

TTA 1

Analysis - water removal - recovery - re-analysis.

A TROJAN 1000 was used on a group of near identical, 3 ph - 66/22 Kv, 10 Mva transmission transformers over 40 years old with 12,000 litres of oil and free breathing. This will form part of a larger study on water removal dynamics and strategy.

Objectives - of this report

1. Analyse the transformer, calculate the true water in cellulose
2. Filter the transformer online for 23 days which removed 3.1 litres of water.
3. Remove the Trojan to allow the transformer to recover equilibrium over 72 days.
4. Re-connect the Trojan, re-Analyse to confirm the cellulose water reduction,
5. Complete two further 30 hour filtering cycles to compare removal trends.

T 1 - results from historical oil sample Analysis

The last traditional oil sample analysis reported

- 37 ppm of water in the oil
- 0.07 Acid NN number
- 25.9 IFT
- 25Kv 2.5 mm

The first Trojan Analysis was on the 13.10.05, prior to Filtering. The transformer experiences very similar daily load cycles, so we will use the Analysis data a little differently for this transformer. We will use two data points during the day, the first at 12 pm midday, and the second at 5pm. The load increase characteristics during both days appeared identical, however the transformer average temperature was 20°C higher during the re-Analysis as it was the peak of summer. The values from the Trojan Analysis (pre & post filtering) are shown in Fig.1 below.

Pre Filtering Analysis	Top Oil temp	Bottom Oil temp	Water In oil	Oil Relative Saturation	Water in Cellulose %	Oil Dielectric Kv/2.5mm
13.10.05 12am	29 C	24 C	21 ppm	35 %	4.44%	25 Kv
13.10.05 5pm	40 C	32 C	30 ppm	37 %	4.32%	26 Kv
Re-Analysis						
21.1.06 12am	51 C	41 C	26 ppm	22 %	2.91%	67 Kv
21.1.06 5pm	63 C	48 C	35 ppm	24 %	2.64%	66 Kv

Fig. 1 – Analysis before and after filtering.

The pre-filtering water in cellulose was calculated at 4.44% at midday (data point 1), and as the transformer increased in load/temperature, the 5pm calculation was 4.32% (data point 2). This is a normal event. When the transformer was re-analysed after 72 days, the noon water in cellulose calculation was 2.91% and the 5pm 2.64% (data points 3 & 4). Most importantly, the oil relative saturation has reduced by 13% at the same load point, and the dielectric is markedly improved. This is really our focus, the relative saturation profile.

Fig. 2 below details the data points. The reduction of water in cellulose is calculated at 1.6% however this reduction will be slightly overstated as the transformer was operating at a lower temperature during pre-filtering Analysis, which will slightly overstate the water in

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cellulose compared to the later Analysis. The actual water in cellulose reduction is more likely over 1%.

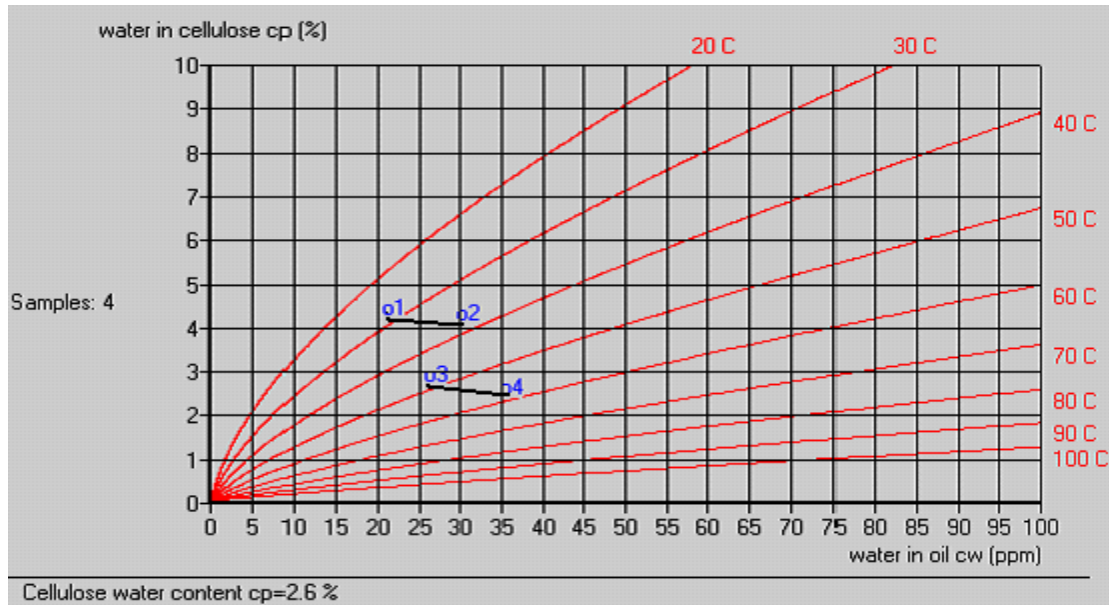


Fig. 2 – Water in cellulose before and after Filtering

Water Filtering – from 14.10.05 for 23 days

Fig. 3 records the temperature and water activity profile over the 23 days of filtering. The operator set the Trojan to filter for 30 hours, between the automatic Re-Dry cycles.

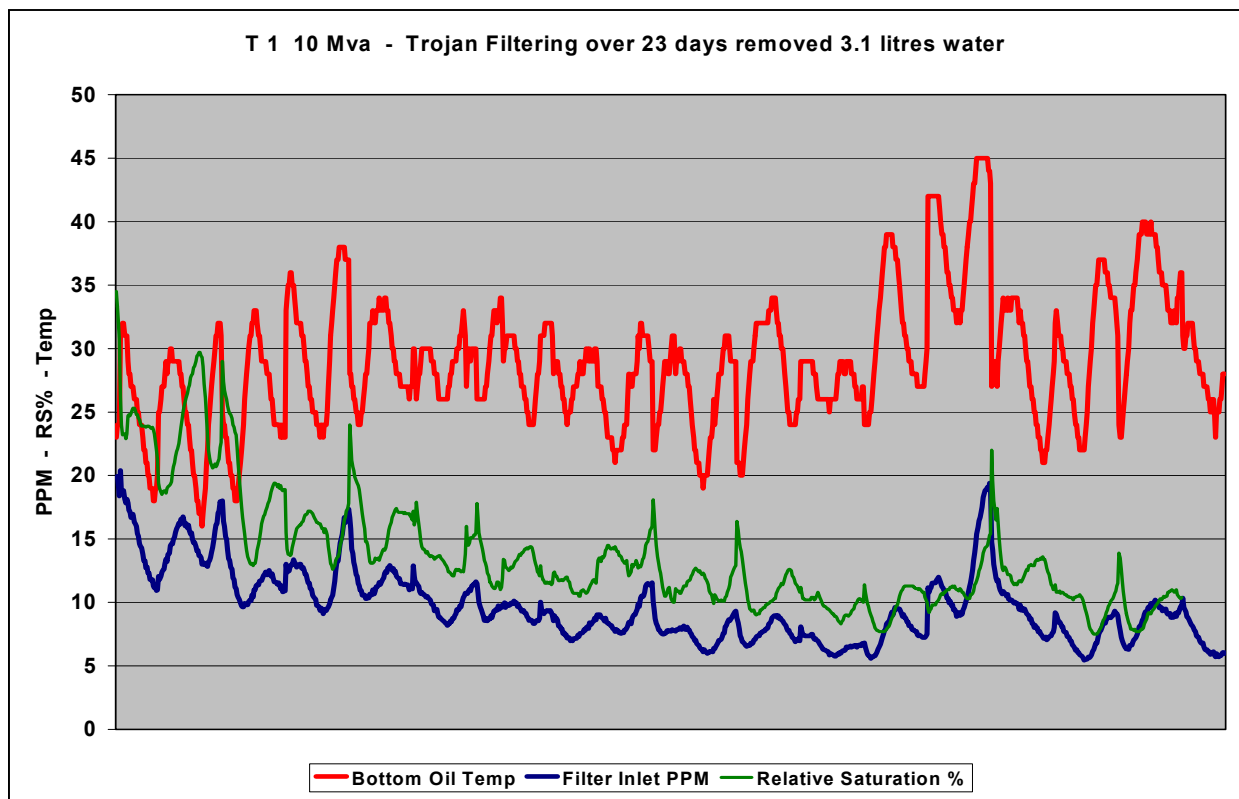


Fig. 3 – Water Filtering cycles over 23 days

The dark blue line in Fig. 3 record the water in the oil ppm as it comes from the transformer main tank and enters the Trojan. Over the 23 days of filtering the average water in oil entering the Trojan was 9.69 ppm, the filters removed 4.65ppm and the oil

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returned to the transformer at 5.04ppm. A total of 3.1 litres of water was removed. The average bottom oil temperature over the 23 days was 29.1°C.

The Trojan causes a rapid decline in relative saturation which immediately improves the oil dielectric. Within the first few days the oil has been reduced down to about 10 ppm creating a significant disequilibrium between the oil and the cellulose. This disequilibrium causes the water to migrate from the cellulose.

Fig. 4 records the water volume removed at each of the Filter Re-Dry cycles.

1. The **blue** data covers the first 23 days where 3.1 litres of water was removed from 16 Filter Re-Dry's, or 130 mils per day average.
2. The two **brown** data points is the water removed during the two filtering cycles after re-analysis on the 21.1.06

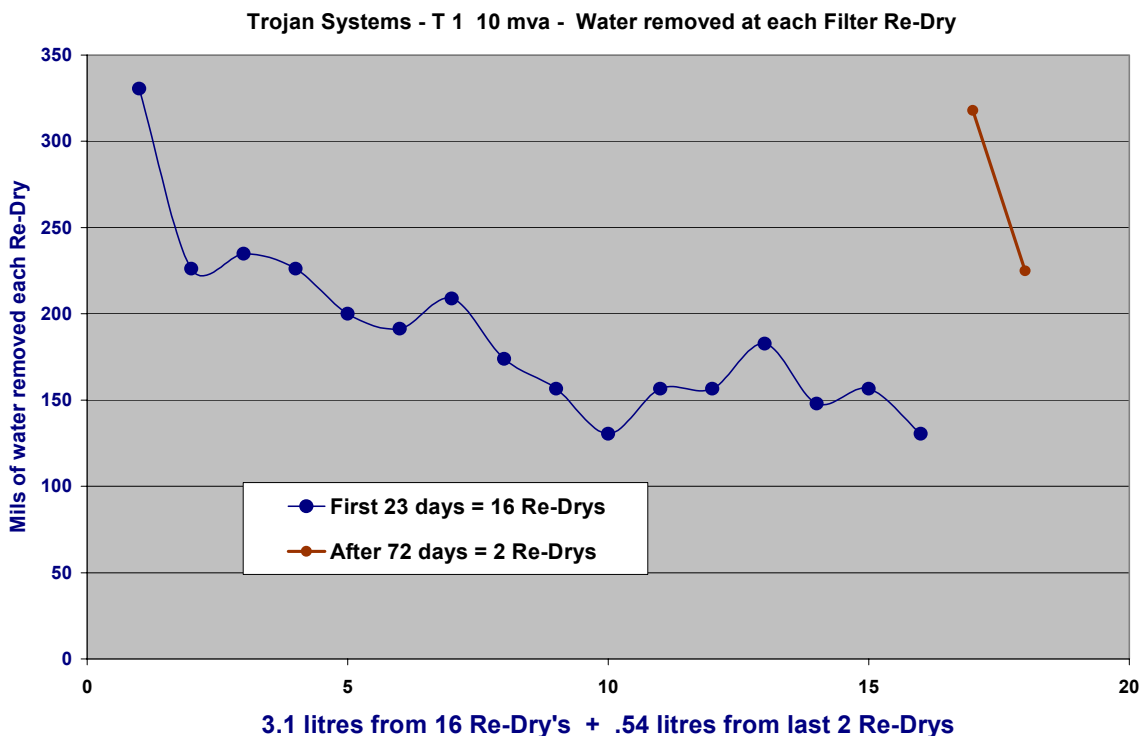


Fig. 4 – Water removed from the Trojan Filter at each Re-Dry

A total of 3.640 litres of water has been removed so far. Note that the last two sample points are when the Trojan was re-attached. The increase in water availability in the oil after recovering equilibrium is evident. This is a good method when you want to remove water from a group of transformers. Leave the Trojan on for 3 to 4 weeks then move it every month between transformers.

The test confirms the significant improvement that can be achieved after only a short filtering period using the Trojan. A further 3 litres will be removed, with the medium term target of 2% water in cellulose. Water in cellulose levels can be progressively reduced and recorded. Don't try to do it all in one session.

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