ADT 2012

ON-POWER DEHYDRATION OF TRANSFORMERS

FOR VERY HEAVY WORKING CONDITIONS
ON POWER RECOVERY OF DIELECTRIC STRENGTH
LIFE EXTENSION OF TRANFORMER
REMOTE PROCESS CONTROL AND MONITORING
EASY CHECK OF FUNCTION VIA YOUR HANDY
ON-LINE DIELECTRIC SCREENING
EASY VERIFICATION BY LAB RESULTS
PLUG & PLAY INSTALLATION
MINIMUM SUPERVISION AND/OR MAINTENANCE

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Drying of transformers

The presence of moisture in the transformer, to whatever degree, actually harms the insulation which will be permanently damaged. Drying methods can substantially reduce that deterioration.

The **ADT** is intended for mobile and preventative use on transformers with more than 2 - 2.5% water content in the cellulose and with particle contamination. The **quick restoration of safe dielectric conditions, life-extending features and remote control** also forms part of this concept. The system can be installed regardless of the size of the transformer.

Main features of ADT 2012

- **Easy and safe installation and commissioning: all procedures are computer controlled to avoid any human lapses and errors**
- **No disconnection of the transformer under treatment, normally not even during installation of dehydrator (Plug & Play design)**
- **No air venting after installation: hydraulical interconections to a transformer oil filling are set under vacuum and subsequently rinsed by oil**
- **Moisture and particles content can be reduced to the level of a new transformer**
- **Quick restoration of dielectric strength of oil**
- **No impact on the insulating oil properties and DGA**
- **Direct check of dehydration efficiency based on amount of removed water: calculated as the product of difference input-otput water content in oil (2 x humidity sensors) x precise volumetric reading of oil throughflow**
- **Easy control of function by SMS via your handy**
- **Remote monitoring & control of drying process: all relevant data are recorded and displayed (printed) as easy comprehensive diagrams**
- **Calculation of actual value of dielectic strength (Ud-value) of oil during the whole dehydration**
- **Easy verification of simulated Ud-values by lab reading(s) by means of Verification diagram**
- **Easy and safely replacement of adsorbent cartridges and filters without a potential oil spill: the oil is removed before replacement and forced back to the oil filling of transformer**

HOW MUCH MOISTURE IS “TOO MUCH MOISTURE” ?

Moisture enters the transformer either through external contamination, or is generated internally by the oxidation (ageing) of insulants. In either case, practically all the water present in the transformer (over 98%) is contained in solid insulants because the cellulose is very hydroscopic.

Figure 1 shows the equilibrium relationship between the water content in the oil Cw (ppm) and cellulose Cp (weight %) at different operational temperatures.

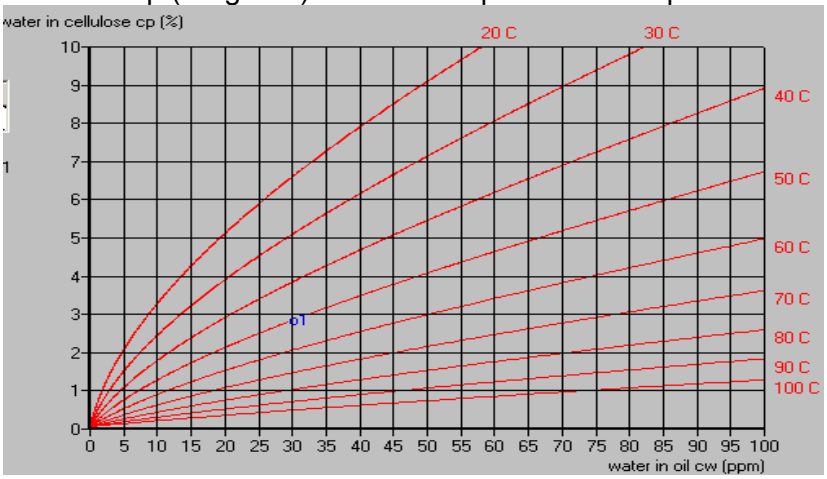

Fig.1 Moisture equilibrium chart (Nielsen Chart)

Example: **10MVA Transformer, 700 kg cellulose, 6000 kg oil**

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Sampling temperature 50C, Cw = 30 ppm of water in the oil → Cp = **2.9%** weight percent of water in the cellulose

Total amount of water in the cellulose: 700 x 0.029 = **20.3 kg**

Total amount of water in the oil : 6000 x 0.000030 = **0.18 kg**

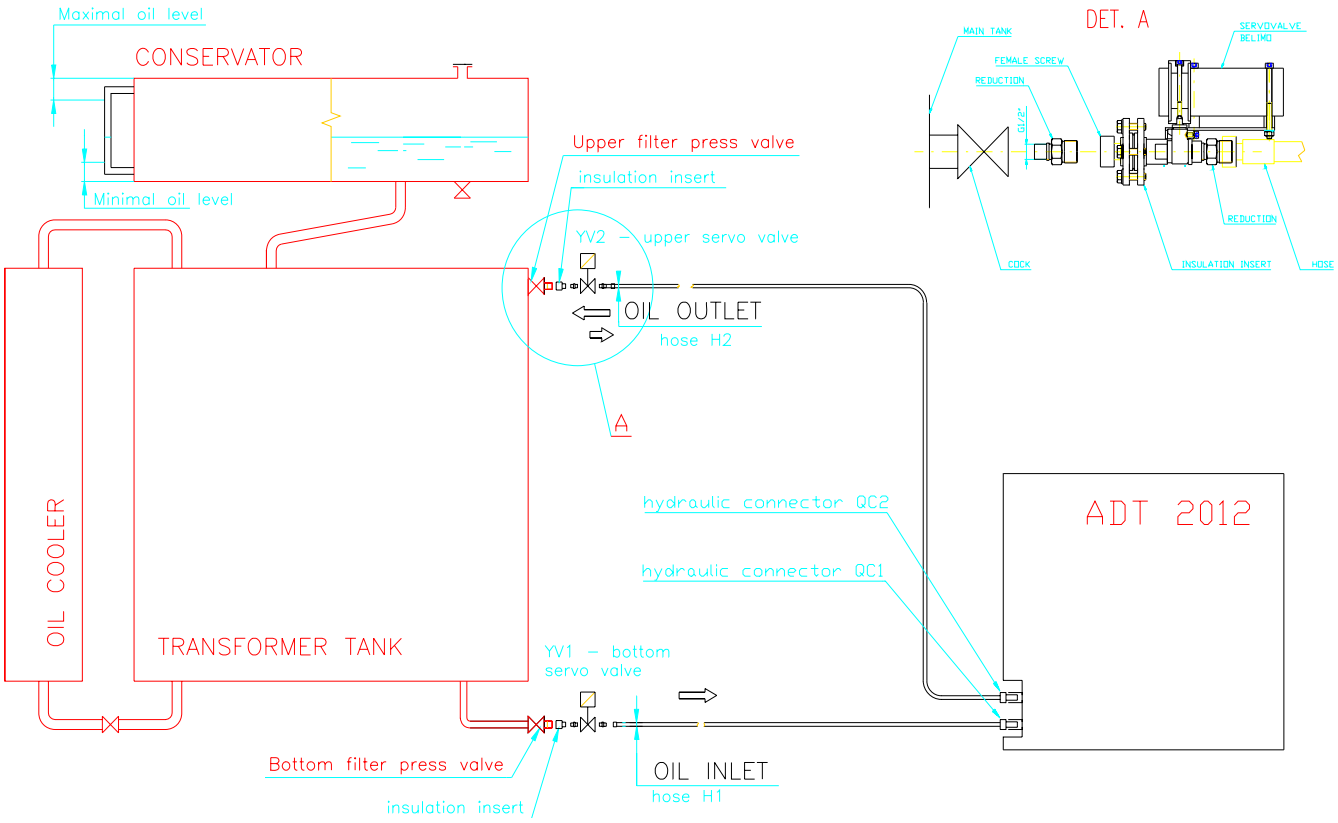
If one wishes to reduce the moisture to an acceptable 2% boundary then: 700 x (0.029 – 0.02) = **6.3 kg** water must be removed from the transformer.

The effect of moisture on the transformer is summarized in Table 1.

Cp (weight % in paper)	**Transformer condition**
0.5	new or highly dried
2.0	acceptable condition
3.3	paper starts to deteriorate
4.5	flashover possible at 90C
7.0	flashover possible at 50C
8.0	who knows ?

In order to avoid the deterioration of solid insulants, the moisture content should be kept under 2%. If the moisture level is suspected to exceed 2% , the transformer must be dehydrated as a matter of preventive maintenance. For basic information about moisture impact in the dielectric behaviour of a transformer See www.ars-altmann.com / TRACONAL or / News.

INSTALLATION



The ADT can be connected to all types of transformers (i.e. open as well as sealed units). It should be located in close proximity to the transformer.

All treatment utilities (hydraulic circuits, input/output filters, control circuits etc.) are installed in the moisture tight and internal air-conditioned box.
For detailed information See ADT Operational Manual 2013.

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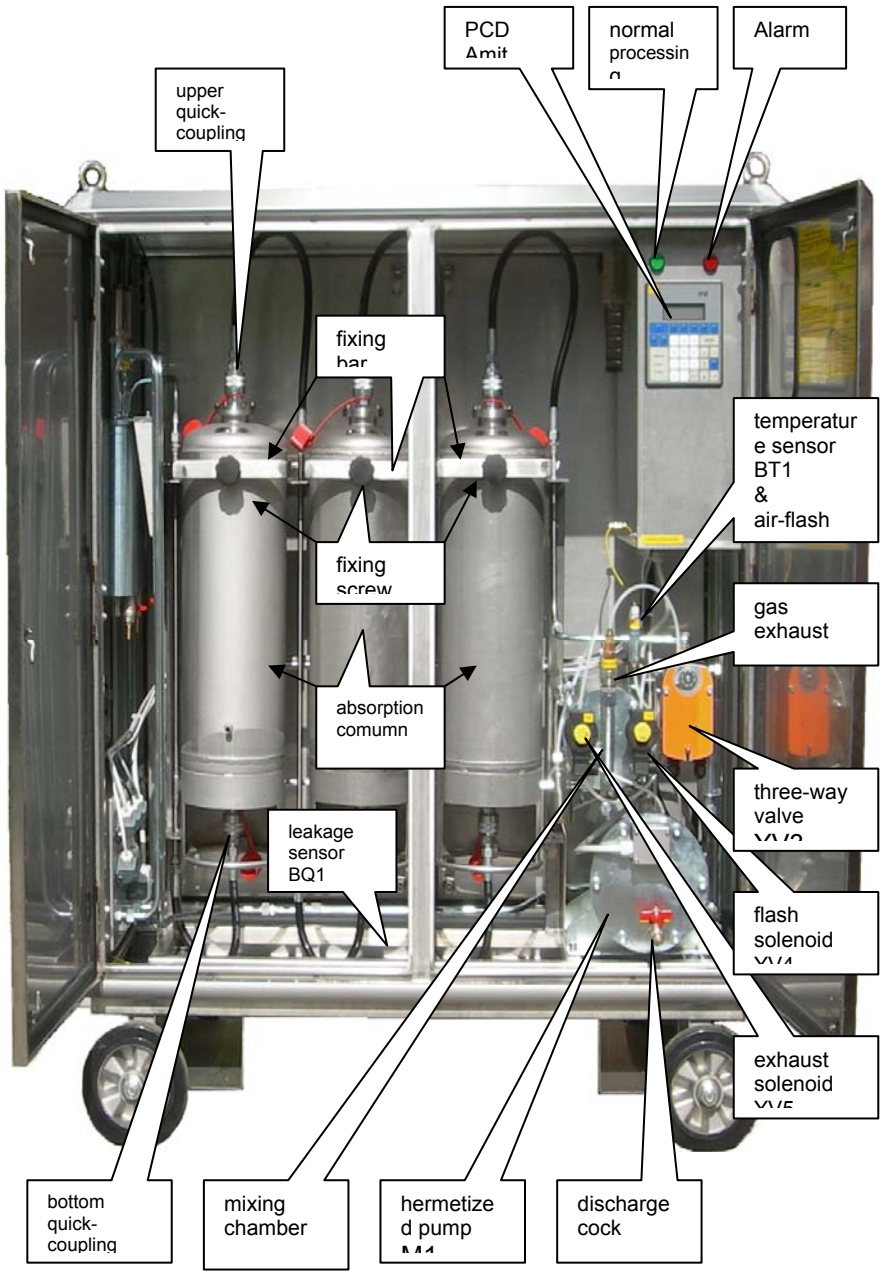
SPECIFICATION

Power supply voltage	230 VAC (or on request)
Power supply frequency	50 Hz (or on request)
Power consumption:	250 W
Oil throughput	10 m^3 per day
Outlet water content	1 ppm
Water adsorption capacity	8.3 kg (three columns)
Outlet filtering grade	1 µm
Dry weight (without oil)	250kg
Operating weight (oil filled)	275 kg
Dimensions:	770 x 1550 x 1350 (mm)
Hydraulical connection	2 x flexible 1/2“ hose, quick couplings
Communication:	faxmodem, GSM modem, LAN link, **SMS, Internet**
Moisture reading :	2 x Vaisala humidity sensor



Internal layout of main components in ADT (open front doors)

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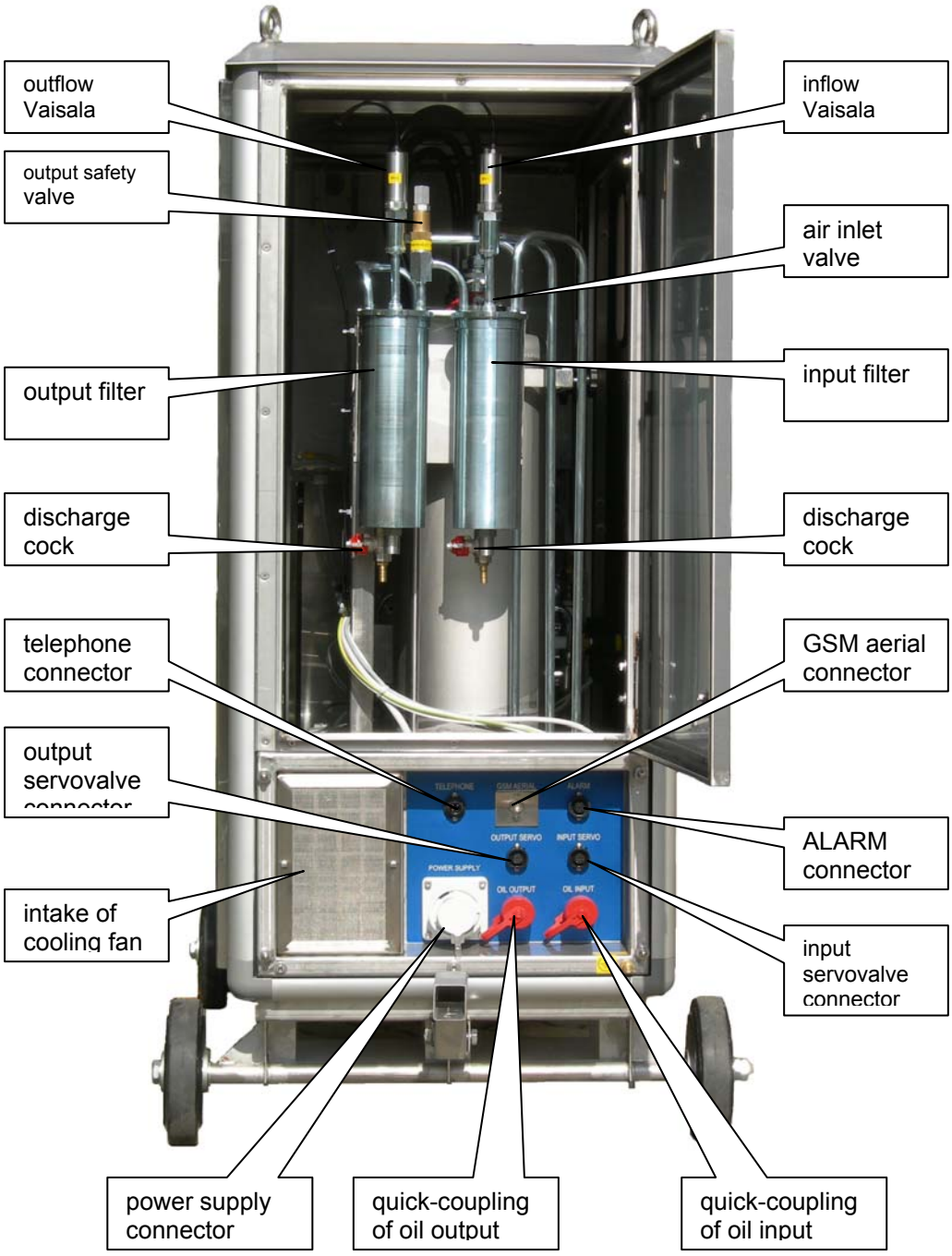

Layout of main components on the left side of ADT dehydrator
Integrated hydraulic, electric and communication interconnections

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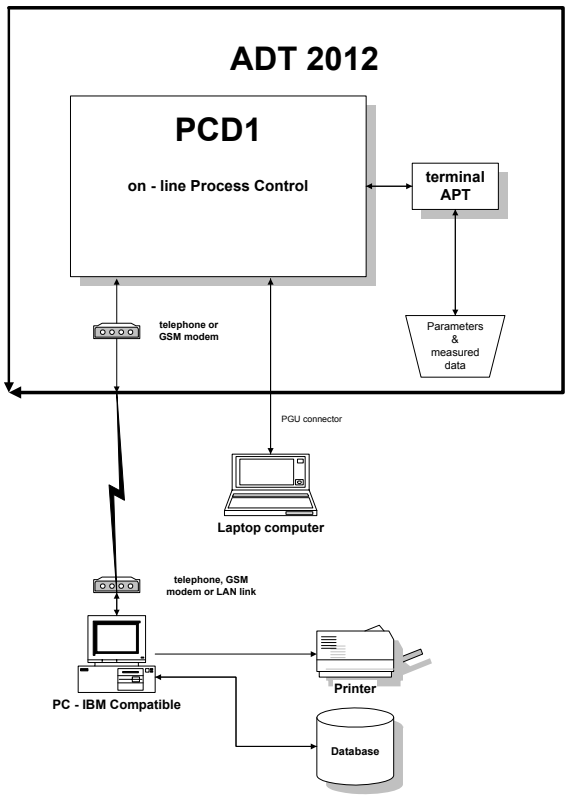
PARAMETRIC REMOTE CONTROL

Regardless of how efficient any method of **oil** dehydration might be - the first law for the dehydration of **transformers** is :

water removal from the cellulose materials of a transformer has to be safe and effective

Any **on-line** transformer dehydration is ultimately governed by the slow diffusion of moisture from the cellulose into the oil and this process can be accelerated only by a significant increase of its temperature. But, be carefull:

high transformer temperature → high water content in oil → high separation rate
which simultaneously means
→ low dielectric strength of oil → low immediate reliability of transformer



In order to avoid the lowering of the immediate reliability of the transformer, it is necessary to tune at least two antagonistic criteria in the whole process of dehydration

- max. separating efficiency of dehydrator (max. water removal rate)
- dielectric strength of oil - has to be maintained or improved

To achieve these targets the ADT can be programmed directly (manually) via the terminal of PCD or alternatively by the PC or lap-top.

This way offers remote monitoring and optimalization of dehydration by strictly controlling warming-up of the transformer.

The figure on the left shows the structure of dehydrator control systems and both connections between PCD1 and lap-top or remote PC.

The software for communication between the PCD1 and both computers - remote user PC and lap-top is provided by ARS.

The easy check of ADT-function can be performed by your handy anywhere and anytime: via SMS.

. The advanced evaluation of the effectivity of transformer dehydration

For a better understanding of the long-term trends of dehydration effectivity of the ADT and a change of the dielectric behaviour of the transformer within the treatment two new procedures are used:

- the **DL** (**D**ehydration **L**og)
- the **DSL** (**D**ielectric **S**trength **L**og)

Both procedures can be started by clicking on the DL or the DSL buttons in the Main window.

and by clicking on the OK button , the final, printable output of the DL procedure is shown

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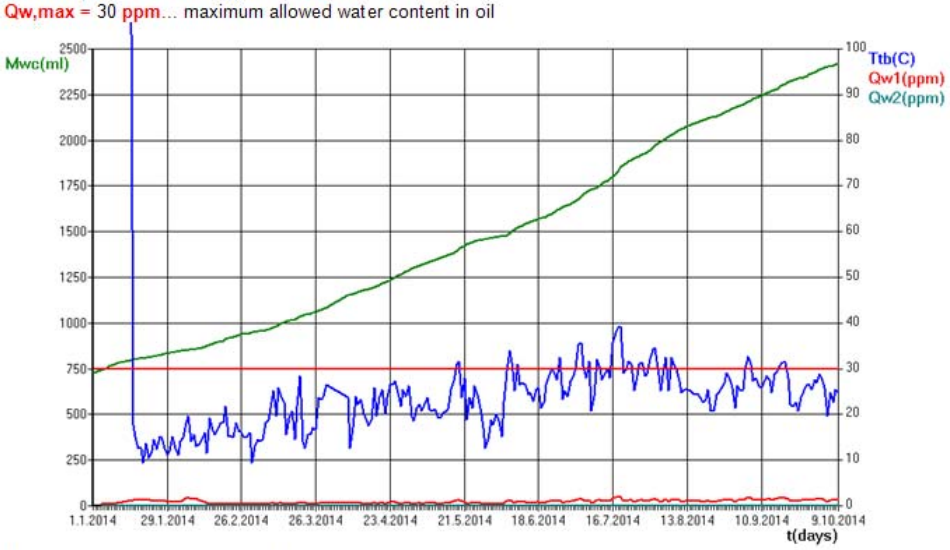
ADT 2012 Dehydrator - Main Data Log
OPTIM D2L (Dehydration Dielectric Log)
Procedure: DL (Dehydration Log)
© Ing. Altmann, 2013

Transformer Location:	**xxxx**
Transformer Serial Number:	
ADT 2012 Serial Number:	**xxxx**

Time-period of evaluation : 01.01.2014 - 09.10.2014

Norm requested value Qw,max - red horizontal line
Qw,max = 30 ppm... maximum allowed water content in oil



Mwc amount of removed water (ml)
Qw1 input value of water content in oil (ppm)
Qw2 output value of water content in oil (ppm)
Ttb transformer temp. bottom (C)

ATTENTION.
Water content in oil Qw exceeded allowed Qw,max-limit:

Day	Qw(ppm)

Remarks & Recommendations

Date of evaluation: 10.10.2014
Replacement of temperature sensor at 11.1 2014

A new kind of assesment can be used now for the on-line diagnostic of dielectric behaviour of the transformer

DSL – Dielectric Strength Log

This absolutely new approach enables the DSL online to calculate the theoretical (maximum attainable) value of the dielectric strength of oil (the Ud,t –value) on the basis of the direct measuring of the water content in the oil (the Qw1-value).

And the following steps are similar as before :

- requested time-range of data (Data File , Start , End)
- Transformer Location, Transformer S/N and VS-06 S/N
- Minimum allowable dielectric strength of the oil (Ud,min)

these can be directly and easily entered from the keyboard.

The DSL procedure enables a substantially more detailed insight into dielectric behaviour of a given transformer especially the „contardictory“ change of the dielectric strength versus the temperature of the transformer.

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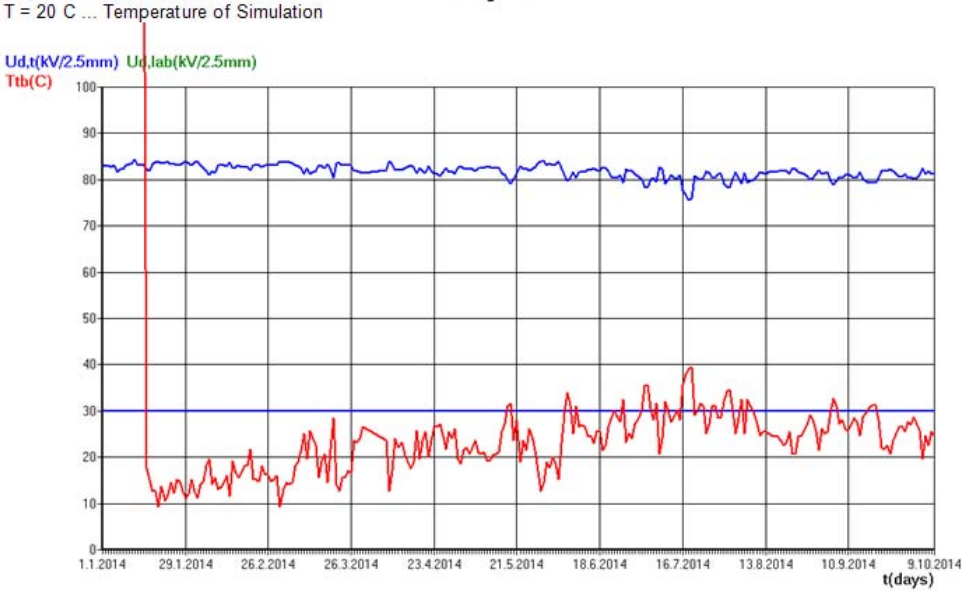
ADT 2012 Dehydrator - Main Data Log
OPTIM D2L (Dehydration Dielectric Log)
Procedure: DSL (Dielectric Strength Log)
© Ing. Altmann, 2013

Transformer Location:	**xxxx**
Transformer Serial Number:	
ADT 2012 Serial Number:	**xxxx**

Time-period of evaluation : 01.01.2014 - 09.10.2014

Norm requested value Ud,min - **blue** horizontal line
Ud,min = 30 **kV/2.5mm**... minimal allowed dielectric strength in oil
T = 20 C ... Temperature of Simulation



Ud,t ... Theoretical Dielectric Strength of oil (kV/2.5mm)
Ttb ... Transformer temperature bottom (C)
Ud,lab ... lab reading(s) of dielectric strength of oil (kV/2.5mm)

ATTENTION.
Dielectric Strength of oil Ud,t decreased under allowed Ud,min-limit:

Number of lab verifications: 0

Day	Ud,t(kV/2.5mm)

Remarks & Recommendations

Date of evaluation: 10.10.2014
Replacement of temperature sensor at 11.1 2014

To obtain relevant diagnostic results, the accuracy of the Ud,t-simulation for the given time-period must always be correspondingly verified:

- by the quantitative comparison of the Ud,t-value and the Ud,lab-value at the same time.

This means that the simulated Ud,t-value has to be compared with the Ud,lab- value at the same sampling time (the time when the oil for the lab Ud-reading has been sampled at the transformer).

The final result of the DSL-procedure is the quantitative verification by means of the Verification Table and the Verification Diagram.

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