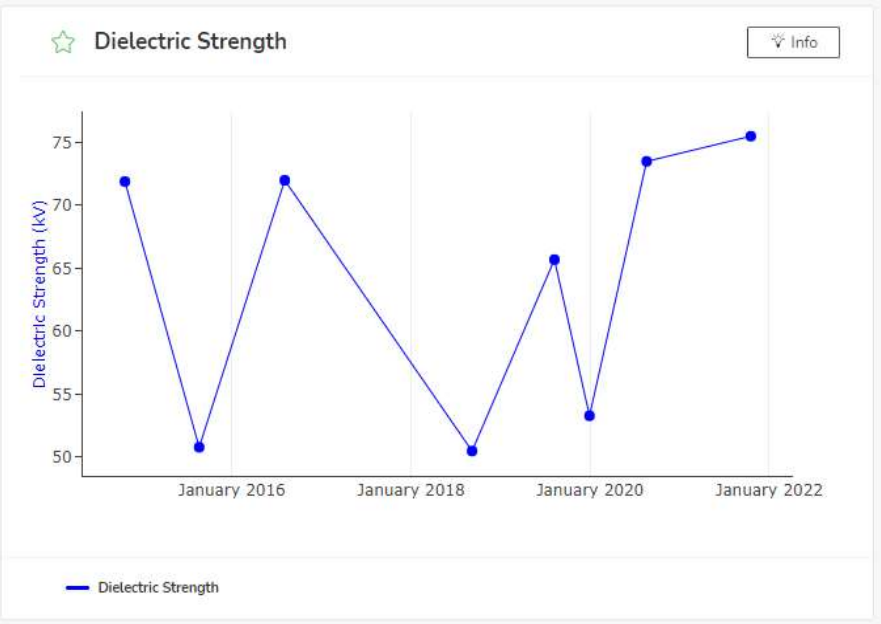
The interfacial tension is a measure of the molecular attractive force between the oil and water molecules. A Low IFT can be a result of contaminants and by-products in the oil.

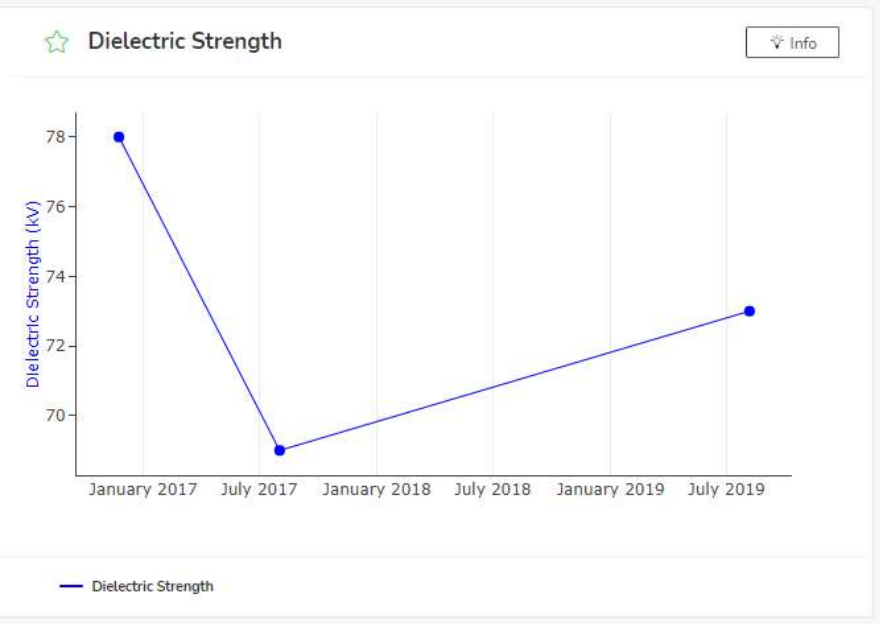




Dielectric Strength

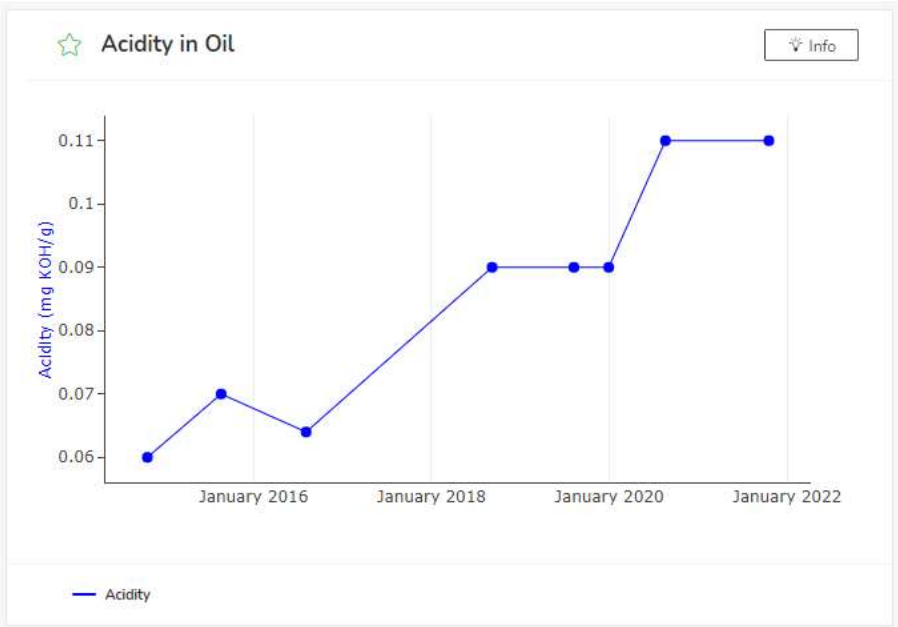
This plot tracks the dielectric breakdown voltage of the oil. The dielectric strength of oil is generally reduced by the presence of contaminants in the oil.

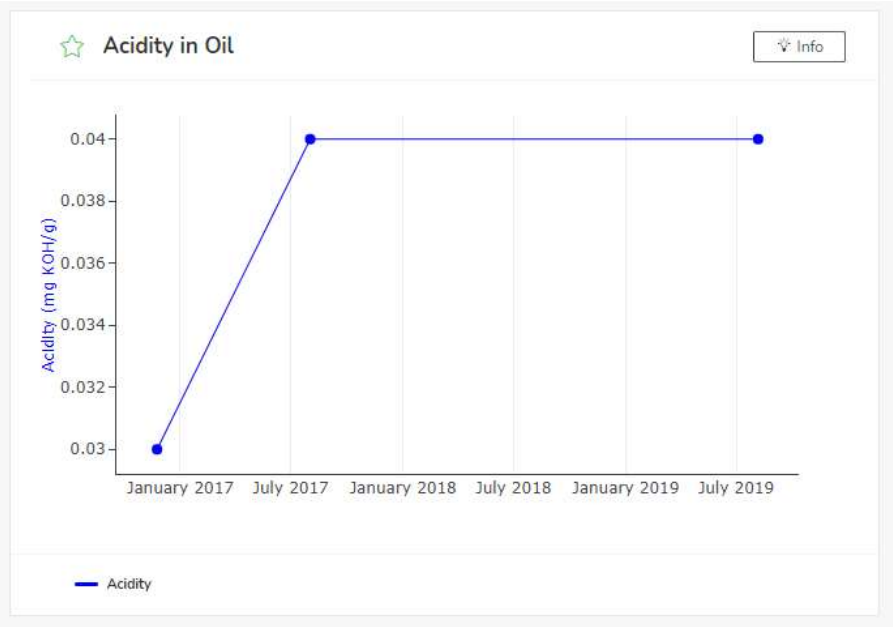




Acidity in Oil

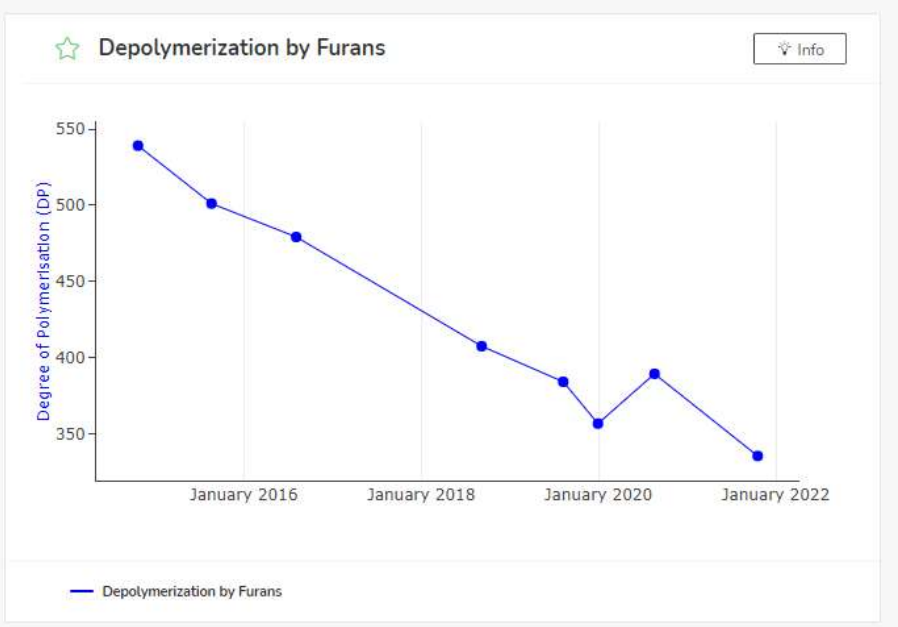
The presence of acidity in the oil is a threat to the transformer, causing it to age faster. It can also indicate the formation of sludge which can impede oil flow and affect efficient cooling.

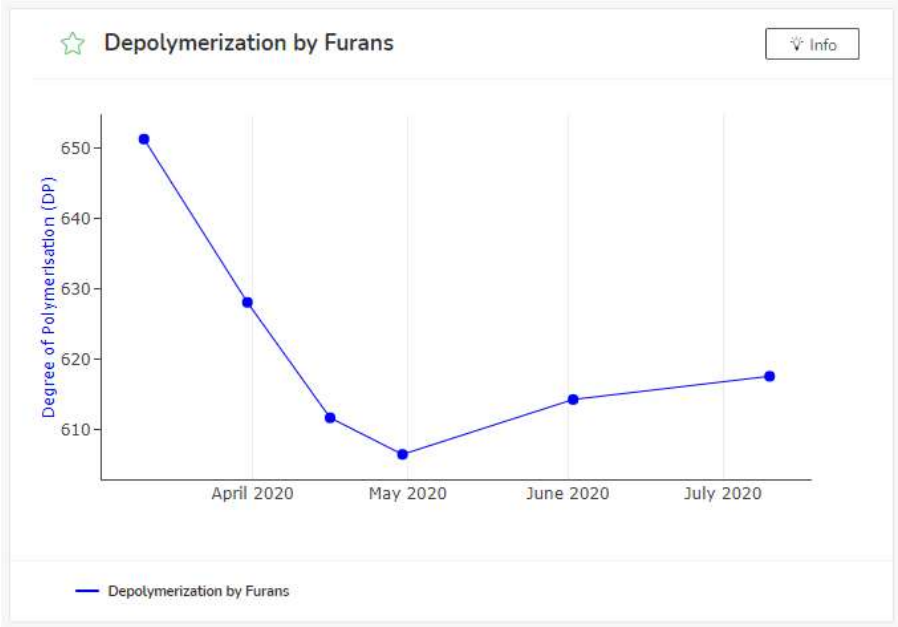




Depolymerization (DP) by Furans

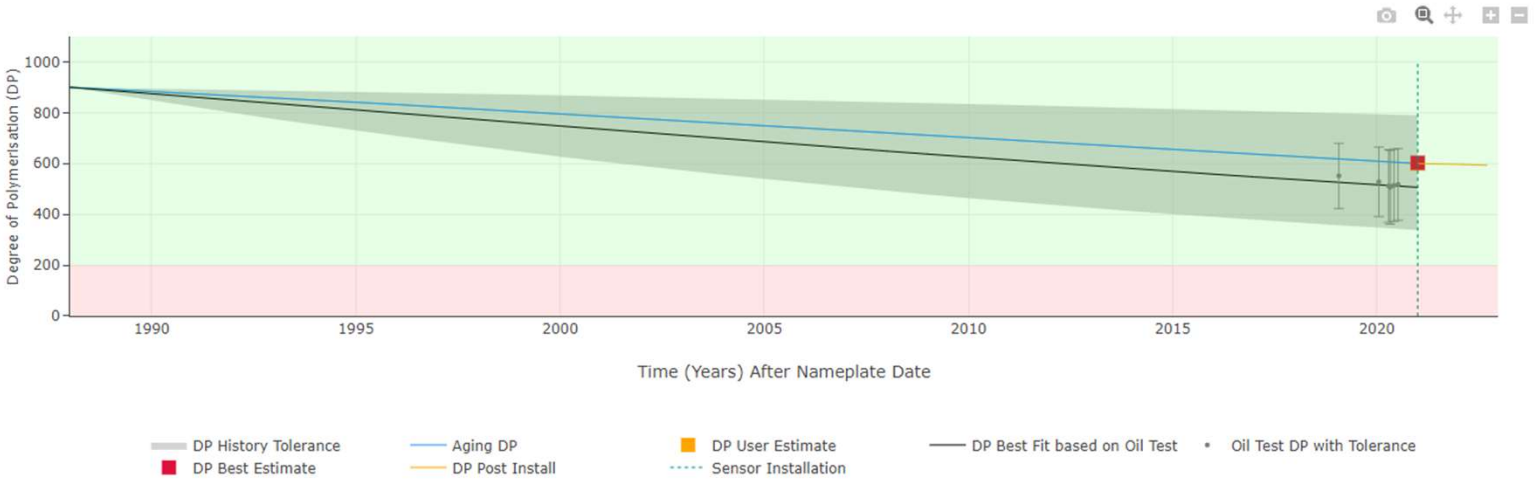
One method of determining the DP of the transformer's solid insulation is by measuring the level of furans in the oil. This graph uses the Chendong model to calculate DP and plot it over each furan reading.





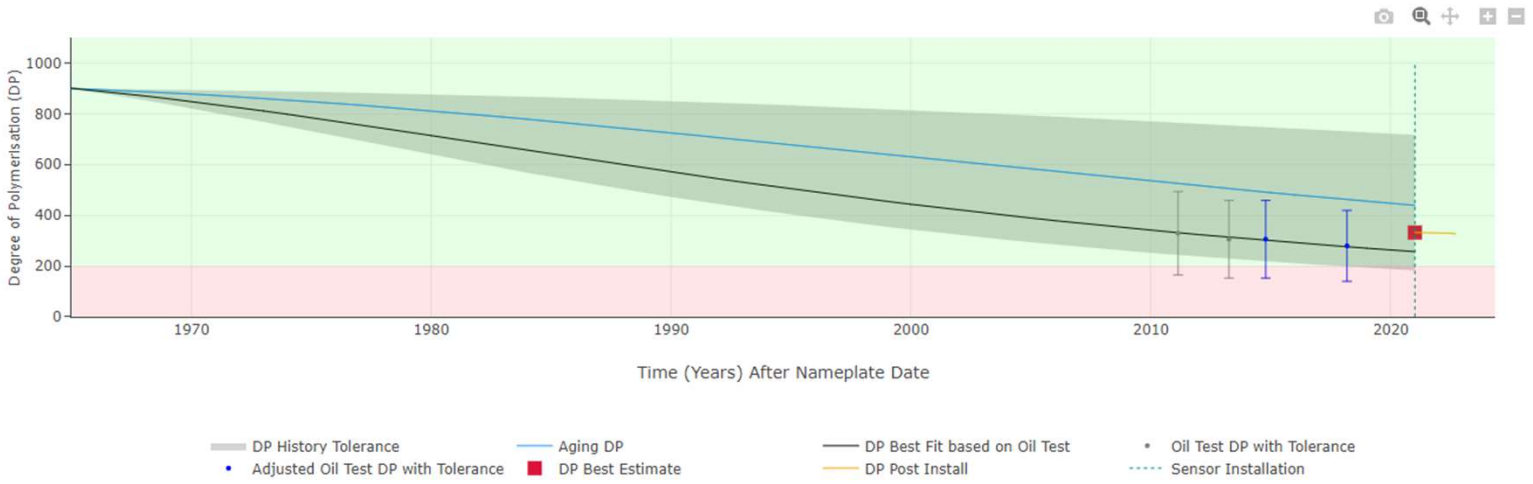
DP History

Using mathematical algorithms and oil test history, ETE can plot the estimated aging profile of the paper insulation. This graph gives insight into the rate of aging of the insulation since the beginning of its service to its current DP.



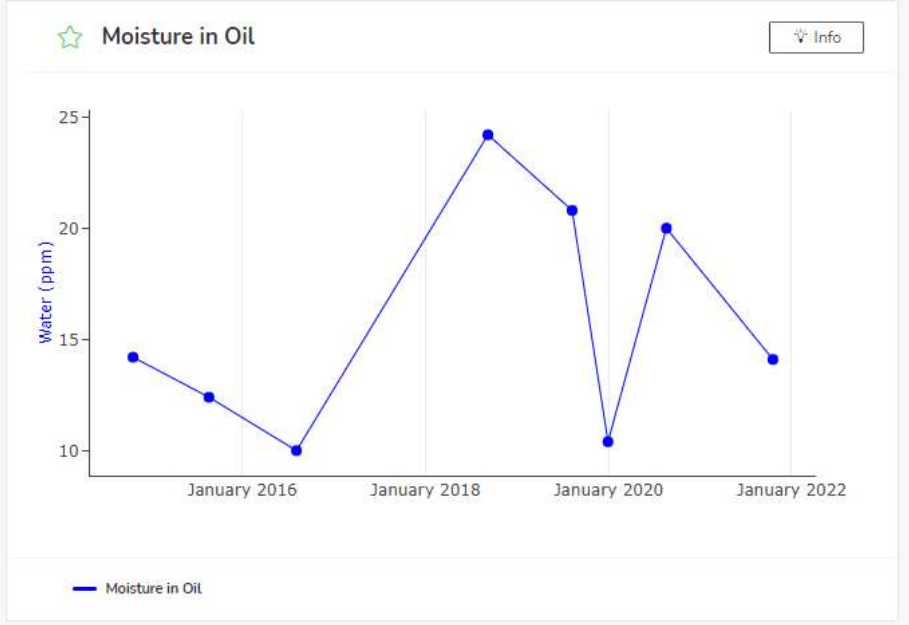
DP History

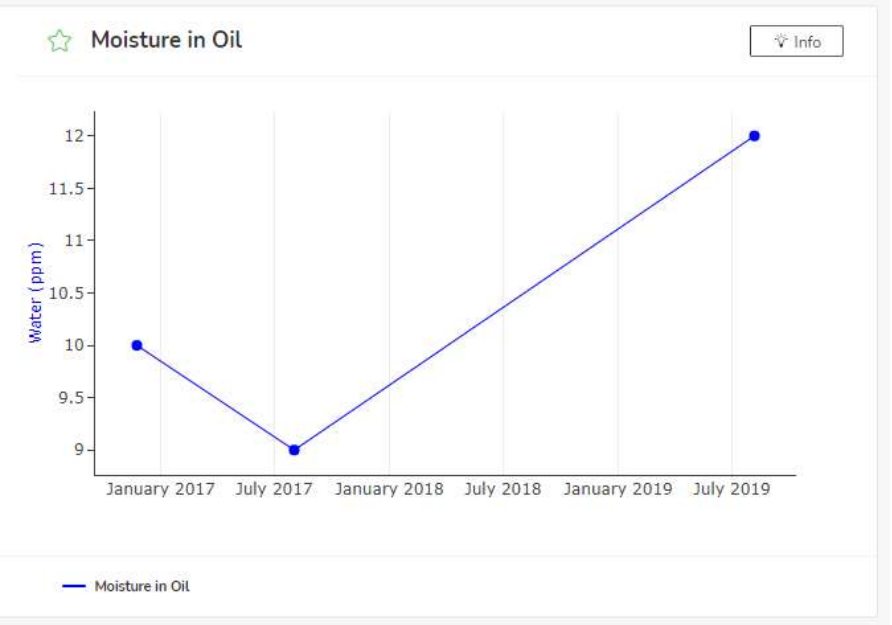
The error bars shows on the chart shows DP from furan using Chendong equation. The red square shows DP best estimate. It is derived from weighted average of historical aging DP with Oil Test DP with tolerance, representing the best estimate DP at the time of ETE installation.



Moisture in Oil

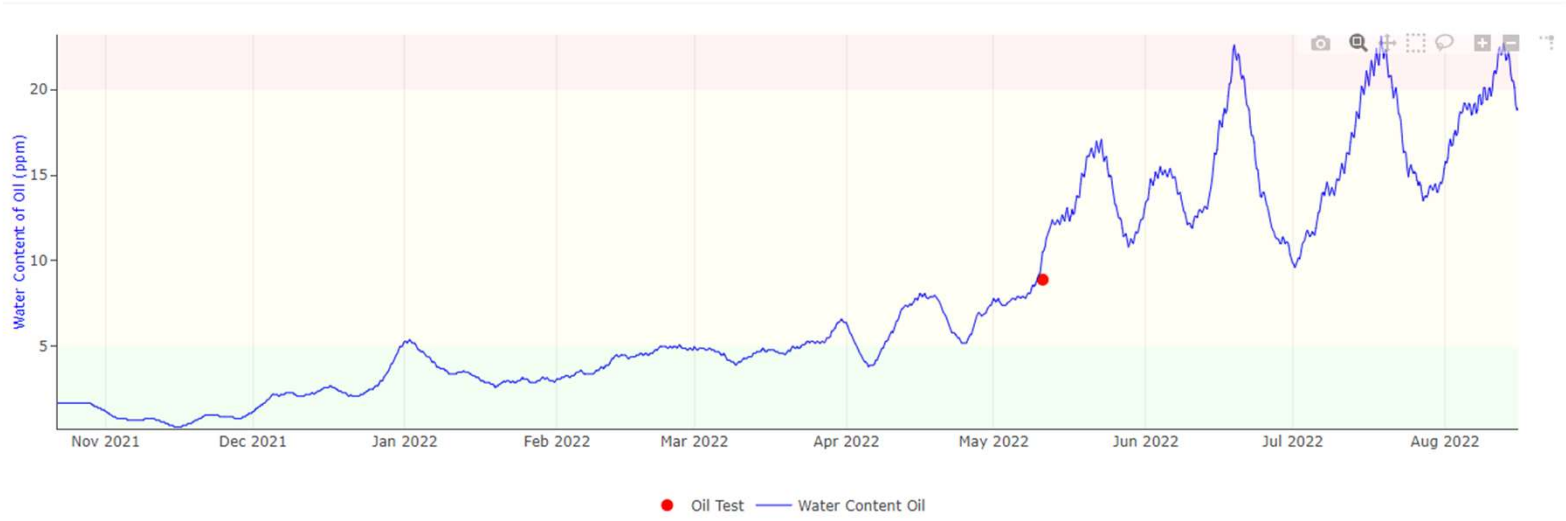
This graph plots the amount of water detected in each oil test conducted by the customer. Moisture moves between the oil and paper insulation as the temperature fluctuates in the transformer. Therefore, this result is very sensitive to the temperature of the oil when it was sampled.





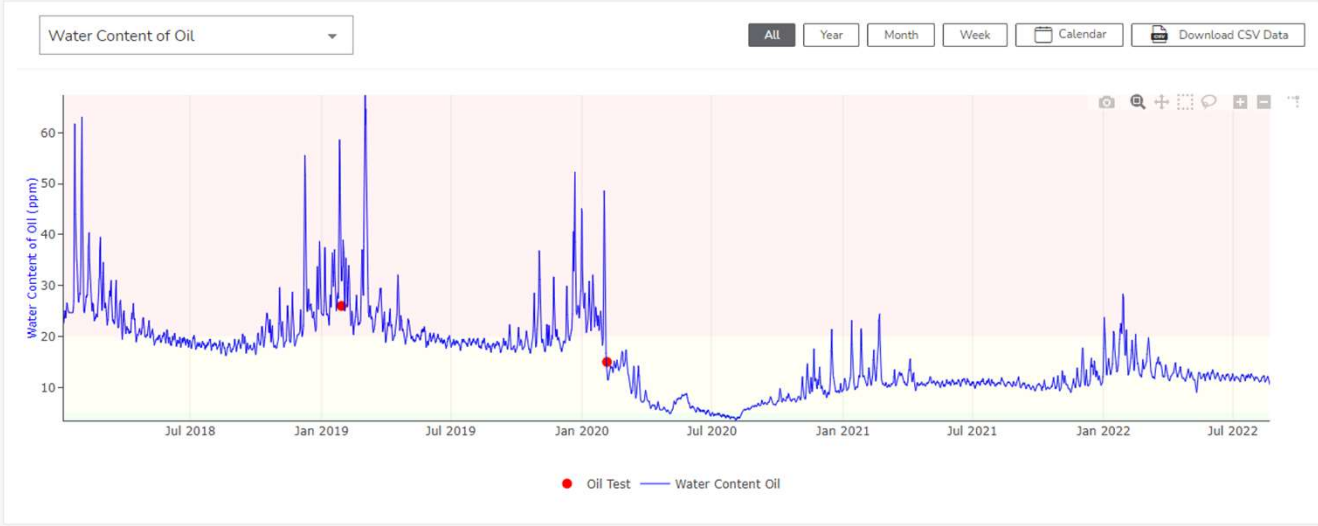
Water Content of Oil

This graph shows WCO measured by the ETE sensor. Red points indicate the moisture measured during oil testing. The ETE sensor records moisture data every hour. It can be clearly seen how much additional data the ETE sensor can provide.



Water Content of Oil

Here is another example from a different transformer. Two red points demonstrate that the moisture measured during oil testing in 2019 & 2020 align with the ETE sensor.



References

To learn more about these graphs, visit the below links using your demo login:

Roger Gas Limit & Ratio Analysis
https://learn.aurtra.net/hc/en-us/articles/360039716331-Rogers-Gas-Limit-Analysis
https://learn.aurtra.net/hc/en-us/articles/360039311152-IEEE-Rogers-Ratio-Analysis

Doernenburg Gas Limit & Ratio Analysis
https://learn.aurtra.net/hc/en-us/articles/360039714671-IEEE-Doernenburg-Gas-Limit-Analysis
https://learn.aurtra.net/hc/en-us/articles/360039714631-IEEE-Doernenburg-Ratio-Analysis

Duval Triangles & Pentagons
https://learn.aurtra.net/hc/en-us/articles/360039311312-Duval-Triangle

Oil Quality
https://learn.aurtra.net/hc/en-us/articles/4403551179289

DP History
https://learn.aurtra.net/hc/en-us/articles/360038865592-Top-Paper-DP-History