Tx-DEHYDRATOR

ADT 2012

OPERATING INSTRUCTIONS 2013.2

C:\MANUAL\ADT 2012 \ VERSION 2013.2

1. Technical data

Power supply voltage	1 phase 230 VAC (or on demand)
Power supply frequency	50 (60) Hz
Power consumption:	200 W
Oil throughput	7.5 m^3 per day maximum
Outlet water content	5 ppm nominal , 1 ppm minimum
Outlet filtering grade	1 µm
Weight	
Dry weight (without oil)	250 kg
Operating weight (oil filled)	280 kg
Dimensions	770 x 1550 x 1350 (mm)
Hydraulical connection	2 x flexible 1/2“ hose
Communication:	On request: Faxmodem,GSM modem, LAN link, SMS

Operational condition:

Max. surroundings temperature: 50°C

For surroundings. temperature over 40°C is neccesary to ensure:

- cooling air with temperature lower as 40°C or
- special cooling unit

Min. temperature of dehydrated transformer 20°C

For successful dehydration of transformer and successfull oil drying it is neccesary to ensure:

hold the temperature of the transformer over 20°C

2. Installation

The dehydrator ADT 2012 is hydraulically connected to the transformer as shown in Fig.1, 2 and 3.

Installation procedure (all hydraulic and electric connectors are situated in the left bottom part of ADT housing See Fig.4):

- attach the oil-inlet set (coupling, insulation insert and servo valve **YV1** See Fig.1 to the lower access of the transformer (i.e. bottom filter press cock), then connect to the open end of the servovalve to the inlet hose **H1** (marked by brown belt), then connect the opposite end of the hose **H1** to the socket of quick-coupling **QC1** (marked by brown strip)
- attach the oil-outlet set (coupling, insulation insert and servo valve See Fig.1 to the upper access of the transformer (i.e. upper filter press cock at the end), then connect to the open end of the servovalve **YV2** the out-let hose **H2** (marked by yellow belt at the end), then connect the opposite end of the hose **H2** to the socket of quick-coupling **QC2** (marked by yellow strip)
- connect cable of servo valve **YV1** to the connector **XC1** situated over the hydraulic connector **QC1**
- connect cable of servo valve **YV2** to the connector **XC2** situated over the hydraulic connector **QC2**
- connect cable of power supply to the connector **XC3**
- check DC voltage of the data line (required 42-45V), then connect the data transmission cable to the connector **XC4** or for communication use the GSM modem and connect its antenna to the connector **XC5**
- connect the allarm line (two-level indications of ADT function to the control room) to the connector **XC6**
- connect the grounding screw by the proper cable to the existing grounding of the transformer

Flow diagram of ADT 2012 is shown on Fig. 2.

Detailed internal layout is shown in Fig. 3.

First start-up of the Altmann ADT 2012 should always be carried out by the manufacturer´s employe or through their designated service technicians.

ATTENTION !

Check the oil-level in the conservator tank always before first start up of the ADT2012.

- oil level should exceed the minimum mark by 1/3 of the scale in the conservator
- monitor this level continuously during the start-up procedure and during the operational stage: the oil level in the conservator tank should never fall below the minimum level indicator
- if the oil level falls below the minimum mark of the conservator tank, refill the oil immediately

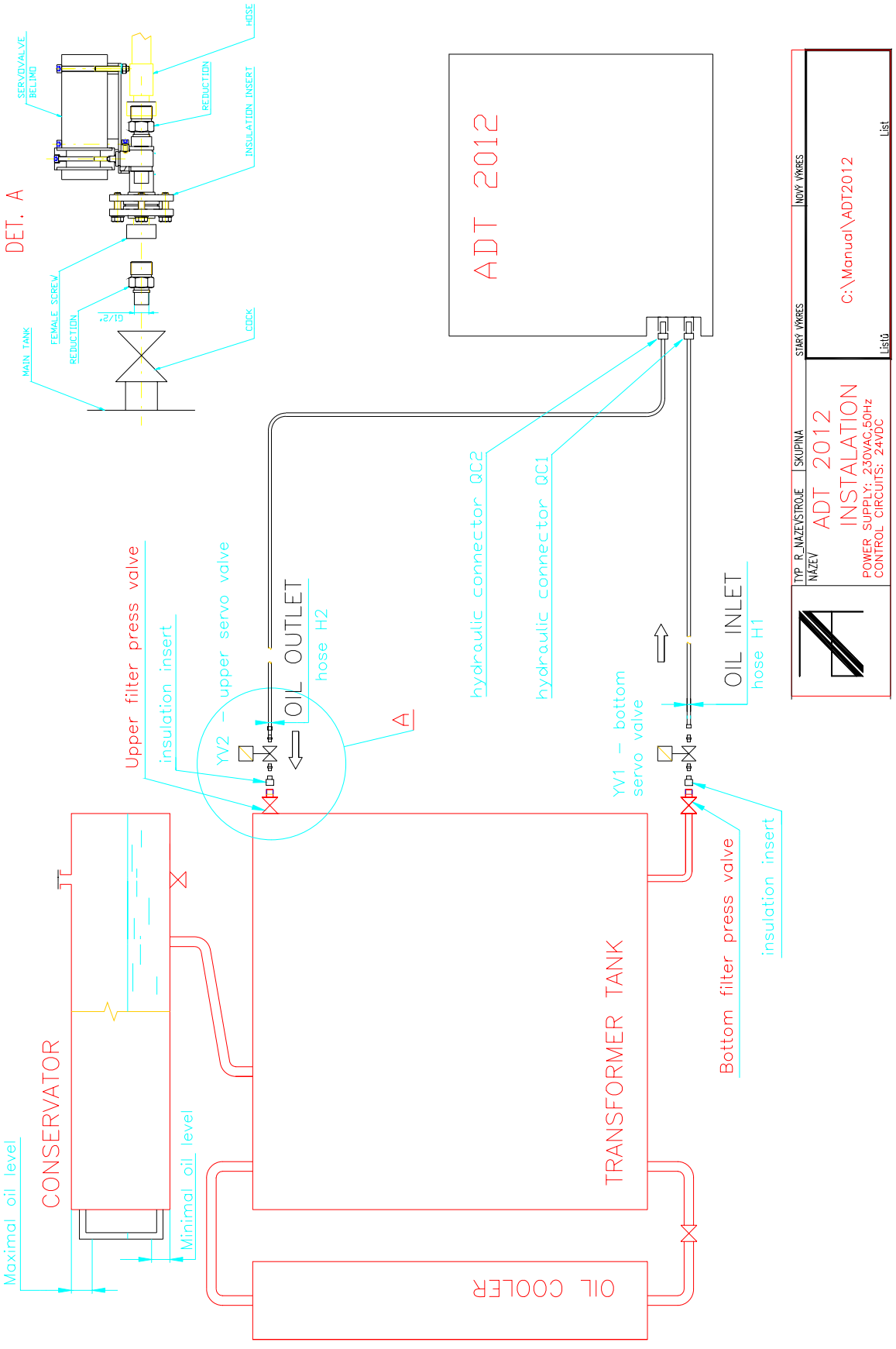
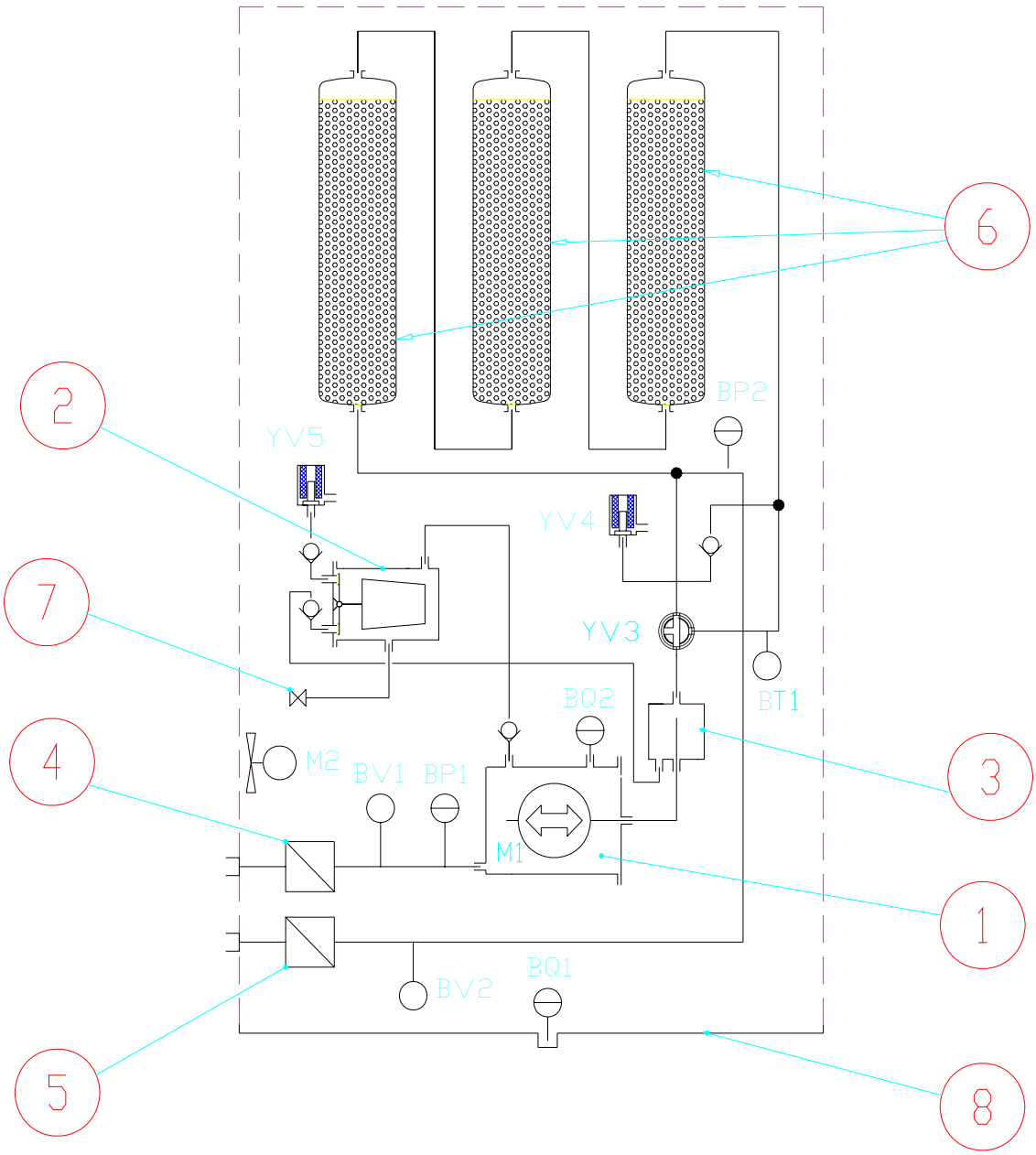


Fig.1 Installation



1	Hermetized gear pump	M1	gear pump
2	Accumulation chamber	BP1	inlet pressure sensor
3	Mixing chamber	BP2	outlet pressure sensor
4	Inlet filter	BV1	inlet humidity sensor
5	Outlet filter	BV2	oulet humidity sensor
6	Absorption column	BQ1	leagake sensor
7	Discharge cock	BQ2	oil level sensor
8	Oil sump	M2	fan
		YV3	three-way servovalve
		YV4	flushing solenoid valve
		YV5	exhaust solenoid valve
		BT1	oil inlet temperature (Tx bottom temp.)

Fig. 2 The ADT 2012 - flow diagram

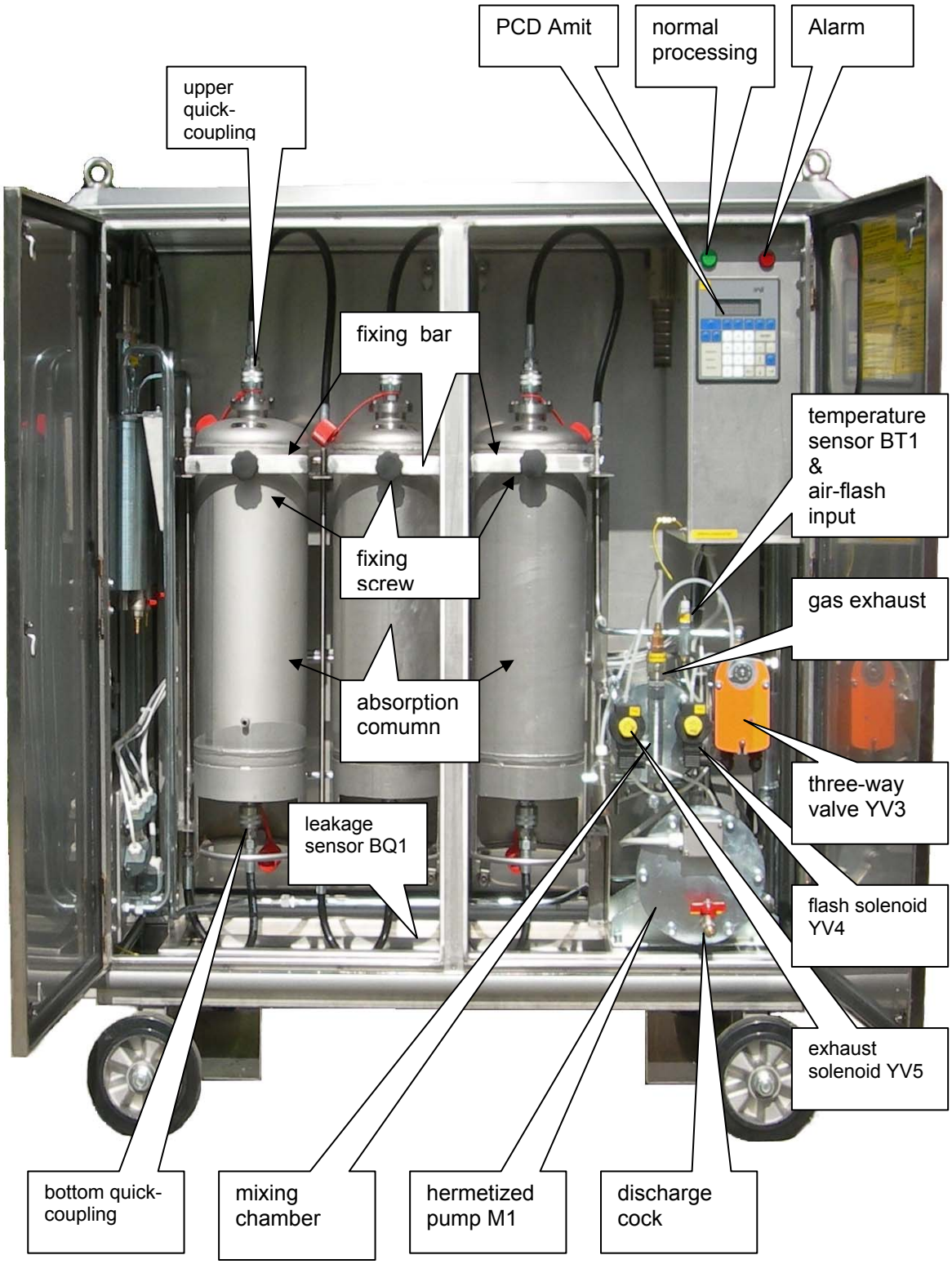


Fig.3 Interal layout of main components in ADT (open front doors)

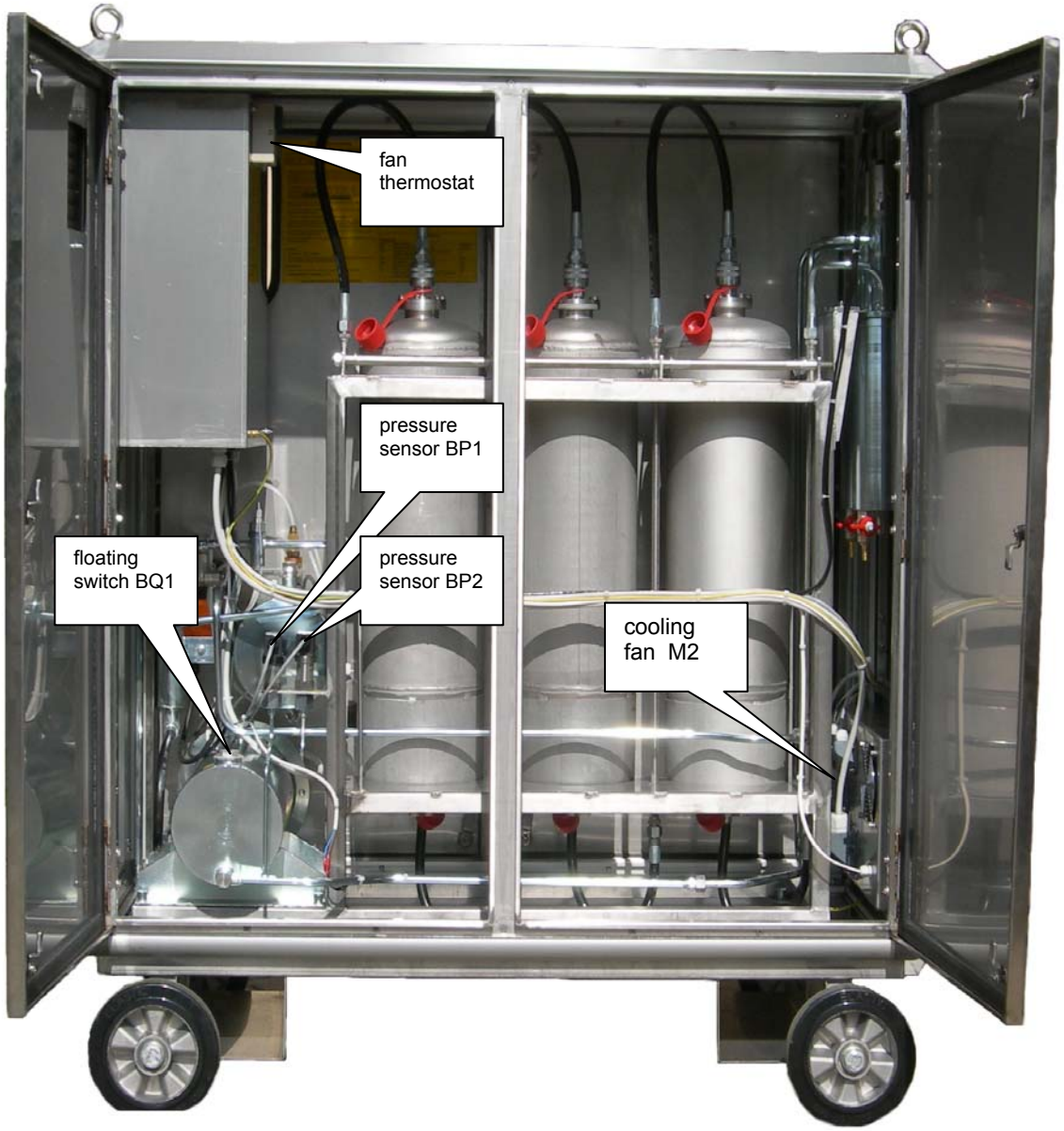


Fig. 4 Layout of components on the back side of ADT dehydrator

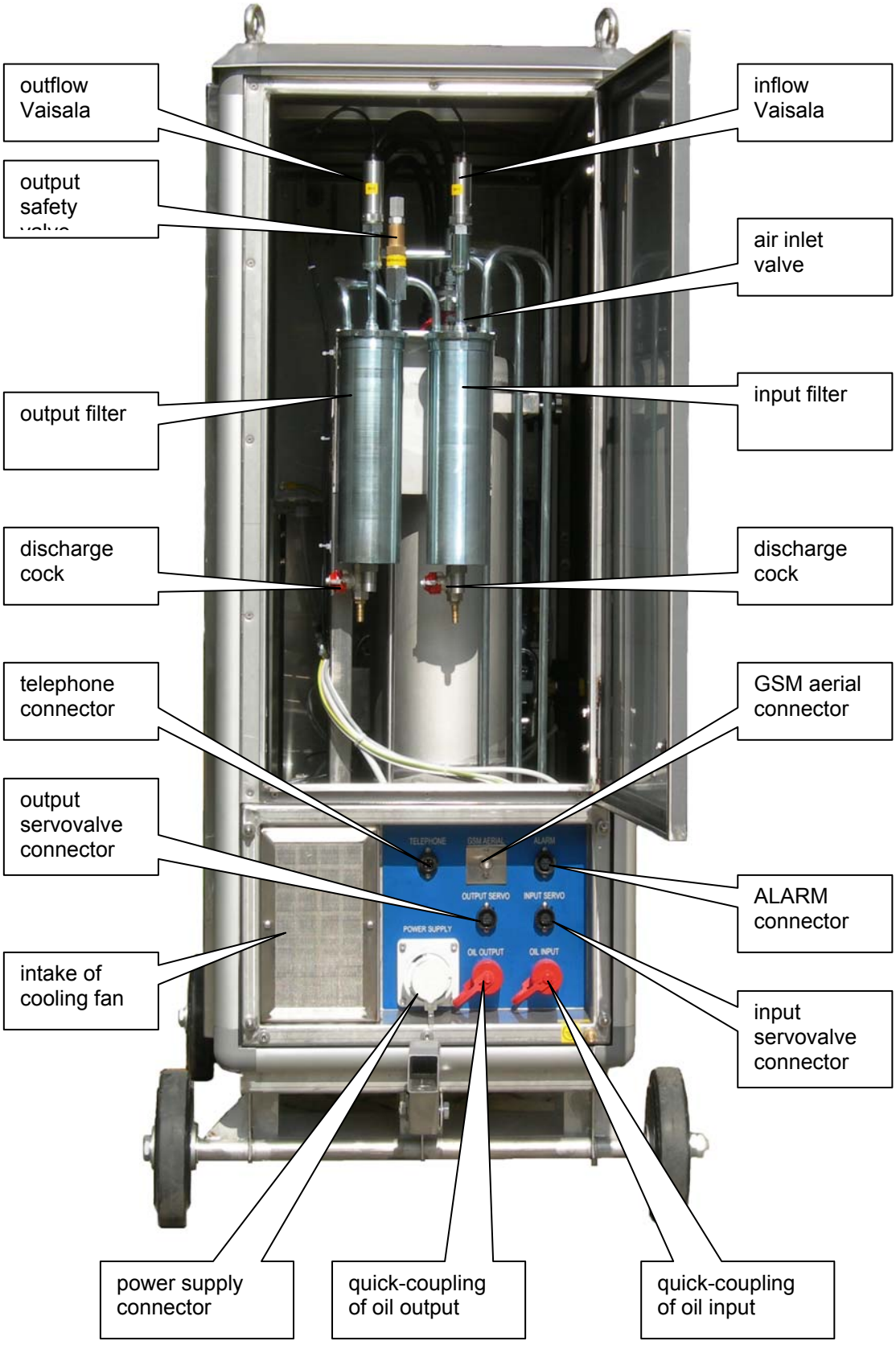


Fig 5. Layout of main components on the left side of ADT dehydrator

3. Function

3.1 Computer control

The ADT 2012 is specifically for on-power dehydration of oil-immersed cellulose insulation systems of power transformers.

The ADT-dehydrator is controlled by the „**P**rocess **C**ontrol **D**evice“ AMIT ART 4000 F.

Through remote data collection and transmission, **PCD** manages on-line the dehydration process in the dehydrator and of the whole transformer.

PCD enables the remote-monitoring of all important parameters of the dehydration process inside the transformer, and of the dehydrator‘s operation itself.

PCD allows to change by remote-control the important operative parameters of the dehydrator in order to guarantee optimum efficiency.

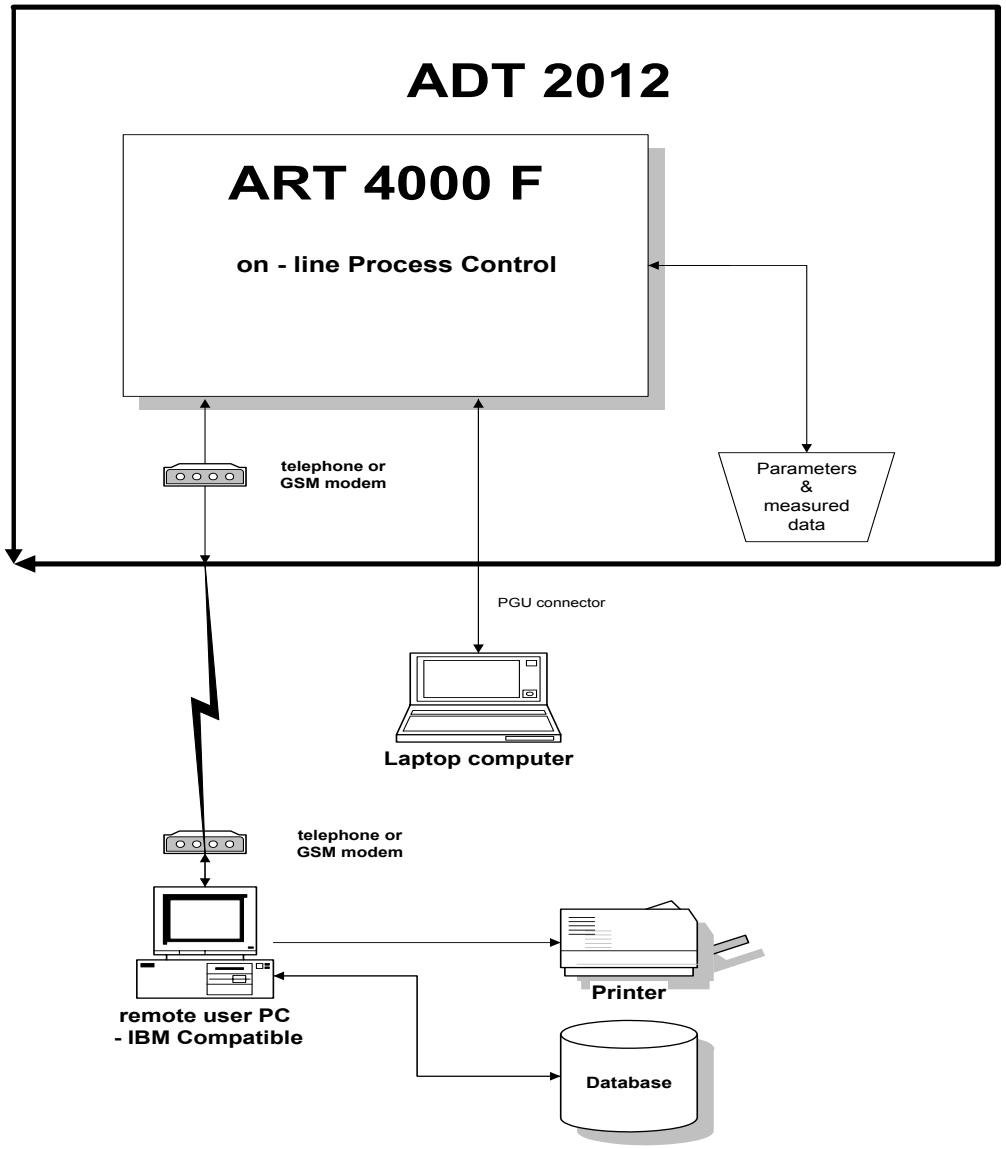


Fig. 6 Structure of control & communication of ADT
For more details about ADT Remote Control See Chapter 8.

The dehydrator is working without any local operator intervention or any necessary operating supervision. The **PCD** is increasing the self-governing autonomy of the dehydrator.

The operator‘s intervention is limited to:

⇒ connecting & disconnecting of the dehydrator to the transformer
(See **Installation**)

⇒ startup of the dehydrator by main-switch **QM1**
(See **Startup – Procedure**)

⇒ shutdown of the dehydrator (by main-switch **QM1** or pushing **F2** key on **AMIT** terminal
(See **Shutdown – Procedure**)

Any other in-situ activities of the operator are:

⇒ replacement of absorption columns - pushing **F3**
(See **Column Replacement – Procedure**)

⇒ changing the input filter insert - pushing **F4** key on **AMIT Terminal** (See **Inlet Filter Replacement - Procedure**)

⇒ changing the output filter insert - pushing **F5** key on **AMIT Terminal**
(See **Outlet Filter Replacement - Procedure**)

All these activities are computer controlled and supported. The computer requires operating activity on its terminal and then checks the results. The protection and any other functions of the dehydrator are solved in the same way.

Periodical monitoring, changes of parameters and all other functions can be realized by remote kontrol as well.

Table 1 shows list basic programs of ADT.

These programs are iniciated by pushing F1…F8 keys on **AMIT** terminal, or using the keyboard (for parameter changing).

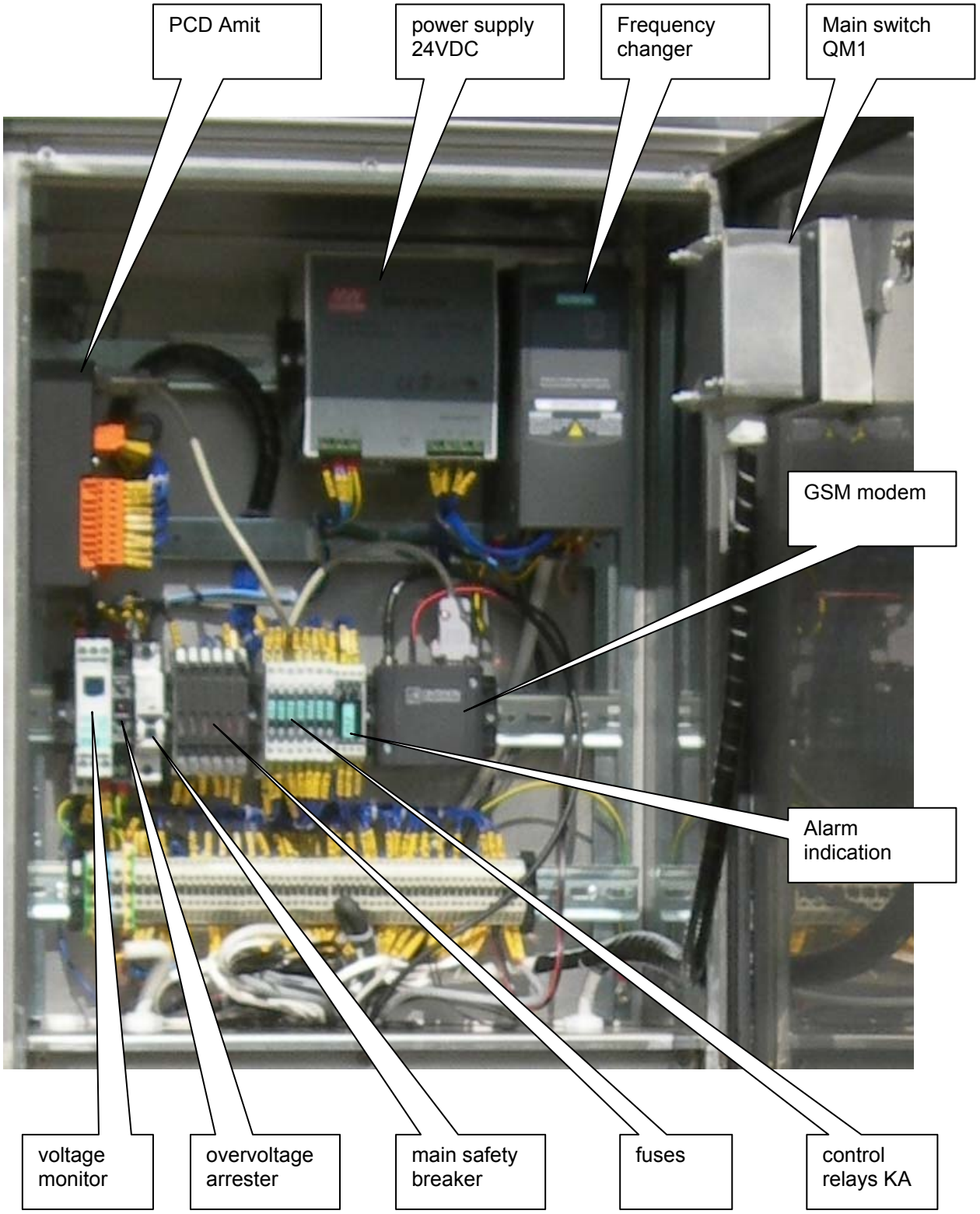
Push the selected key will start the choosen program.

Table 1 Key control

KEY	Activity
F1	Parameter change
F2	Computer controlled shutdown
F3	Computed controlled replacement of absorption columns
F4	Computer controlled input filter replacement
F5	Computer controlled output filter replacement
F6	Zero Setting (after startup at new transformer: Mwc-value has to be set to zero) *
F7	Calibration of moisture sensors
F8	Manual Control (all active elements of ADT can be switched ON/OFF)

* Mwc …. total amount of water removed from a given transformer during its dehydration
See: Data Table

The visual control of input / output relation of the PCD AMIT can be followed by means of LEDs situated in the ADT-switchboard See Relays K1-K5, Fig. 6



LED lighting = ON

KA1	Gear pump direct run	KA4	Oil output servovalve
KA2	Gear pump reverse run	KA5	ON/OFF indication
KA3	Oil input servovalve	KA6	

Fig. 7 Layout of ADT switchboard (right side of ADT)

Parameter Table

The function of Dehydrator ADT 2012 are controlled by four basic pre-set parameters and parameters can be changed any time by double pusching the key F1 which enables you to overwite the given parameter.

Value	Description	
PMAX	maximum allowed absolute pressure	250 kPa
PMIN	minimum demanded absolute pressure	30 kPa
PAUTO	filling pressure	90 kPa
Qwmin	minimum demanded amout of removed water per day	10 ml/day

Attention

All parameters are optimally selected by the producer.
Don´t change them without previous consultation.

3.2 Startup Procedure

To start the dehydrator switch the main switch **QM1** situated on the right side of ADT to the position I (ON).

The first STARTUP after the first installation of the ADT 2012 by a new klient *(or after the download of a new software)* always begins with the safeguard protocol :

PASSWORD ?
0

< ENTER >

Clicking on ENTER starts the subroutine for entering of the code numbers via PCD Amit keyboard.

PASSWORD ?
*** * * ***

< ENTER >

Four numbers have to be entered and confirmed by ENTER.

The safeguard protocol keeps the observance of contract and/or payment conditions.

ATTENTION :

Three attempts are allowed, then the PCD of the ADT 2012 is completely blocked and its recovery has to be performed either in situ by the producer staff or by remote control .

Two kind of PASSWORD are used here :

- **for time-limited operation** (ADT works only for limited time-period usually for 30 days). Then its ADT is automatically switched off.
- **for permanent operations** (the client obtains this specific password immediately after the fulfilment of contract conditions. When it is entered the ADT works permanently)

Under standard conditions e.g. by switching the main switch QM1 OFF / ON, the first display of the ADT dehydrator will show

COMMISSIONING

NEW START ?
PUSH < ENTER >

and enables to handle two accidental conditons which can happen during a standard ADT operation :

- **manual shut-down** (not recommended procedure) of the dehydrator via main switch **QM1 (OFF)**. Then the new start of the dehydrator is performed by switching on the **QM1** (**ON)** and subsequently by pushing ENTER.

Attention: Manual shutdown performed by QM1 usually induces the Overflow procedure : See Chapter ALARMS, which is only semiautomatic and requires the discharge of oil from the ADT.

- **automatic ADT restart after power outage**. As soon as power supply is restored, the PCD waits 3 minutes. If ENTER button isn´t pushed during this time-period then the dehydrator will continue in the previous procedure (dehydration).

The automatic start-up procedure first evacuates the whole outflow section of the dehydrator and the display shows:

ADT START UP **VACUUM PROCESSING** **IN OUTLET SECTION** **P1 =** P1 **P2=** P2 **(kPa)**

If the pressure **P2** in outlet section decreases below the preprogrammed absolute pressure **PMIN,** then the servovalve **YV2** will open automatically, **but the (upper) sampling cock at main tank of the transformer is still closed.** The air is expelled from the dehydrator via the exhaust valve and via the exhaust servovalve **YV5** into the surroundings.

If the desired vacuum cannot be reached the ADT automatically goes to the Overflow procedure See Chapter 5.

If the desired vaccuum is reached the PCD demands the opening of the upper valve (cock) on the transformer main tank

OUTLET ON VACUUM **OPEN UPPER VALVE** **AT TX MAIN TANK** **< ENTER >**

Subsequently the oil from the main tank will flush the outlet section. The flush of oil from the transformer continues automatically until the outlet part of dehydrator is filled.

If the pressure **P2** exceeds the preprogrammed absolute pressure **PAUTO,** the automatic transition to the next step begins

VACUUM PROCESSING **IN INLET SECTION** **P1 =** P1 **P2=** P 2 **(kPa)**

if the pressure **P1** in inlet section decreases below the preprogrammed absolute pressure **PMIN ,** then the servovalve **YV1** will open automatically.

The **AMIT Terminal** will report:

INLET ON VACUUM **OPEN BOTT. VALVE** **AT TX MAIN TANK** **< ENTER >**

The whole inlet section is in that way flushed by the oil from the transformer and if pressure **P1** exceeds the preprogrammed level **PAUTO** the **AMIT Terminal** will subsequently report the begining of ADT main procedure, theTx-dehydration.

3.3 Dehydration of transformer

The dehydration procedure is fully automatized and remote controled, local operator action is not necessary.

The display then show in the main window all basic data describing dehydration process

TX DEHYDRATION
Date …… time : ……..
Mw= …. Mwc= …. ml
Qw1= …., Qw2= …. ppm

any remaining data can be acccessed at any time by rolling the display down ↓

TX DEHYDRATION
P1 = …. kPa
P2 = …. kPa
T1 = …. C

and to get back to the main window roll up the display by ↑

Data Table

Value	Description	dimension
Mw	amount of removed water per day	ml/day
Mwc	total amount of water removed from specific transformer	ml
Qw1	input value of water content in oil	ppm
Qw2	output value of water content in oil	ppm
P1	Pressure in inlet section	kPa
P2	Pressure in oulet section	kPa
T1	temperature of oil (which roughly corresponds bottom temperature of transformer)	C

All the above mentioned data can be monitored from remote, their time-related change can be diagrammatized by the software packet OPTIM D2L. The basic data transfer is possible by SMS as well.

If the water capacity of absorption colums are exhausted the replacement of absorption columns is necessary.

The dehydration of transformer generally proceeds untill:

- o required amount of the water from given transformer is removed
- o required level of water content in oil is met
- o absorption capacity of dehydration columns (ca 8 kg of water) is exhausted and columns have to be replaced.

The ADT reports this specific situation as

COLUMNS EXHAUSTED
REPLACEMENT ?

YES <ENTER>

The exhaustion of absorption columns is reported by the red indicator lamp situated on the roof of ADT housing and simultaneously reports to control room.

After confirmation by ENTER the ADT goes to the procedure REPLACEMENT OF ABSORPTION COLUMNS

3.4 Replacement of Columns

The replacement of absorption columns can be started :

- o automatically as described above
- o manually by pusching the key F3, the same display is shown as above

To avoid :

- ➢ loss of oil from maintained transformer
- ➢ undesired mixing of oil from formerly maintained transformer into next transformer
- ➢ to reduce a potential oil spill
- ➢ decrease the transportation weight of exhausted collumns

the first step of replacement procedure, after the confirmation by ENTER, is always to remove the oil from all of the columns.

The oil removal is then indicated by the display

REMOVAL OF OIL
FROM COLUMNS
WAIT PLEASE
P1= …. P2= …. kPa

The output servovalve **YV2** is closed, three-way servovalve **YV3** is turned into second position and the reverse run of the gear pump gradually removes oil from all three absorption columns. The oil is then forced via the inlet hose back into the transformer.

If the pressure P2 decreases under pre-defined limit 80 kPa, the PCD opens the flush solenoid valve **YV4** and air ingress into the upper part of absorption columns then gradually forces all of oil residuals from the columns into the mixing chamber and then the gear pump subsequently forces the oil back into the transformer.

The flushing process is finished if all oil is removed and air flows into a mixing chamber and into the tank of the hermetized pump. When oil level in this tank decreases the float sensor **BQ2** is activated and the PCD will swich the pump off and close the input servovalve **YV1**.

End of oil removal is reported by the display

COLUMNS EMPTY
REPLACE ALL COLUMNS
FINISHED ?
YES <ENTER>

and replacement of all columns can be performed.

The replacement of columns is quite easy due to the quick-coupling in their upper- and bottom parts See Fig.8 :

- o disconnect upper and bottom quick coupling of all the columns (turn the sleeve of quick coupling counter-clockwise and remove the female connector from the socket)
- o loosen the front screw of the crossbar and tilt the crossbar upwards
- o lift the exhausted column from its bottom hook and remove it from the ADT
- o install new column(s), fix it by the crossbar and by the front screw and connect it hydraulically to the ADT in the opposite sequence

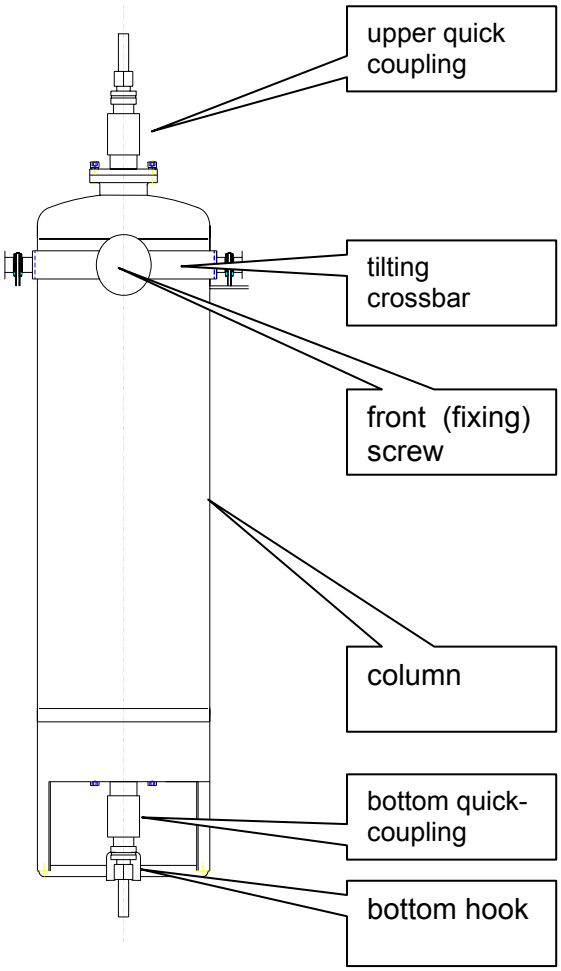


Fig. 8 Hydraulic connections and fixing points of a column

If properly prepared the replacement of all columns takes ca 10 min, maximum.

After pusching of ENTER then the ADT goes automatically back into START UP procedure both servovalves are closed and this transition process is indicated by the display

WAIT PLEASE

Before beginning of new STARTUP procedure the ADT demands

CLOSE BOTH VALVES **AT MAIN TANK** **CLOSED ?** **YES <ENTER>**

And the confirmation by ENTER then starts the STARTUP procedure and subsequently the DEHYDRATION procedure.

3.5 Shutdown - procedure

Dehydrator ADT can be any time shut down by :

- main switch **QM1**
- key **F2**

3.5.1 Main switch

When main switch **QM1** is set **ON→OFF** in approx. 10 sec both servo valves **YV1** and **YV2** are closed. This way the dehydrator is quickly a safely disconnected from the oil filling of transformer.

When **QM1** is set **ON** and the button ENTER is pusched the dehydrator is automatically started again.

But the ADT is usually full od oil and the requested underpressure P2(Pmin-level) in a subsequent Start Up procedure cannot be stabilized: See Overflow Alarm Chapter 5.1

Use the QM1 Shutdown under emergency conditions only

3.5.2 Computer controlled shutdown (this procedure is always strongly recommended especially before the ADT is installed on a next transformer to avoid an undesirable mixing of oils and to enable smooth Start up procedure)

Computer controlled shut-down procedure is inicialized by key **F2**

```
ADT SHUTDOWN


YES <ENTER
```

The output servovalve **YV2** will be closed and the reverse run of gear pump removes most of oil from the whole outlet section the same way as by REPLACEMENT Procedure.

```
REMOVAL OF OIL
FROM COLUMNS
WAIT PLEASE
P1= …..  P2 = …. kPa
```

The process is finished if all the oil is removed and air flows into the mixing chamber and hermetized pump.

```
COLUMNS EMPTY


<ENTER>
```

The residual oil volume in the ADT is in this way strongly reduced to avoid undesired contamination of oil filling of next transformer.

and after the clink on ENTER the ADT then demands the manual closing of both valves at main tank

```
CLOSE BOTH VALVES
AT MAIN TANK
CLOSED ?
YES <ENTER>
```

And after the confirmation of closing of both valves at main tank of Tx by pushing ENTER the last display will be shown

```
SHUTDOWN FINISHED
SWITCH ADT OFF
```

BY MAIN SWITCH

For the new Start-Up use the Main Switch OFF-ON .

3.6 Filter Replacement

Both filters, the inlet and outlet filter, are easy accesssible after opening the left door of ADT See Fig. 5.To avoid any loss and/or spil of oil, the computer controlled replacement of both filters is recommended.

3.6.1 Input Filter Replacement

The computer controlled replacement of input filter is started by pusching key F4.

INPUT FILTER
REPLACEMENT ?

YES <ENTER>

The inlet servovalve **YV1** will be closed and subsequently the gear pump runs in the normal direction.

If the pressure **P1** decreases under the **PMIN**-level, the gear pump is switched off and the output servovalve **YV2** is closed. The ADT dehydrator is hydraulically disconnected from oil filling of the transformer and the PCD reports that the replacement of input filter can begin.

REPLACE INLET FILTER

REPLACEMENT FINISHED?
YES <ENTER>

For detailed internal lay-out of both filters See Fig. 9.

Replacement Procedure:

- situate the oil-resistant bucket under the filter body
- loosen the bottom nut and drain the oil off into the bucket
- lift down the cylindrical mantle of the filter
- loosen the cartridge fixing nut from central holder and remove the washer
- pull down clogged inlet filter and replace with new
- check upper and bottom O-ring and replace them if necessary
- pull new cartridge on and fix it by the washer and fixing nut (the cartridge of output filter has to be modestly axially compressed by fixing nut to avoid bypassing of oil)
- reassembly the filter in the opposite sequence
- push ENTER

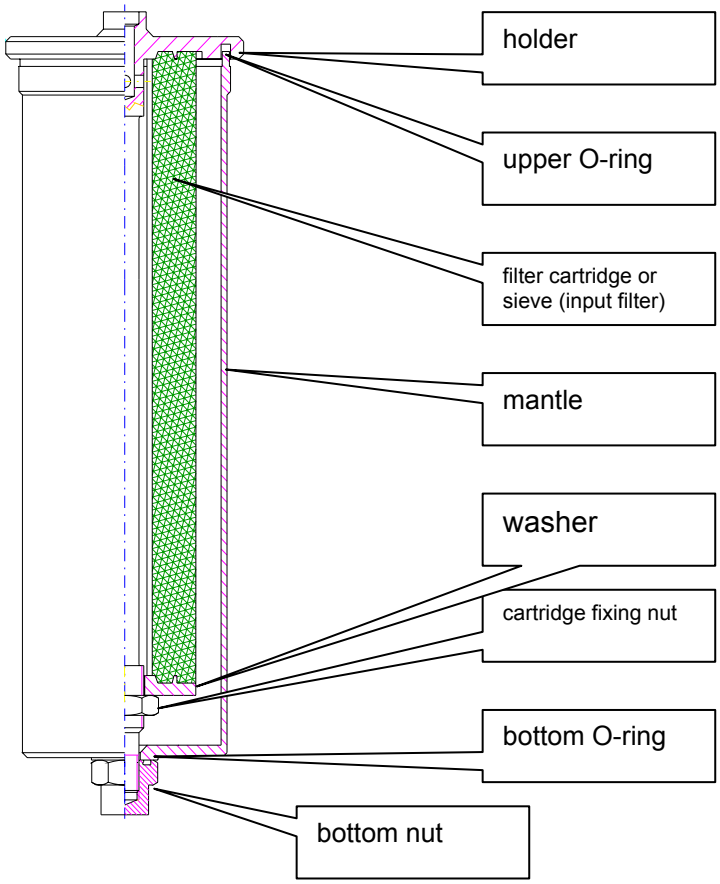


Fig. 9 Lay-out of the input and output filter

If properly performed the whole procedure takes ca 5 minutes.

After punching ENTER the ADT automatically continues in Start-Up procedure and subsequently starts the Dehydration again.

3.6.2 Output Filter Replacement

The computer controlled replacement of input filter is started by pusching key F5.

OUTPUT FILTER **REPLACEMENT** **YES <ENTER>**

The outlet servovalve **YV2** will be closed and subsequently the gear pump goes into the reverse run.

If the pressure **P2** decreases under **PMIN**-level, the gear pump is switched off and the input servovalve **YV1** is closed.

The ADT dehydrator is hydraulically disconnected from oil filling of the transformer and the replacement of output filter can begin.

REPLACE OUTPUT **FILTER** **FINISHED ?** **YES <ENTER>**

The Replacement Procedure is the same as by the Inlet Filter only different filter cartridge (1µm) is used:

After pusching of ENTER the ADT automatically continues in the Start-Up procedure and subsequently goes into the Dehydration.

3.7 Manual Control

The function of all computer controled parts of ADT (servovalves, direct and reverse run of gear pump) can be checked any time by Manual Control Procedure which is activated by pusching key F8.

ATTENTION

This kind of operation shoud be performed by authorized staff only.

The displays then show:

- in the first row the operation status of given part (ON or OFF)
- in the second row offers the change of given status by pushing **+** for ON , **-** for OFF
- in the third row shows the quantitative effect of this specific instruction on the main values P1 and P2.

The first display is used for a manual control of input servovalve

INPUT SERVOVALVE = ON **CHANGE : + ON / - OFF** **P1 = …. P2 = …. kPa** **ROLL FOR NEXT INSTR.**

All next displays are then achieved by rolling down by ↓

OUTPUT SERVOVALVE = ON **CHANGE : + ON / - OFF** **P1 = …. P2 = …. kPa** **ROLL FOR NEXT INSTR.**

INPUT SERVOVALVE = ON **CHANGE : + ON / - OFF** **P1 = …. P2 = …. kPa** **ROLL FOR NEXT INSTR.**

THREEWAY SERVO = ON **CHANGE : + ON / - OFF** **P1 = …. P2 = …. kPa** **ROLL FOR NEXT INSTR.**

PUMP DIRECT RUN = ON
CHANGE : + ON / - OFF
P1 = …. P2 = …. kPa
ROLL FOR NEXT INSTR.

PUMP REVERSE RUN = ON **CHANGE : + ON / - OFF** **P1 = …. P2 = …. kPa** **ROLL FOR NEXT INSTR.**

AIR FLUSH = ON **CHANGE : + ON / - OFF** **P1 = …. P2 = …. kPa** **ROLL FOR NEXT INSTR.**

AIR EXHAUST = ON **CHANGE : + ON / - OFF** **P1 = …. P2 = …. kPa** **ROLL FOR NEXT INSTR.**

and by rolling all displays up we will go back into the Dehydration procedure.

3.8 Calibration

The precision of input / output reading of water content in oil and subsequently the operation efficiency as the whole can be any time calibrated by pushing key F7.

The begining of calibration procedure is reported as

HUMIDITY SENSORS
CALIBRATION

WAIT PLEASE

The three-way valve YV3 is then adjusted such way that the same oil flows around active parts of input and output moisture sensor.

To avoid any distortion of reading the last absorption column of ADT has to be manually disconnected See Picture.

Disconnection procedure is very simple: turn sleeve in anticlockwise till decoupling

The ADT requests this kind of hydraulical disconnection by the display

DISCONNECT QUICK
COUPLING ON BOTTOM
OF LAST COLUMN
YES <ENTER >

and after pusching ENTER the Calibration procedure begins.

The readings of both sensors are compared and the absolute and relative deviation of reading is calculated.

The result of mutual calibration of both sensors is then presented as

CALIBRATION
ABS. DEVIATION = …. ppm
REL. DEVIATION = …. %
<ENTER>

after pushing ENTER the ADT requests the re-join of columns

CONNECT QUICK
COUPLING TO BOTTOM
OF LAST COLUMN
YES <ENTER >

if confirmed by ENTER the ADT goes then back into Dehydration procedure.

4. Protections

The ADT dehydrator is designed and build speciffically with remote control in order to operate for prolonged time periods without the necessity of any local supervision.

Therefore it is very important that any significant oil-loss will be ruled-out under any circumstances.

4.1 Oil loss

The dehydrator system consists of hermetically sealed hydraulic circuits (See Fig.1, 2 and 4). All these parts are hydraulically connected to the leakage tube (sump) in the bottom of dehydrator Ses Fig 8.

Any oil spil in the dehydrator system will be collected in this leakage tube. In the unlikely event of spill, leakage sensor **BQ1** mounted in the lowest part the tube will then generate oil loss Alarm. Immediatedly the dehydrator is stopped, and the servo valves shut-down.

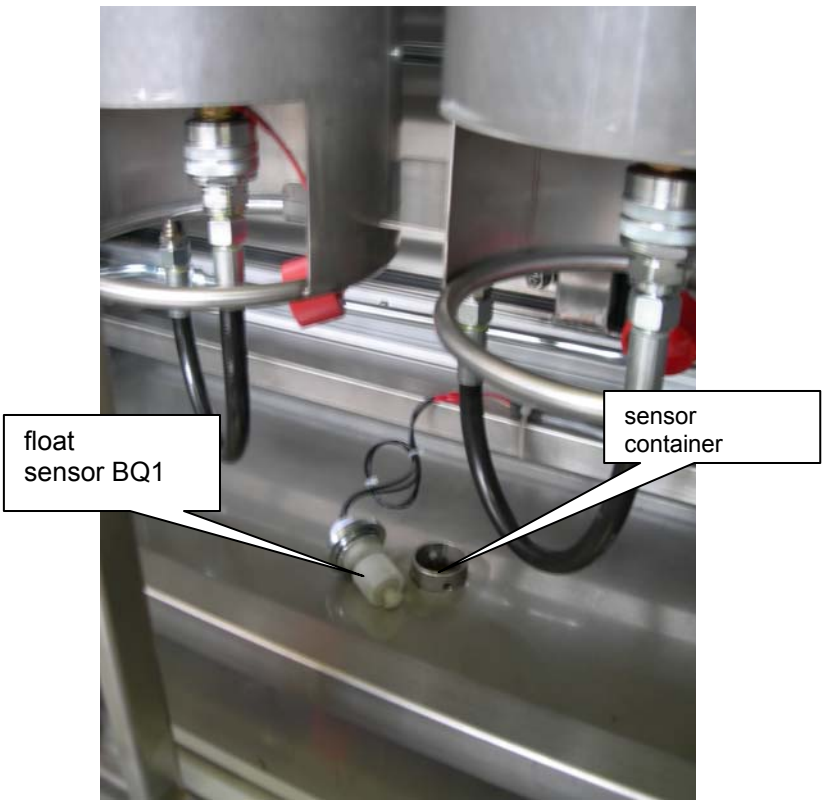
Thus, in 10 seconds of detecting oil-spill, the transformer will be hydraulically disconnected from the dehydrator by closing down the two servo valves **YV1** and **YV2.**

The oil-leak Alarm is immediately indicated on the display of the **ADT** display

OIL LEAK **FIND & REPAIR LEAKAGE** **DRY OUT SENSOR BQ1** **RESET BY QM1 OFF/ON**

by the red lamp on the roof of dehydrator and by the ALARM line to the control room (if requested).

After the detecting and sealing of leakage (and drying of container of leakage sensor **BQ1** – See photograph picture showing disassembled float sensor), reset the dehydrator by switching main switch **QM1** OFF and ON.



4.2 Overpressure

All hydraulic chambers of ADT are protected against overpressure in two levels:

- PCD controls the pressure **P1** and **P2**, and will recognize if these values will exceed the allowed limits **PMAX** (See **Parameter Table** . If this happens, the dehydrator is automatically shut off, and this state is indicated on the display, the the red lamp on its roof and corresponding signal is transmitted into control room.

If pressure P1 on the pump exceeds **PMAX** , alarm is generated (the red bulb on the roof is ON), and display on **ADT** terminal will indicate:

OVERPRESSURE P1
ÄLL VALVES ON
INFLOW ARE OPEN ?
RESET BY QM1 OFF/ON

If pressure P2 in the main chamber exceeds **PMAX** , alarm is generated (the red bulb on the roof is ON),, and display on **ADT** terminal will indicate:

OVERPRESSURE P2
ALL VALVES ON
OUTFLOW ARE OPEN ?
RESET - QM1 OFF/ON

- Hydro-mechanically **-** by safety valve. See the Fig.2,3 and 5 . If the pressure exceeds allowed limit **PMAX** + 50 kPa , the safety valves will be opening. Thus both pressure levels will stabilize.

In a very improbable case of the failure of both above mentioned safely levels, the third safely level represents the properly-dimensioned motor of the gear pump.

If the P2-level exceeds ca 500 kPa , the motor of gear pumps is overloaded, stops and corresponding overcurrent relay switch-off the motor.

5. Alarms

All vital functions of dehydrator are continuously observed, recognized and supervised by PCD.

ALARM is generated and indicated if PCD recognizes, that measured parameters P1, P2 will exceed preprogrammed , given criteria (oil loss) or the Overflow condition occurs .

ALARM is indicated on ADT terminal, by the red bulb on the roof and corresponding two-level signal can be transmitted to control room as well (See Fig. 4: two-level connector) .

ALARM is transmitted to the supervisor by remote PC – See Manual **VS-06 Remote Control** .

5.1 Overflow

The Overflow procedure is initialized by manual shutdown or a similar process which causes the overfilling of ADT internal spaces by oil and subsequently blocks a vacuum processing during the Start-Up procedure.

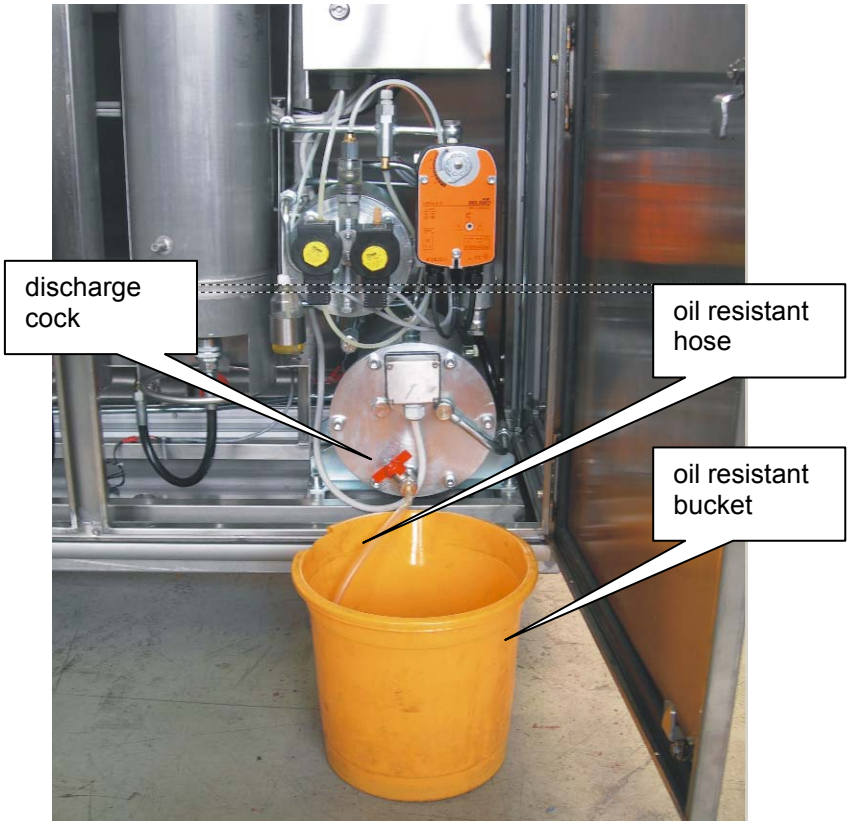
The Overflow procedure is reported by the display

OIL OVERFLOW
CLOSE BOTH VALVES
AT MAIN TANK
CLOSED ? YES <ENTER>

Next displays then recommend the necessary steps according to this procedure

CONNECT HOSE TO
DISCHARGE COCK AND
OPPOSITE END PLACE
INTO BUCKET <ENTER>

The example of this connection is shown in the next picture.



The next display demands opening of discharge cock

SLOWLY OPEN **DISCHARGE COCK** **OPENED ?** **YES <ENTER>**

Clicking on ENTER starts the discharge of superfluous oil from ADT: ca 2 literes have to be discharged till full recovery of vacuum processing conditions occurs.

Required and stable vacuum level is then reported by the display

CLOSE **DISCHARGE COCK** **CLOSED ?** **YES <ENTER>**

And after confirmation by ENTER the ADT automatically goes back to STARTUP procedure.

6. Maintenance

The ADT Dehydrator requires minimum maintenance.

Neverthelless, it is recommended that a regular maintenance schedule concerning potential clogging of both filters should be established:

6.1 Input filters - for Replacement See Chapter **3.6.1**

6.2 Ouput Filler - for Replacement See Chapter **3.6.2**

7. Electrical circuits

Power Circuit diagram is shown on Fig. 10 , Control Ciscuit diagram is shown on Fig.11

Name	Function	Designation	Qty.	Producer / Vendor
QM1	Main switch	3LD064-OTB53	1	Siemens
CONNECTORS				
XC1	Power supply	Mennekes, typ 826, 16A, 3p	1	Siemens
XC2	Output servovalve	C016 20G003 100 12	1	Amphenol
XC3	Input servovalve	C016 20G003 100 12	1	Amphenol
QF1	Main breaker	5SX21-B16	3	Siemens
FV1	Overvoltage relay	DA 275 DJ	1	Saltek
Tube fuse				
FU1	Frequency changer	T/12,0A 5x20 35A	1	GES Electronics
FU2	Power Supply	T/4,0A 5x20 35A	1	GES Electronics
FU3	Fan	T/2,0A 5x20 35A	1	GES Electronics
FU4	Lighting	T/2,0A 5x20 35A	1	GES Electronics
FU5	Control Circuit	T/2,0A 5x20 35A	1	GES Electronics
FU6	Control circuit	T/2,0A 5x20 35A	1	GES Electronics
AC / DC POWER SUPPLY UNIT				
GS1	Frequency changer	Micromaster 420, 6SE 6420-2UD21-1AA1	1	Siemens
GU1	Power supply 24DVC	MW,DRP 240-24	1	MEAN WELL
FV2	Monitoring relay	3UG46 33-AL30	1	Siemens
SERVOVALVES				
YV1	Oil Input	Belimo LF 24	1	MaR
YV2	Oil Output	Belimo LF 24	1	MaR
YV3	Three-way valve	Belimo LF 24	1	MaR
YV4	Air Flashing		1	
YV5	Air Exhaust		1	

MOTOR				
M1	Gear pump	1LA7063-4AB16	1	Siemens
M2	Fan	4114NH4, 24V DC	1	Pabst

SENSORS				
Process pressure 4-20 mA				
BP1	Pressure sensor	DMP331 0– 6 b	1	BD Sensors
BP2	Pressure sensor	DMP331 0 – 6b	1	BD Sensors
ON/OFF				
BQ1	Leakage sensor	RSF 54 Y 100 RC	1	LAC
BQ2	Pump Oil level sensor	CCS-1-FL-1-8T		Control Components Pty
Temperature				
BT1	Input Oill temp.	PT30, Ni 1000	1	Rawet
Water content in oil				
UA1	Oil input	MMT 162	1	Vaisala
UA2	Oil output	MMT 162	1	Vaisala

CONTROL				
DF1	Proces Control Unit	ART 4000F	1	AMIT

COMMUNICATION				
UH1	Modem (landline)			US Robotics
	or GSM Modem	Cinterion Mc55i	1	SEA s.r.o.

Process Relays				
KA1	Motor pump-direct run	3TX7 004 1MB00	1	Siemens
KA2	Motor pump–reverse run	3TX7 004 1MB00	1	Siemens
KA3	Input servovalve	3TX7 004 1MB00	1	Siemens
KA4	Output servovalve	3TX7 004 1MB00	1	Siemens
KA5	Three-ways servovalve	3TX7 004 1MB00	1	Siemens
KA6	Solenoid valve-Flashing ON/OFF	3TX7 004 1MB00	1	Siemens
KA7	Solenoid valve-Exhaust ON/OFF	3TX7 004 1MB00	1	Siemens
KA8	Signal On/Off Operation	3TX7 004 1MB00	1	Siemens

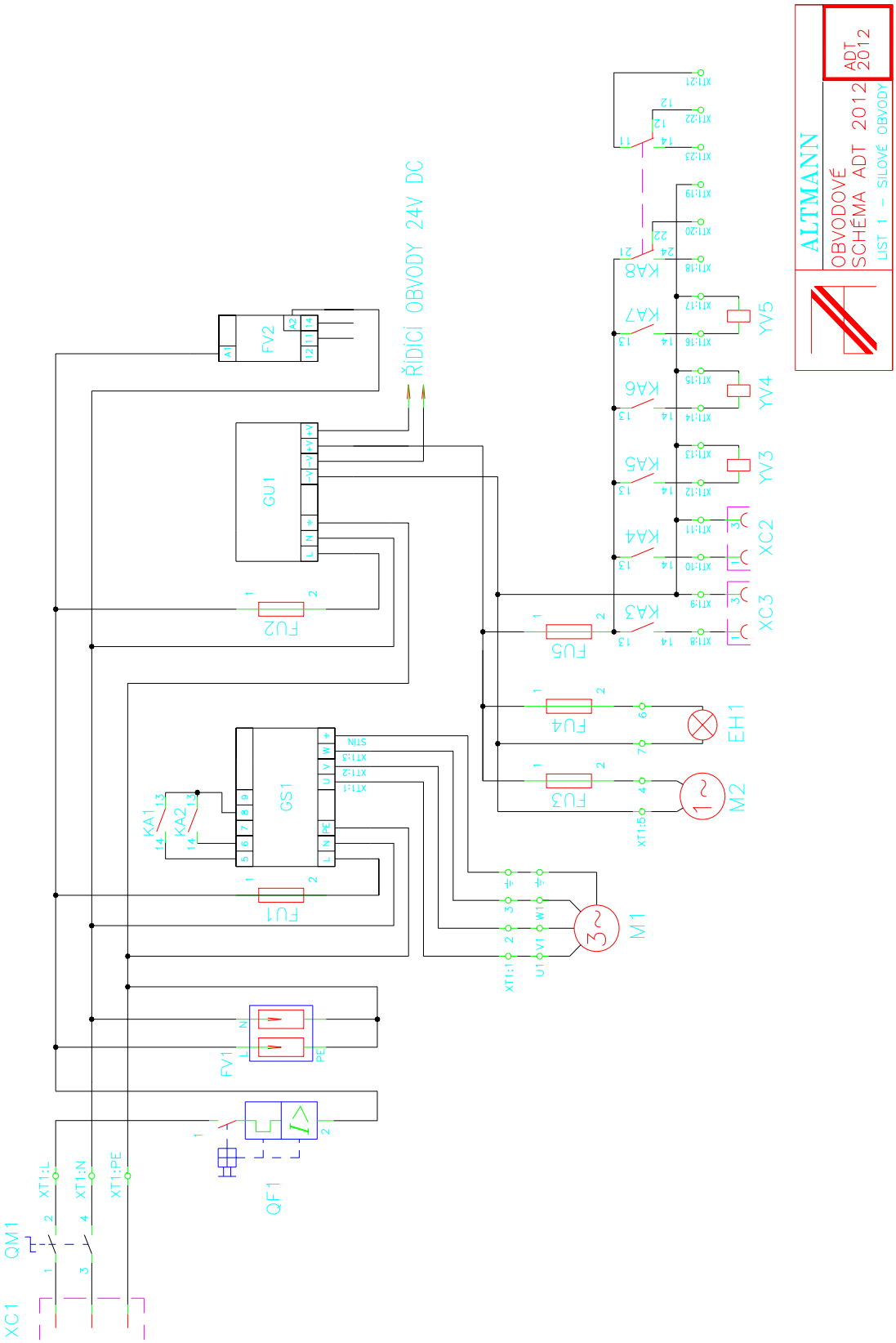


Fig. 10 Power circuit diagram

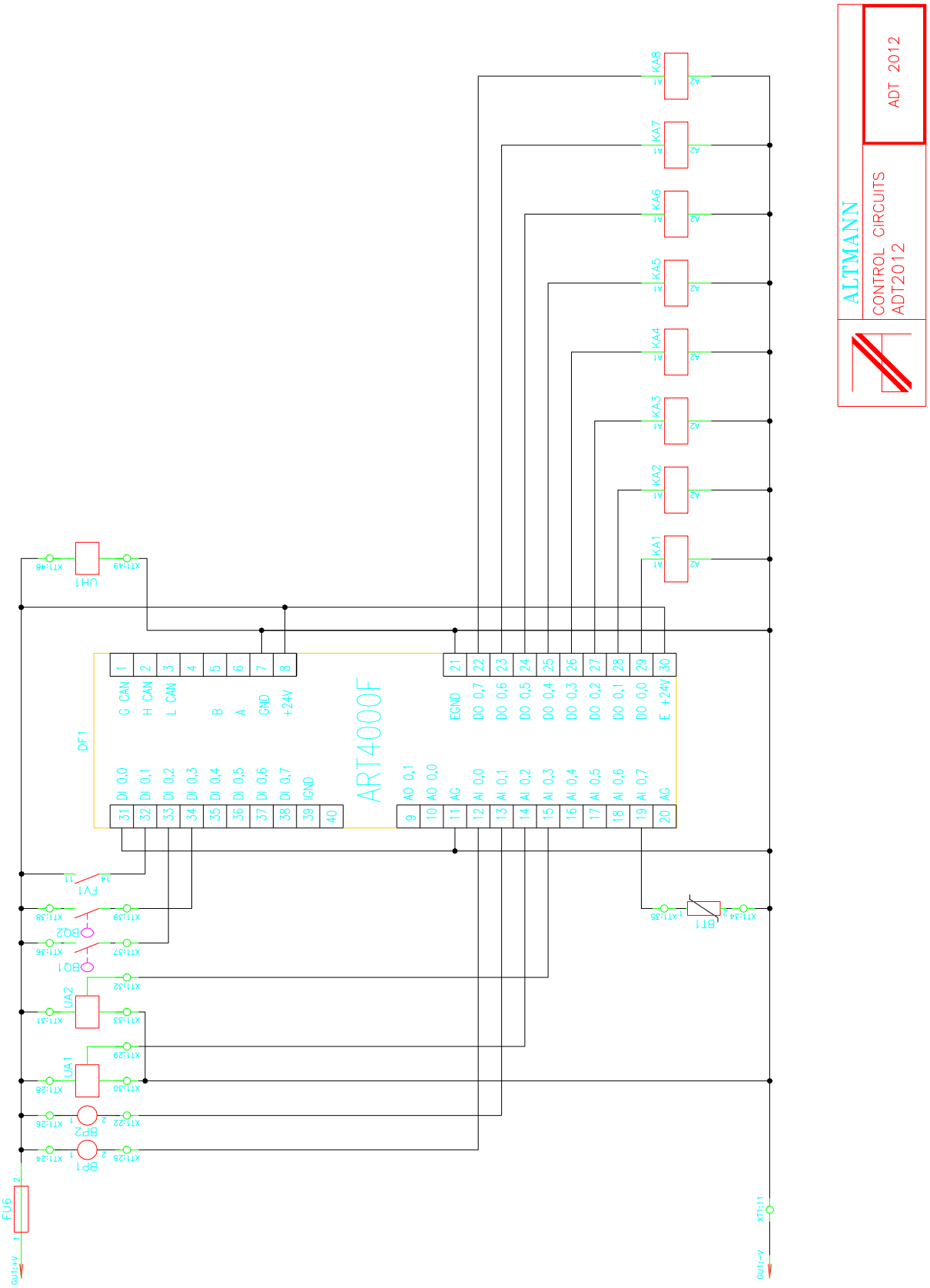


Fig. 11 Control circuits

8. Remote Control

8.1 Program installation

Program OPTIM D2L - delivered CD disk - contains the main program for the remote (and in situ) control and the monitoring of ADT 2012 and additional sub-programs that enable an easy installation of the whole firmware into your computer.

Installation procedure:

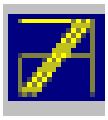
- insert ALTMANN CD into disk drive (usually **D**)

  under a normal operational condition is CD installed automatically

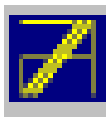
  if not

  - choose **START** and press **RUN**
  - type **D:\setup.exe**. into the command line
  - Press **OK (Enter)** to confirm the procedure.
  - After the **SETUP** panel has appeared, click on **TARGET** and choose the target directory into which you want to install the program. The program will offer you one of the possibilities (C:\ Altmann). Press OK to accept this offer
  - Click on **START** and program SETUP will install program ALTMANN into your computer
  - Press **OK (Enter)** to confirm the procedure

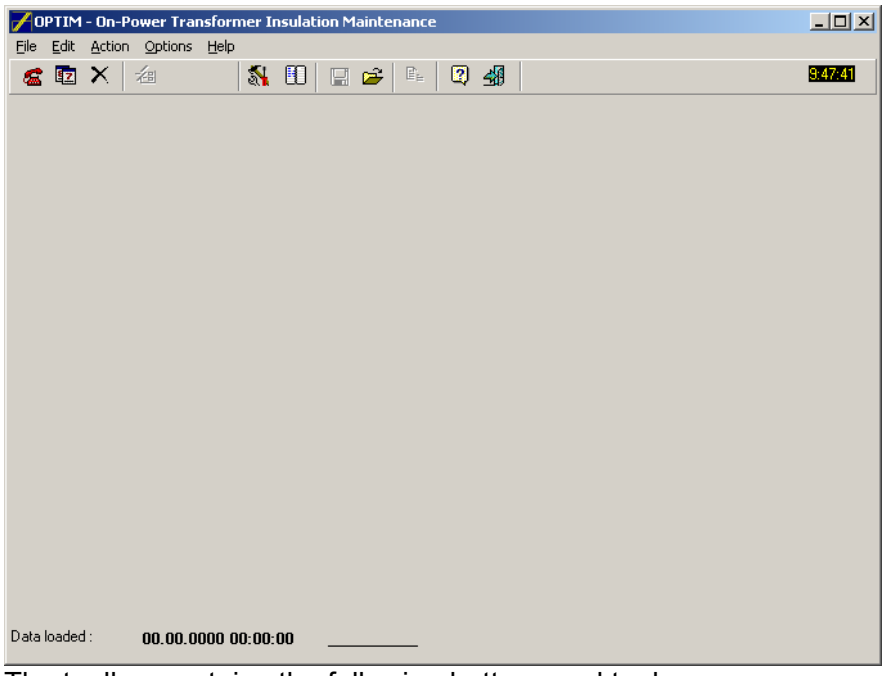
and your PC will offer you a window with the firm icon.



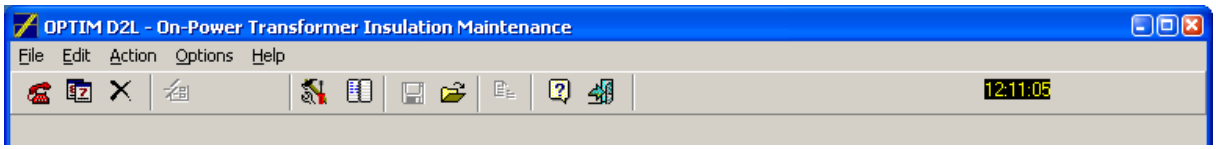
8.2 Starting the program

Click on the Altmann´s firm icon to  launch the program.

Having launched the program basic windows will appear.

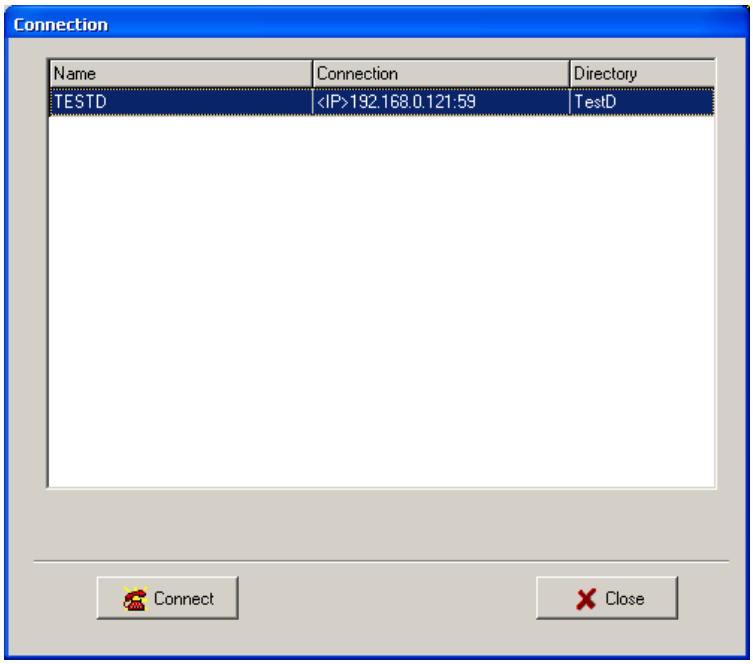


The toolbar contains the following buttons and tools -
click on particular buttons of the toolbar to enter various applications



8.3. Remote communication

Click on the icon opens the new window for the choice of the telephone number of the desired separator.

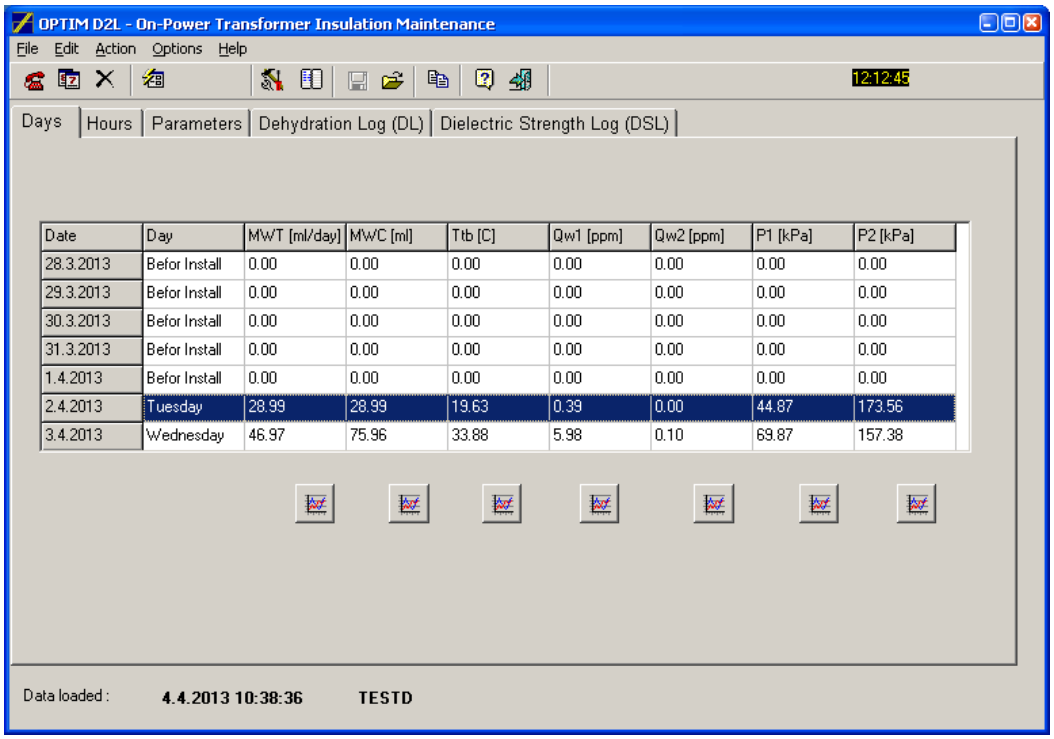


Attention : Before beginning a communication the programming of ***Communication Setup*** *and* ***Telephone directory*** *is neccessary.*

After click on the **Connect** the modem is started and the connection realized. The operational data separator are transfered at two time levels and summoned under auxiliary toolbar:

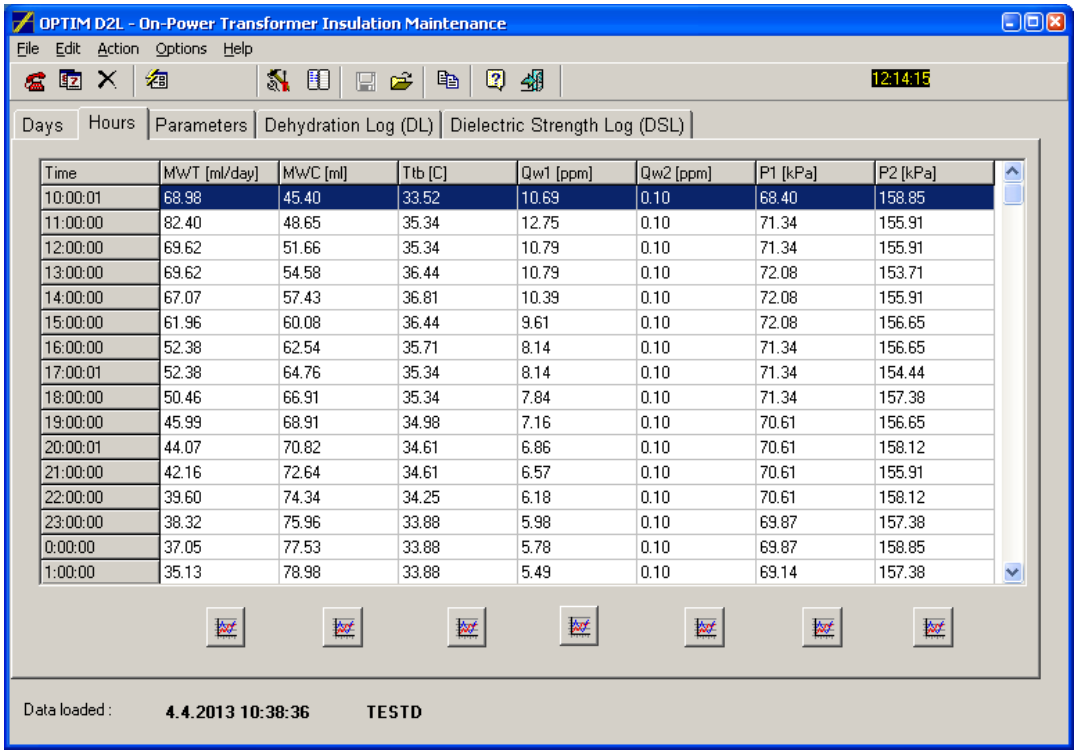
8.4 Data Transfer Button 

- last seven days (button **Days**)



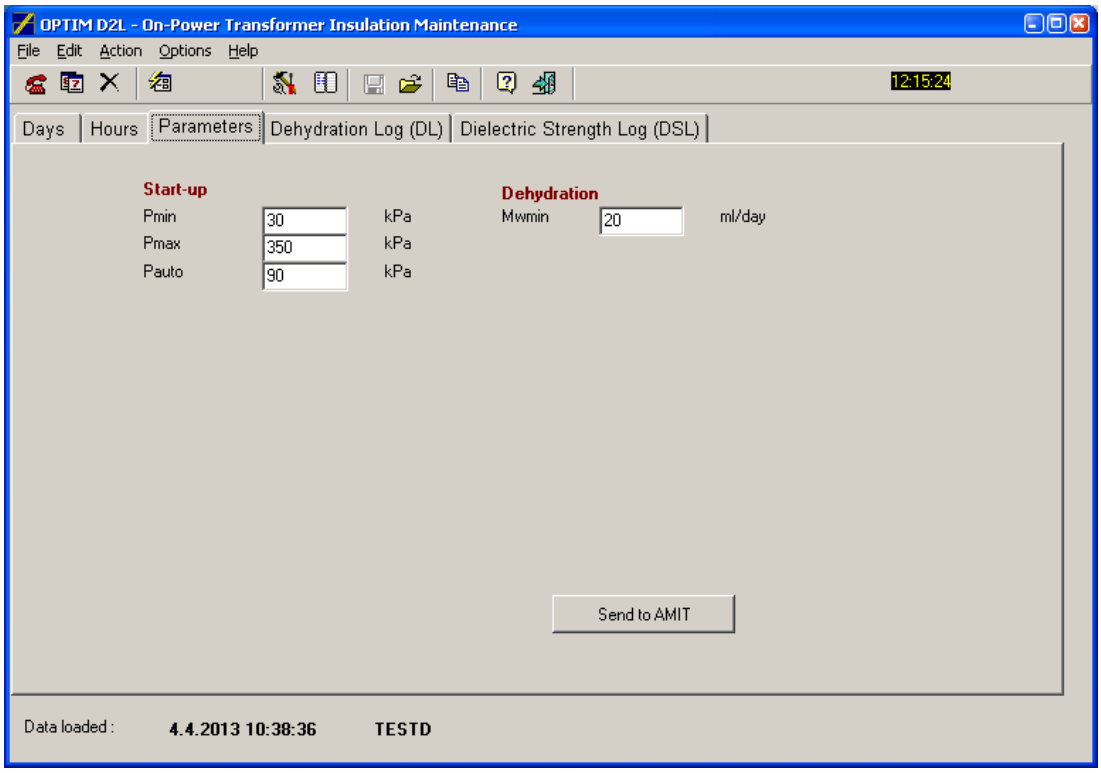
Date	Day	MWT [ml/day]	MWC [ml]	Ttb [C]	Qw1 [ppm]	Qw2 [ppm]	P1 [kPa]	P2 [kPa]
28.3.2013	Befor Install	0.00	0.00	0.00	0.00	0.00	0.00	0.00
29.3.2013	Befor Install	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30.3.2013	Befor Install	0.00	0.00	0.00	0.00	0.00	0.00	0.00
31.3.2013	Befor Install	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.4.2013	Befor Install	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.4.2013	Tuesday	28.99	28.99	19.63	0.39	0.00	44.87	173.56
3.4.2013	Wednesday	46.97	75.96	33.88	5.98	0.10	69.87	157.38

- last 24 hours (button **Hours**)



Time	MWT [ml/day]	MWC [ml]	Ttb [C]	Qw1 [ppm]	Qw2 [ppm]	P1 [kPa]	P2 [kPa]
10:00:01	68.98	45.40	33.52	10.69	0.10	68.40	158.85
11:00:00	82.40	48.65	35.34	12.75	0.10	71.34	155.91
12:00:00	69.62	51.66	35.34	10.79	0.10	71.34	155.91
13:00:00	69.62	54.58	36.44	10.79	0.10	72.08	153.71
14:00:00	67.07	57.43	36.81	10.39	0.10	72.08	155.91
15:00:00	61.96	60.08	36.44	9.61	0.10	72.08	156.65
16:00:00	52.38	62.54	35.71	8.14	0.10	71.34	156.65
17:00:01	52.38	64.76	35.34	8.14	0.10	71.34	154.44
18:00:00	50.46	66.91	35.34	7.84	0.10	71.34	157.38
19:00:00	45.99	68.91	34.98	7.16	0.10	70.61	156.65
20:00:01	44.07	70.82	34.61	6.86	0.10	70.61	158.12
21:00:00	42.16	72.64	34.61	6.57	0.10	70.61	155.91
22:00:00	39.60	74.34	34.25	6.18	0.10	70.61	158.12
23:00:00	38.32	75.96	33.88	5.98	0.10	69.87	157.38
0:00:00	37.05	77.53	33.88	5.78	0.10	69.87	158.85
1:00:00	35.13	78.98	33.88	5.49	0.10	69.14	157.38

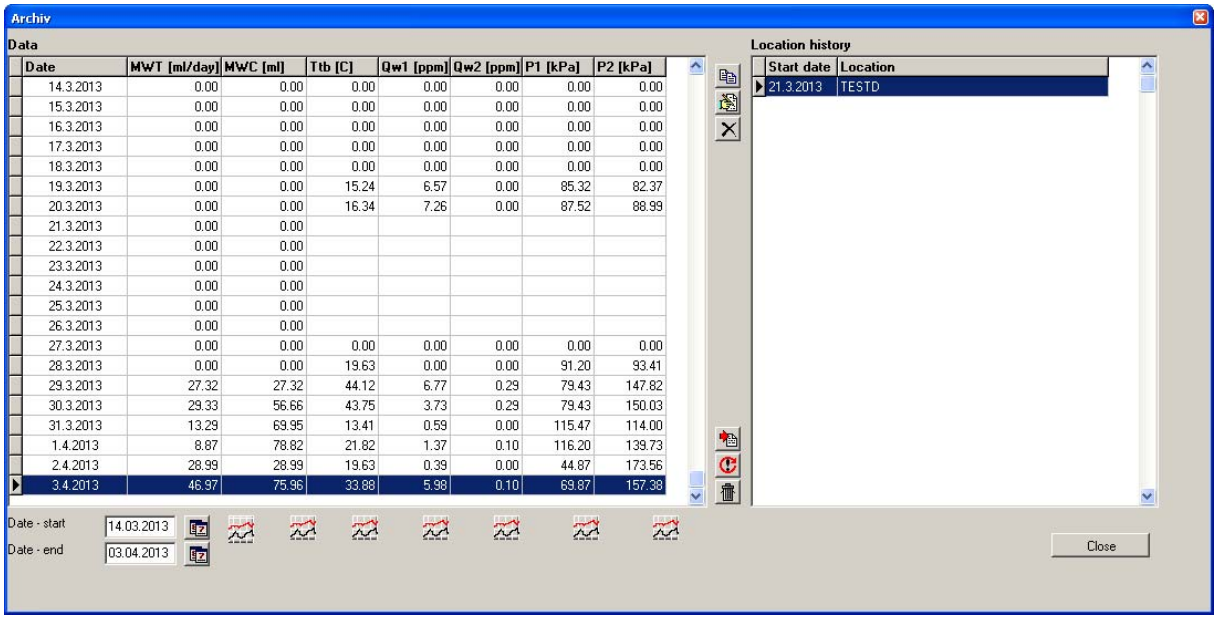
and the same toolbar contains a table **Parameters** which enables the remote re-programing of the vacuum separator (See Parametrical Programming)



8.5 . Return button – enables return into a main window

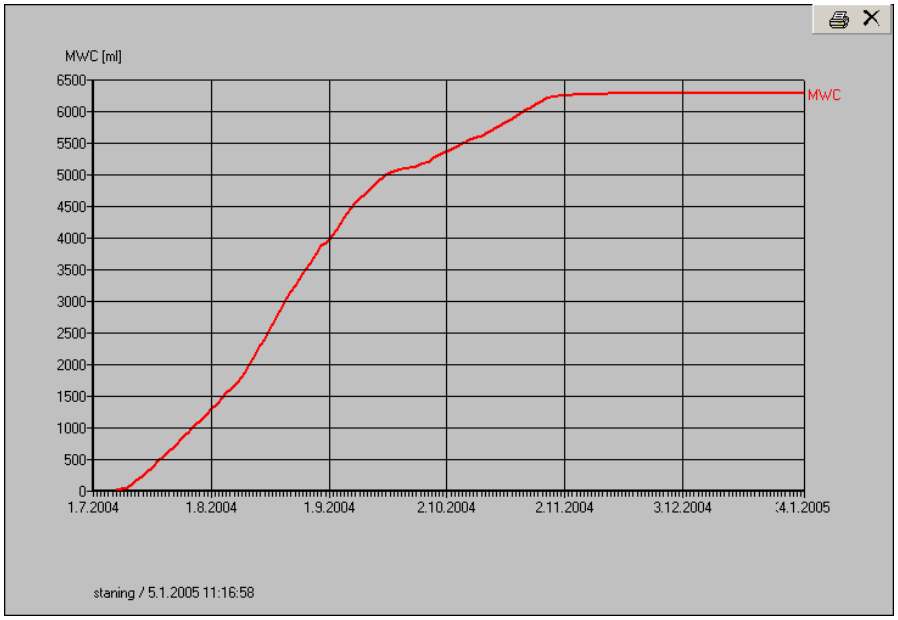
8.6 Archive

Click on button **Archive** opens a data table which contains all **Days** data from the beginning a drying procedure at the given transformer. This database is automatically actualized by click on **Connect**. The database Archive contains data all maintained transformers by the given separator and is saved at a remote PC level .



Date	MWT [ml/day]	MWC [ml]	Ttb [C]	Qw1 [ppm]	Qw2 [ppm]	P1 [kPa]	P2 [kPa]
14.3.2013	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15.3.2013	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16.3.2013	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17.3.2013	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18.3.2013	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19.3.2013	0.00	0.00	15.24	6.57	0.00	85.32	82.37
20.3.2013	0.00	0.00	16.34	7.26	0.00	87.52	88.99
21.3.2013	0.00	0.00					
22.3.2013	0.00	0.00					
23.3.2013	0.00	0.00					
24.3.2013	0.00	0.00					
25.3.2013	0.00	0.00					
26.3.2013	0.00	0.00					
27.3.2013	0.00	0.00	0.00	0.00	0.00	0.00	0.00
28.3.2013	0.00	0.00	19.63	0.00	0.00	91.20	93.41
29.3.2013	27.32	27.32	44.12	6.77	0.29	79.43	147.82
30.3.2013	29.33	56.66	43.75	3.73	0.29	79.43	150.03
31.3.2013	13.29	69.95	13.41	0.59	0.00	115.47	114.00
1.4.2013	8.87	78.82	21.82	1.37	0.10	116.20	139.73
2.4.2013	28.99	28.99	19.63	0.39	0.00	44.87	173.56
3.4.2013	46.97	75.96	33.88	5.98	0.10	69.87	157.38

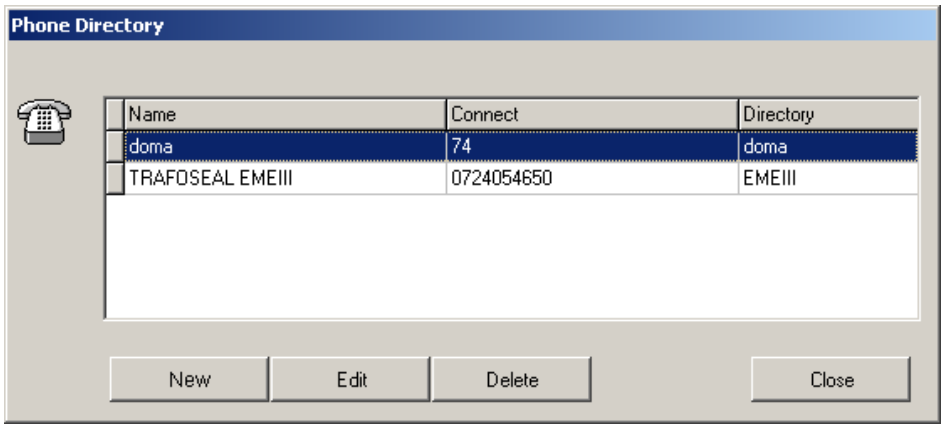
and click on the graph button under the data column opens time-related data visualisation



For detailed data evaluation See Section 12 and 13.

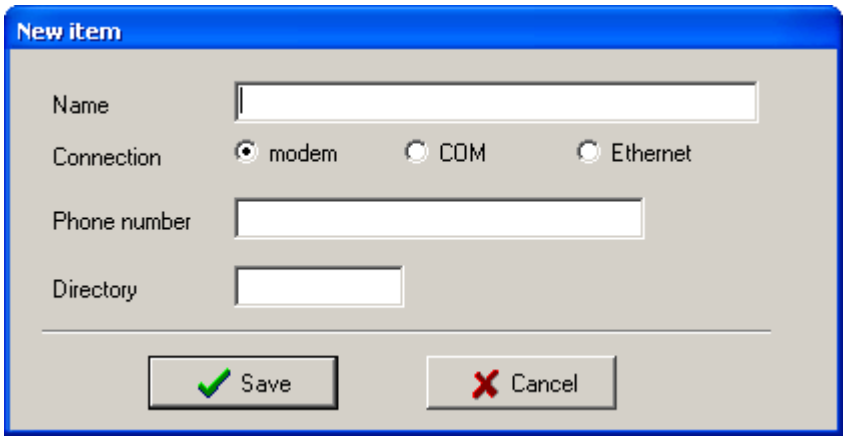
8.8 Telephone directory

The „telephone directory“ database is used to avoid mistakes and for fast choice of the communication with the separator.



For actualizing choose button on the toolbar

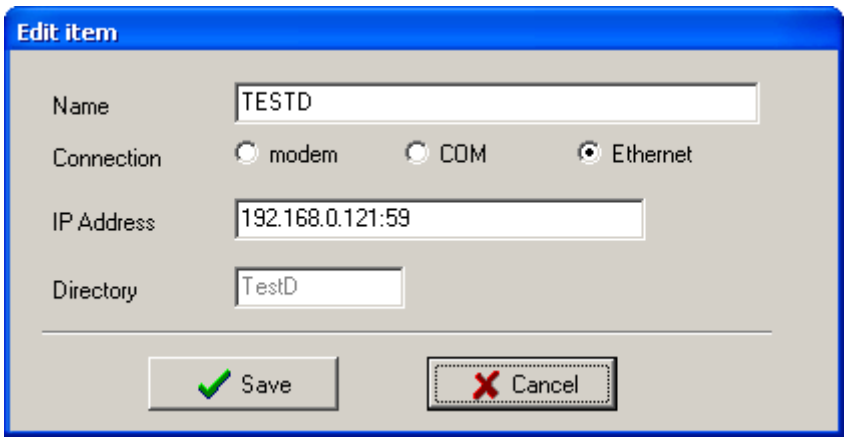
Click **New** - a new „card“ of the telephone directory will appear.



Write down in the **new record** all desired data concerning given transformer very carefully to avoid a very unpleasant mutual exchange of maintained transformers.

- (identification) name - **customer name, location, Serial Number** (S/N) of a given transformer
- connection
  - having chosen the **modem** connection write down into the **Phone** window:
    - the number of the telephone line assigned to the separator
    - or the number of the separator GSM modem
  - the COM connection is destined for a direct cable connection of PC or lap-top with an internal computer (for detailed in-situ data transfer procedure See ….)
  - identification of Ethernet connection via IP address
  - put down the name of the directory where you will archive the monitored data
  - Click on **Save** to put down required connection in memory

Button **Edit** serves to actualize records in the telephone directory. Click on **Edit** to open the following window



where you can change any items and confirm it by the button **Save** or you can the change cancel by click on button **Cancel.**

If you need to cancel any record from the **Telephone directory** you can do it very easy by click on **Delete** and the following window will be opened

and confirm clicking on (Yes) or you can go back to **Telephone Directory** by click on(No).

8.9 Save

click on Save will store data Days, Hours, and Parameters of a given separator into a time-specified file.

8.10 Open

This command opens time-specified files and shows them under Optim D2L enviroment (See Data Transfer).

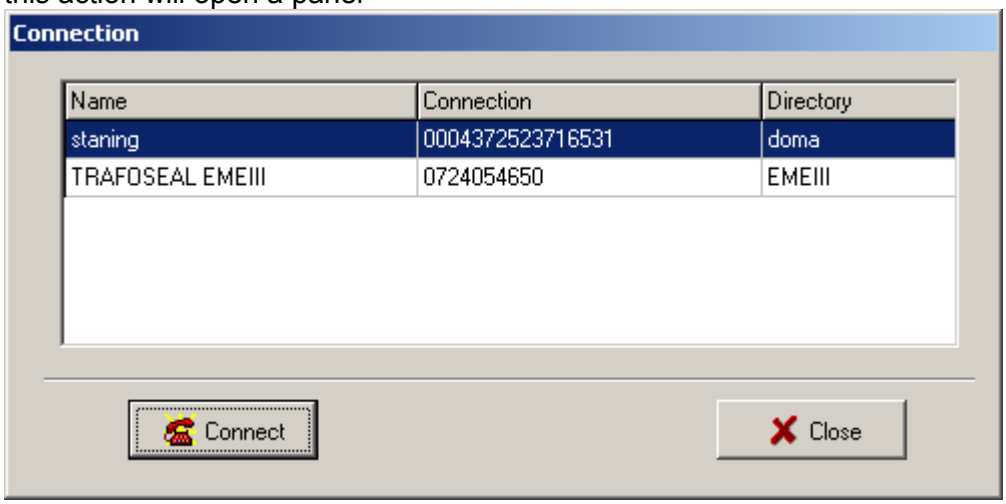
8.11 Copy to Clipboard

Command **Copy to Clipboard** saves the data from the actual screen into a clipboard file and this packet can be freely used e.g. by Excel.

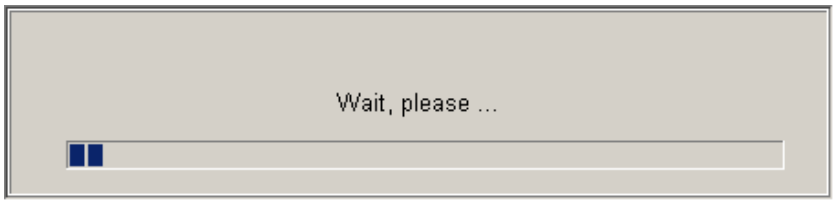
8.12 Standard communication with the ADT dehydrator

After setup you can start proper communication between your PC and the dehydrator pushing button

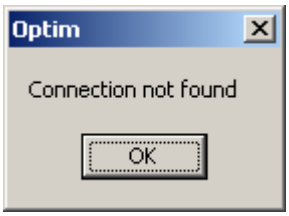
this action will open a panel



after you have finished the choice of a particular number, click on **Connect** – it will start the communication (RUNDMODEM procedure) and will show the following panel

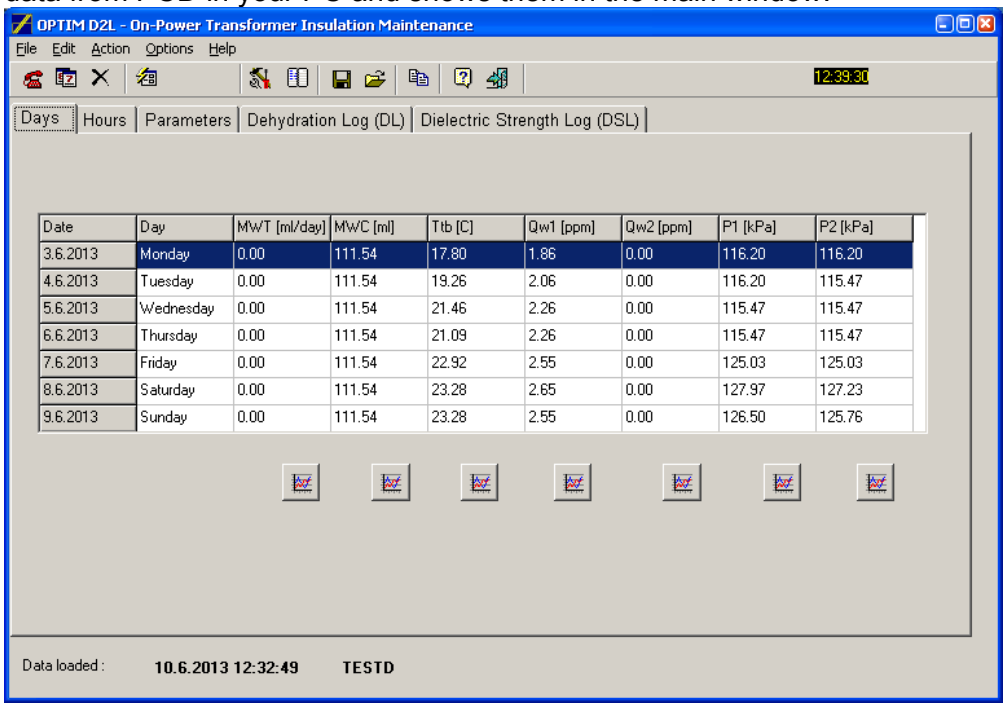


if the connection fails, the program opens the following window



This may happen when the phone or GSM network is busy – simply repeat the process to get the connection.

After achieved the satisfactory connection the program loads the data from PCD in your PC and shows them in the main window.



In order to cut communication fees, the program always works off-line – takes the pre-worked data from PCD, checks them and switches off the connection.

The program offers implicitly so called Days data first – this means the PCD measured 7 quantities are averaged over 24 hours and stored in PCD for 7 days.

Together with the day values the program also loads so called Hours data – PCD measured 5 quantities are averaged over 1 hour and stored in PCD for 24 hours.

Day and hour averages can be also showed in the form of diagrams pushing the graph button below each column of the values.

The same is used for the Virtual On-Line procedure which dominantly serves as a check of the proper function of vacuum separator self.

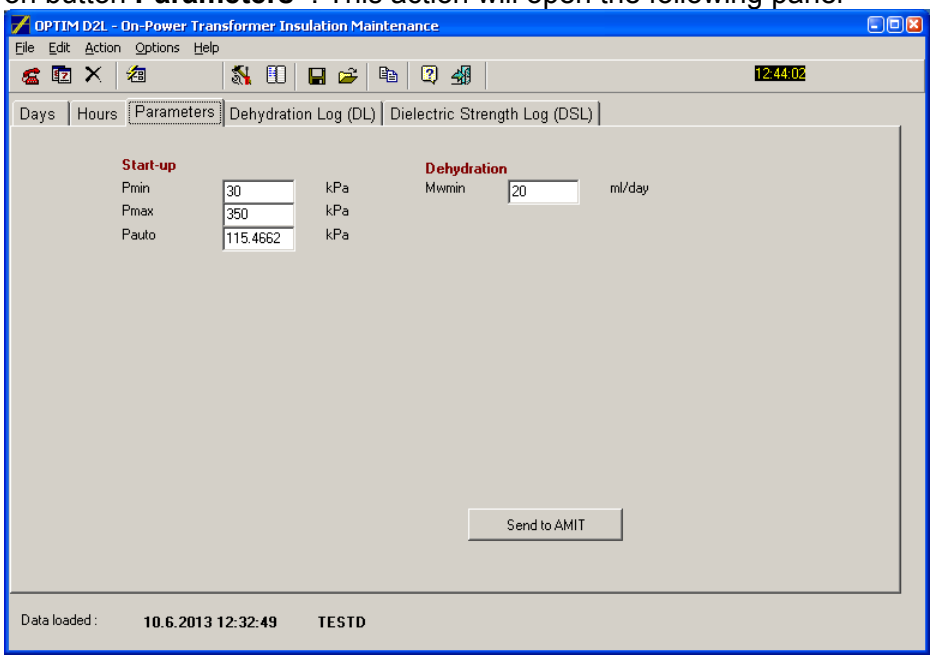
The PCD of the separator can (only on demand of PC !) implicitly scan , average and store the following basic values send at any time to the remote user PC:

MWT ….	water removal rate (ml/24 day)
MWC…..	total amount of water removed from a particular transformer (ml)
T1 ….	temperature of the transformer derived from oil temperature inflowing into the dehydrator (^{o}C)
Qw1	water content in inflow oil (ppm)

Qw2	water content in outflow oil (ppm)
P1	pressure in the intlet section (kPa)
P2	pressure in outlet section (kPa)

8.13 Parametric process control

To optimize of the dehydrator function and the dehydration process of the transformer, click on button **Parameters** . This action will open the following panel



Every basic function of the dehydrator (from start up to shut down) can be parametrically programmed, but:

ATTENTION !!

Parameters are already optimally pre-set.

If you want to change any parameter consult it with your dealer or producer of the separator first.

Adjusting parameters

- Re-write the given parameter to change it
- Click on button **Send to AMIT** to send the changed value back to the separator PCD

8.14 Transformer dehydration record

For the dehydration record and an evaluation of achieved results the procedure **Archive** is obviously used.

Click on 

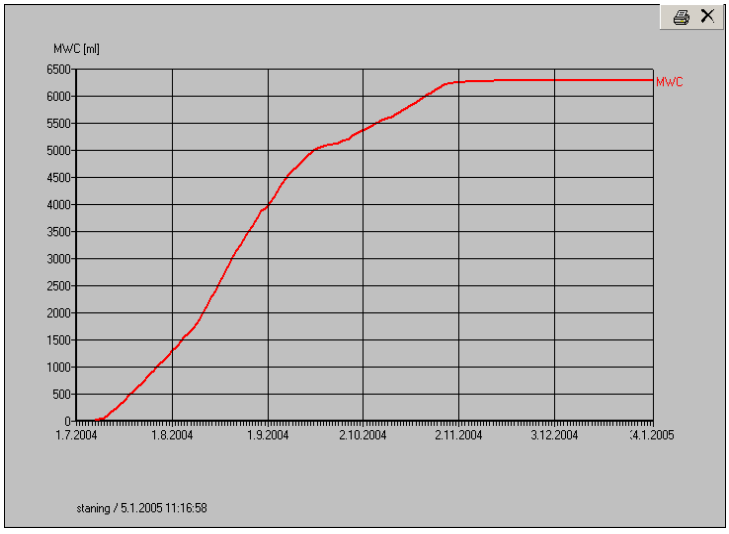
and this step will be confirmed showing the panel

Archiv

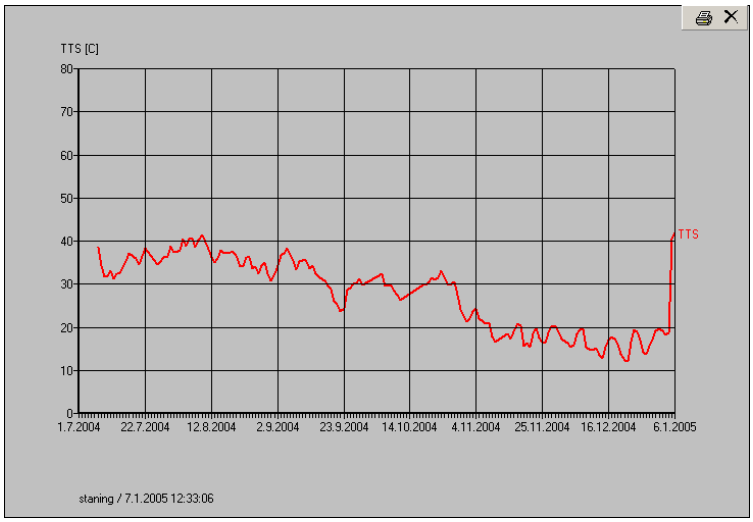
DATUM	MWT [ml/day]	MWC [ml]	TTS [C]	T1S [C]	P2S [kPa]	CW[ppm]
15.12.2004	0.00	0.00	0.00	0.00	0.00	0.00
16.12.2004	0.00	0.00	0.00	0.00	0.00	0.00
17.12.2004	0.00	0.00	0.00	0.00	0.00	0.00
18.12.2004	0.00	0.00	0.00	0.00	0.00	0.00
19.12.2004	0.00	0.00	0.00	0.00	0.00	0.00
20.12.2004	0.00	50.00	29.86	-5.05	81.54	0.00
21.12.2004	25.00	75.00	36.35	-4.84	24.74	0.00
22.12.2004	25.00	100.00	39.02	-4.28	20.93	0.00
23.12.2004	50.00	150.00	42.35	-4.11	17.68	0.00
24.12.2004	25.00	175.00	40.81	-4.21	15.63	0.00
25.12.2004	25.00	200.00	39.13	-3.93	13.76	0.00
26.12.2004	50.00	250.00	42.44	-3.72	13.05	0.00
27.12.2004	25.00	275.00	39.10	-3.69	12.80	0.00
28.12.2004	50.00	325.00	41.79	-3.61	12.82	0.00
29.12.2004	25.00	350.00	38.79	-3.92	12.23	0.00
30.12.2004	25.00	375.00	38.87	-3.87	12.40	0.00
31.12.2004	25.00	400.00	39.06	-3.89	12.31	0.00
01.01.2005	25.00	425.00	39.33	-3.64	12.27	0.00
02.01.2005	25.00	450.00	37.73	-3.88	12.44	0.00
03.01.2005	25.00	475.00	41.18	-4.03	12.42	0.00
04.01.2005	25.00	500.00	43.04	-3.83	12.25	0.00

Date - start 14.08.2003
Date - end 04.01.2005

For a better understanding of a on-line drying process of a transformer is most often used time-related graphical output which is inicialized by click on the graph button under chosen columns e.g. MWC (total amount of water removed from the given transformer)



and Ttb (Transformer temperature bottom)



The comparison of both time-related graphs gives us very often plausible answer at a basic questions about the drying process.

In this case is quite obvious that the reduction of the amount of removed water was induced by the strong decline of the transformer temperature.

8.15 Optimization of the on-power dehydration of transformers .

The relevant moisture and dielectric diagnostics is always absolutely necessary before the beginning of any dehydration procedure.

The SIMMS and TRACONAL should be used to evaluate the water content in the cellulose materials of the transformer.

To avoid a overdrying of transformer and subsequent very dangerous loss of clamping forces the dehydration target has to be defined .

Generally : water content in cellulose insulants, the Qp-value should be not reduced under ½ of original value.

Do not forget, regardless of how efficient any method of **oil** dehydration might be, the water removal from the transformer under normal operational conditions - the **transformer dehydration** - is ultimately governed by slow diffusion of moisture from cellulose and this process can be accelerated only by high temperature.

That is why you always have to describe any dehydration process of **transformer** with at least two values – **MWT** (average water removal rate and) **or MWC** (total amount of removed water) and **TTS** (temperature of the transformer).

In order to avoid lowering the immediate reliability of the transformer we have to tune at least two antagonistic criteria:

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

The first criterion is fully understandable – we want to dehydrate the transformer as soon as possible. Thus we need to release maximum of water from the cellulose into the oil filling by raising the temperature of the transformer.

This fundamentally collides with the second criterion – if the temperature of the wet transformer will be too high, water contents in oil may easy exceed 30 ppm limit and the dielectric strenght of oil drops relatively quickly under 40 – 50 kV/2.5mm.

If the moisture sensor is installed, follow always its on-line reading. The Qw1-value should never exceed 30 ppm.

To solve the dilemma between both criterions the method of gradual heating of the transformer is recommended especially if an on-line Qw1-reading isn´t available:

- check at first both actual values of water content in the oil (Qw1-value) and dielectric strength of the oil (Ud-value).

- If the Qw1-value is substantially under 30 ppm, increase the temperature TTS of the transformer, about 10 C, wait 5 days and check the result, if necessary, repeat the procedure until the Qw1-value is about 20 – 25 ppm is reached

- If the Qw1-value is about 30 ppm, decrease the temp. ca 5 C, check the result

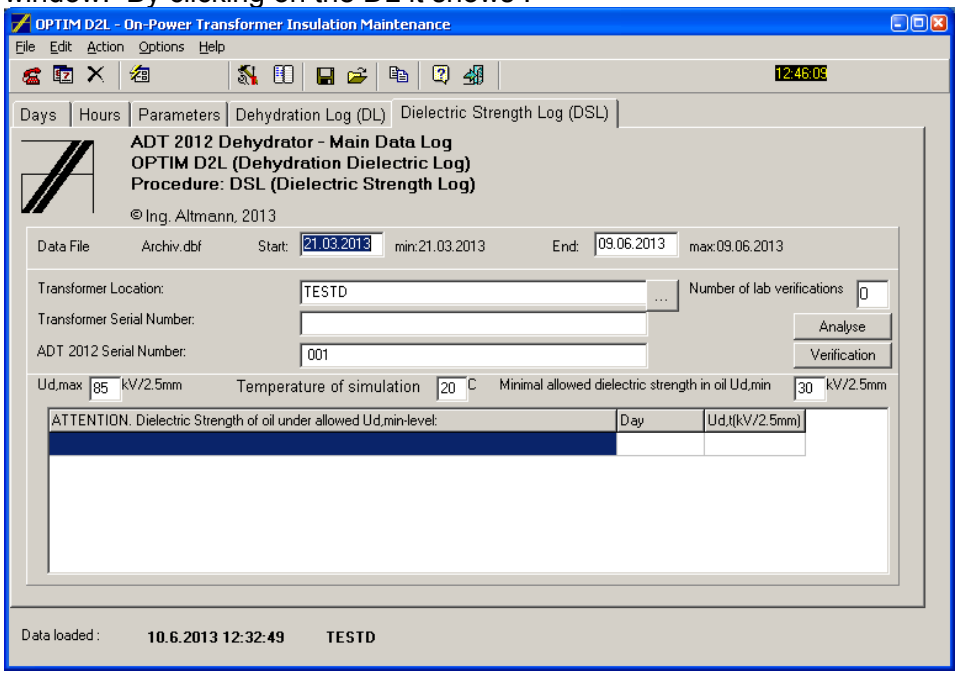
- If the Qw1-value is substantially over 30 ppm, the temp. has to be immediately decreased until the allowed Qw1-level is reached and simultaneously the Ud-level will be over 30 kV/2.5mm.

9. 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. By clicking on the DL it shows :

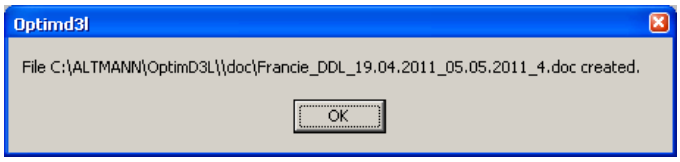


all the necessary basic data concerning :

- requested time-range of data (Data File , Start , End)
- Transformer Location, Transformer S/N and VS-06 S/N
- Maximal allowed water content in oil (Qw,max)

can be directly and easily entered from the keyboard.

By clicking on the Analyse button the time-related change of basic variables (Mwc, Ttb, Qw1, Qw2,) are shown on the screen and by clicking on the printer icone (in the upper part of the diagram), the diagram is converted into the user-friendly version. The end of the conversion is indicated as



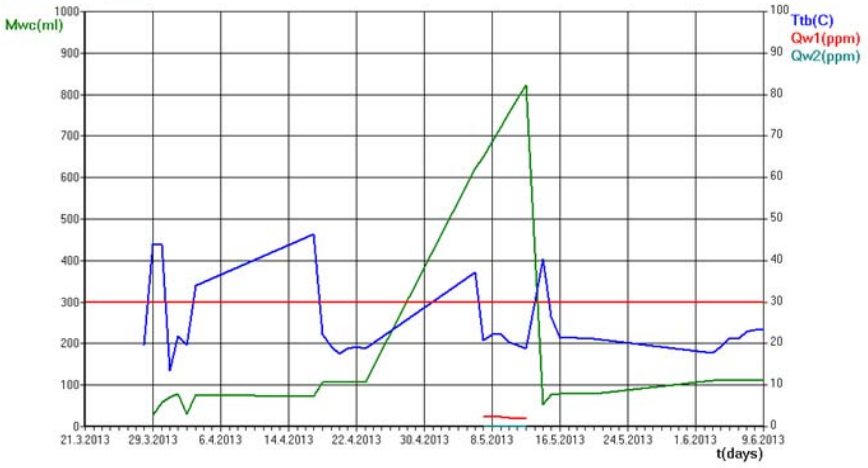
and by clicking on the OK button , the final, printable output of the DL procedure is shown

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

Transformer Location:	**TESTD**
Transformer Serial Number:	
ADT 2012 Serial Number:	**001**

Time-period of evaluation : 21.03.2013 - 09.06.2013

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: 10.6.2013

where all directly measured values are clearly defined and shown in the form of a time-related diagram.

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

DSL – Dielectric Strength Log

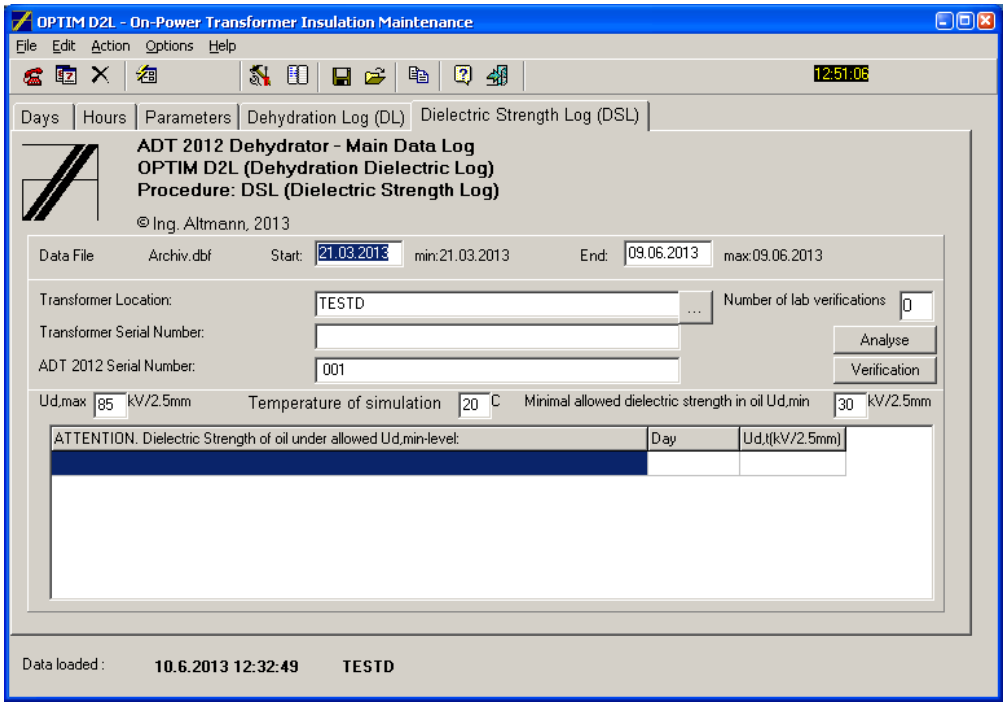
This absolutely new approach enables the DSL online to calculate the theoretical (maximum attainable) value of the dielectric strength of oil (the Ud,t –value) on the basis of the direct measuring of the water content in the oil (the Qw1-value).

This is the first time, that this specific online diagnosis can be validated by the offline data.

This mathematical model used for the calculation is based on the well documented near-linear relation between the decrease of dielectric strenght due to the increase of the relative humidity of oil (at lab temperature).

And this theoretical relationship can be verified by lab data.

By clicking on the DSL button the first Windows shows



And the following steps are similar as before :

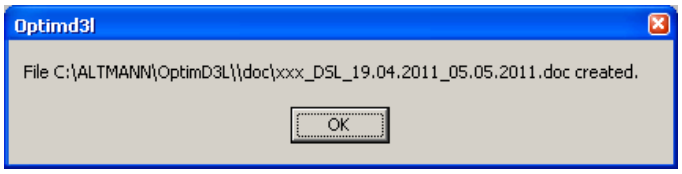
- o requested time-range of data (Data File , Start , End)
- o Transformer Location, Transformer S/N and VS-06 S/N
- o Minimum allowable dielectric strength of the oil (Ud,min)

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.

After clicking on the Analyse button the resulting time-related Ud,t-relation is shown on the screen together with bottom temperature of the transformer.

clicking on the printer icone shows



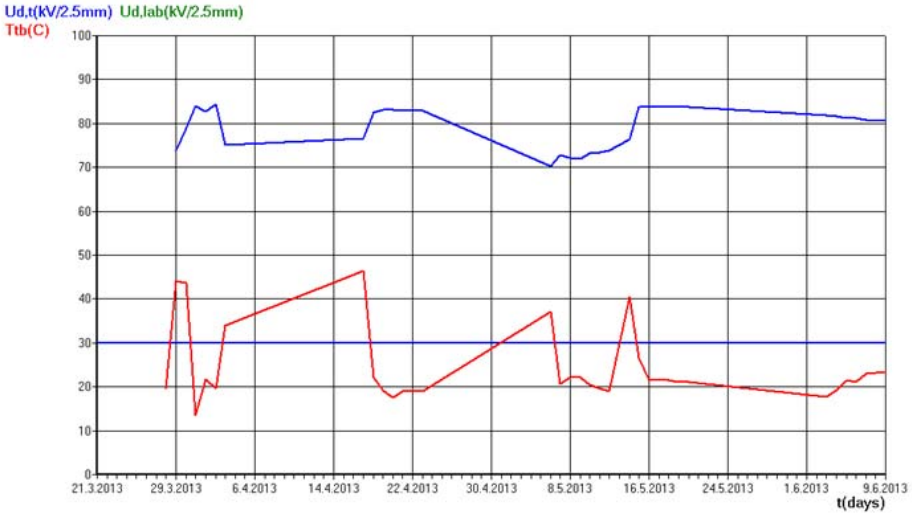
And clicking on the OK shows the description of the dielectric behaviour of the transformer for the requested time period

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

Transformer Location:	**TESTD**
Transformer Serial Number:	
ADT 2012 Serial Number:	**001**

Time-period of evaluation : 21.03.2013 - 09.06.2013

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: 10.6.2013

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.

By clicking on the Verification button in the DSL window, the Verification Table and the Verification Diagram is shown.

At first the time(s) of sampling and the corresponding Ud-lab value(s) and other lab values have to be entered into the Verification Table:

The Verification Diagram gives a direct and easy insight into the accuracy of on-line Ud,t-simulation and/or the Ud,lab-value :

- if the Ud,lab≈Ud,t–point is situated in the 10kV/2.5mm band around the transverse 45^{o} line, the consistency of the simulated Ud,t-value and the Ud,lab-value is very good and the subsequent diagnosis of the dielectric behaviour of the transformer for the given time-period is precise enough
- if the Ud,lab≈Ud,t–point is situated in the 20kV/2.5mm band, the consistency of simulated Ud-value and measured Ud-value is sufficient (for field conditions) and the subsequent diagnosis is acceptable
- if the Ud,lab≈Ud,t–point is situated outside of the 30kV/2.5 band, means that either the simulated Ud,t-value or the Ud,lab-reading is not precise enough. The relevant check of a dielectric behaviour of the transformer is not possible. Therefore the veracity of both values has to be checked.

The mutual comparison of simulated and directly measured Ud-values gives us an opportunity to check the plausibility of both values.