ARS-ALTMANN SYSTEMS

Vacuum Separator VS-06
CLIMABOX

OPERATING INSTRUCTIONS 2018

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</tbody>
</table>
### Chapter 1  **Technical data**

<table>
<thead>
<tr>
<th><strong>Power supply voltage</strong></th>
<th>400 V (or on request)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Power supply frequency</strong></td>
<td>50 Hz (or on request)</td>
</tr>
</tbody>
</table>

#### Power consumption:

<table>
<thead>
<tr>
<th>Without oil heater</th>
<th>850 W</th>
</tr>
</thead>
<tbody>
<tr>
<td>With oil heater PO-01</td>
<td>5200 W maximum</td>
</tr>
<tr>
<td>Air-condition unit</td>
<td>300W</td>
</tr>
<tr>
<td>Oil throughput</td>
<td>10 m³ per day maximum</td>
</tr>
</tbody>
</table>

| Outlet water content | 10 ppm nominal, 4 ppm minimum |
| Outlet gas content | 1% nominal, 0.3 % minimum |
| Outlet filtering grade | 1 μm |

Weight – CLIMABOX version (separator, heater, ultrafilter, external water trap, etc.):
- **Dry weight (without oil)**: 520 kg
- **Operating weight (oil filled)**: 580 kg

Hydraulic connection: 2 x flexible 1/2” hose

**Communication:** faxmodem, GSM modem, LAN, SMS

**Operational condition:**
- Max. surroundings temperature: 60°C
- Max. humidity: 100 %
- Min. temperature of dehydrated transformer: 40°C

For successful dehydration of transformer and successful oil drying it is necessary to ensure: 
**hold the temperature of transformer over 40°C**
Chapter 2. **Installation**

The separator VS-06 A CLIMABOX is attached to the transformer as shown in Fig. 1.

Installation procedure:

- attach the oil-inlet set (coupling, insulation insert and servo valve YV4 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 YV4 the in-let hose H1, then connect the opposite end of the hose H1 to the hydraulic connector HC1 (see Fig. 2 – right side of the CLIMABOX -cock K-IN), open the cock K-IN

- attach the oil-outlet set (coupling, insulation insert and servo valve YV3 See Fig.1) to the upper access of the transformer (i.e. upper filter press cock), then connect to the open end of the servovalve YV3 the out-let hose H2, then connect the opposite end of the hose H2 to the hydraulic connector HC2 (K-OUT), open cock K-OUT

- remove the face and rear cover of the CLIMABOX

- check if all cocks on right and left side of separator and at the rear side are full open

- check if all 3 filter insterts of the ultrafilter are installed

- connect cable of servo valve YV4 to the input servo-connector

- connect cable of servo valve YV3 to the output servo-connector

- check the correct level of the supply voltage (required 400 V +/- 15V) Five wire connection cable and connector (3x400V, PE,N) is neccesary (N-light blue 0-phase, PE-green-yellow security)

- set the supply circuit breaker (in the power-supply box ) for a minimum load of 16A, then connect the separator to the power-supply box.

- check DC voltage of the data line (required 42-45V), then connect the data transmission cable to the telephone connector

Right side of VS-06 which is used for a hydraulic connection to the transformer, the power supply and the communication, is shown on Fig.2.

Left side of VS-06 is equipped either with air-condition unit (for air temperatures over 40C) or in the left niche is installed the stainless-steel sieve – for air temperatures under 40C.

Flow diagram of VS-06 is shown on Fig. 3.

Detailed internal layout of VS-06 – the face part - inclusive external water trap is shown in Fig. 4.

Rear part of VS-06 is shown in Fig. 5.

*First start-up of the VS-06 has to be carried out by the manufacturer himself or through from him authorized service technicians.*

**ATTENTION!**

Check the oil-level in the conservator tank always before first start up of the VS-06.

- oil level should exceed the minimum mark by 1/3 of the scale in the conservator

- survey this level continuously during the start-up procedure and during the operational condition – the oil level in the conservator tank shall never fall below the minimum level indicator

- if the oil level would fall below the minimum mark of the conservator tank, refill oil immediately or/and use a auxiliary conservator
Fig. 1  Installation of VS-06
Fig. 2        Right side of VS-06 CLIMABOX without cover
Fig. 3 The flow diagram of the internal part of the VS-06 CLIMABOX
<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Hermetized pump</td>
<td>22</td>
<td>Oil leakage sensor</td>
</tr>
<tr>
<td>2</td>
<td>main vacuum chamber</td>
<td>23</td>
<td>Proces Control Unit AMIT 4001 A</td>
</tr>
<tr>
<td>3</td>
<td>wet gas accumulator</td>
<td>24</td>
<td>Modem US Robotics (or GSM Modem)</td>
</tr>
<tr>
<td>4</td>
<td>wet gas separator</td>
<td>25</td>
<td>Main switch box</td>
</tr>
<tr>
<td>5</td>
<td>oil accumulator</td>
<td>26</td>
<td>Main switch</td>
</tr>
<tr>
<td>6</td>
<td>collecting chamber</td>
<td>27</td>
<td>Autotransformer</td>
</tr>
<tr>
<td>7,8</td>
<td>Inlet, process ejector</td>
<td>28</td>
<td>Fan thermostat 2 (external cooling)</td>
</tr>
<tr>
<td>9</td>
<td>gas flow monitoring chamber</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>batch unit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>cooling unit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>fan thermostat</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>exhaust valve</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>throttle valve</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Water level sensor ext. water trap</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Return valve (vacuum building)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>External water trap</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>water removal cock</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Desluging cock</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Air bleed valve</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Oil sump</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fig. 4  Internal layout of main components in separator VS-06 (without cover)
1 Ultrafilter  | BT2        | Heater output temperature sensor
2 Inlet rough filter | BT3       | Inlet temperature sensor
3 Inlet fine filter | Bps1      | Bypass of fine inlet filter
4 Oil heater | Bps 2   | Bypass of outlet filter
KA auxiliary cock (used e.g. by the exchange of the fine filter (4) or by the cleaning of filter (2))

Fig. 5 Layout of main components in rear part of separator (without cover)
Chapter 3. Function

3.1 Computer control

The Altmann System VS-06 (Vacuum Separator) is designated for on-power dehydration of oil-immersed cellulose insulation systems of power transformers.

The separator is controlled by the “Process Control Device” AMIT ART 4000 F.

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

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

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

Fig. 6 Structure of control & communication of VS-06

For more details about VS-06 A Remote Control See Chapter 8.

The separator is working practically without any local operator intervention or any necessary operator supervision. The PCD is increasing the self-governing autonomy of the separator.
The operator’s intervention is limited to:

⇒ connecting & disconnecting of the separator to the transformer
   (See 2. Installation)

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

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

Any other in-situ usual activities of the operator are:

⇒ changing the input and output filter inserts - pushing F4 key on AMIT Terminal
   (See Filter Changing - Procedure)

⇒ removing water from the external water collector - pushing F3 key on AMIT terminal
   (See Water removal – Procedure)

All this activities are computer controlled and supported. Computer recommends operator desired activity on terminal AMIT and checks the results.

Fig. 7 AMIT Terminal & Supply Unit

Protection and any other function of separator are solved in the same way.

Periodical monitoring, change of parameters and all other functions can be realized by remote control.

Table 1 shows list basic programs of VS-06.
These programs are initialized by pushing F1…F4 keys on AMIT terminal, or using the keyboard (for parameter changing).

Tree structure is used:
- First step: Select common program by pushing of F1…F4 key
- APT display then shows another menu (second level)

Example:
After pushing the F1 key in the first step, another choice of menus appears: pushing again F1 key for Parameter change (Parameter Table), or F2 for Manual Defrost, or F3 for Manual Control
- Second step: Pushing of selected key will start the chosen program.

**Table 1  Key control**

<table>
<thead>
<tr>
<th>KEY</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1</td>
<td>F1 – Parameter change, F2 – Manual Defrost, F3 – Manual Control</td>
</tr>
<tr>
<td>F2</td>
<td>Computer controlled shutdown</td>
</tr>
<tr>
<td>F3</td>
<td>Computer controlled Water Removal</td>
</tr>
<tr>
<td>F4</td>
<td>Computer controlled filter Check &amp; Replacement.</td>
</tr>
<tr>
<td>F5</td>
<td>Computer controlled Oil Sampling</td>
</tr>
</tbody>
</table>

The visual control of input / output relation of the PCD AMIT can be followed by means of LEDs situated under the AMIT Terminal.
Parameter Table

The functions of Vacuum Separator are controlled by basic pre-set parameters and parameters can be changed any time by:

- double push of the key F1
- rolling display down/ up till requested parameter is shown
- pushing Enter to overwrite the given parameter
- pushing Enter to confirm new parameter
- back to main display via simultaneous pushing of ALT-ENTER

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1min</td>
<td>Abs. pressure of inlet section (deaeration)</td>
<td>40 kPa</td>
</tr>
<tr>
<td>P2min</td>
<td>Abs. pressure of outlet section (deaeration)</td>
<td>40 kPa</td>
</tr>
<tr>
<td>DP1</td>
<td>Pressure difference - cavitation control of gear pump</td>
<td>15 kPa</td>
</tr>
<tr>
<td>P2auto</td>
<td>Pressure level of forced removal of gases (reverse run of gear pump)</td>
<td>120 kPa</td>
</tr>
<tr>
<td>P2max</td>
<td>Maximal allowed pressure in vacuum vessels</td>
<td>250 kPa</td>
</tr>
<tr>
<td>DP2</td>
<td>Pressure difference for forced removal of gases</td>
<td>4 kPa</td>
</tr>
<tr>
<td>P2vc</td>
<td>Transition to internal cycle</td>
<td>15 kPa</td>
</tr>
<tr>
<td>P2atm</td>
<td>Atmospheric pressure (seal-level), for higher elevation has correspondingly</td>
<td>105 kPa</td>
</tr>
<tr>
<td>DTVC</td>
<td>Time delay of internal cycle</td>
<td>30 sec</td>
</tr>
<tr>
<td>Tmax</td>
<td>Max. allowed time-period of freezing cycle</td>
<td>20 min</td>
</tr>
<tr>
<td>T1min</td>
<td>Freezing temperature of cooling unit</td>
<td>-15 C</td>
</tr>
<tr>
<td>DT1</td>
<td>Temp. hysteresis of cooling control loop</td>
<td>1 C</td>
</tr>
<tr>
<td>T1max</td>
<td>Max. allowed temp. of defrost. process</td>
<td>15 C</td>
</tr>
<tr>
<td>Todt</td>
<td>Time-period of defrost. process</td>
<td>5 min.</td>
</tr>
<tr>
<td>T1alarm</td>
<td>Max. allowed temp. of defrost. process</td>
<td>20 C</td>
</tr>
<tr>
<td>Talarm</td>
<td>Time-delay of T1alarm initialization</td>
<td>20 min</td>
</tr>
<tr>
<td>T2max</td>
<td>Output temp. of oil (preheater)</td>
<td>50 C</td>
</tr>
<tr>
<td>DT2</td>
<td>Hysteresis of preheater control loop</td>
<td>5 C</td>
</tr>
<tr>
<td>T2alarm</td>
<td>Max. allowed temp. of oil</td>
<td>85 C</td>
</tr>
<tr>
<td>Podst</td>
<td>Separator - shut-down removal of oil from both hoses</td>
<td>85 kPa</td>
</tr>
<tr>
<td>P2minvac</td>
<td>Minimal allowed pressure (to avoid water boiling in batch unit)</td>
<td>3 kPa</td>
</tr>
<tr>
<td>P3auto</td>
<td>Gas removal from separator</td>
<td>108 kPa</td>
</tr>
<tr>
<td>T1MD</td>
<td>Minimal required T1-temp under emergency control</td>
<td>0 C</td>
</tr>
<tr>
<td>P1max</td>
<td>Max. allowed pressure in outlet section (if higher = output probably clogged = ALARM)</td>
<td>450 kPa</td>
</tr>
<tr>
<td>Parameter</td>
<td>Description</td>
<td>Value</td>
</tr>
<tr>
<td>------------</td>
<td>-----------------------------------------------------------</td>
<td>--------</td>
</tr>
<tr>
<td>P3max</td>
<td>Maximal allowed pressure in non-vacuum vessels</td>
<td>220 kPa</td>
</tr>
</tbody>
</table>

### Parameters of stripping procedure

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>P2ST</td>
<td>Stripping pressure (0 kPa - stripping process OFF)</td>
<td>15 kPa</td>
</tr>
<tr>
<td>DTS1</td>
<td>Stripping servovalve ON</td>
<td>10 s</td>
</tr>
<tr>
<td>DTS2</td>
<td>Stripping servovalve OFF</td>
<td>20 s</td>
</tr>
</tbody>
</table>

For remote change of main parameters See 8.13 Parametric process control

**Attention**

All parameters are optimally selected by the producer.
Don’t change them without previous consultation

### The Setting of internal clock of PCD AMIT

The change of Date and Time of the PCD AMIT according to local conditions can be performed anytime:

- main switch QM1 OFF/ON and immediately (within ca 3 seconds, maximum) click on key F2
- AMIT displays two rows with date and time e.g.

<table>
<thead>
<tr>
<th>10.06.16</th>
<th>(date)</th>
</tr>
</thead>
<tbody>
<tr>
<td>06.23.06</td>
<td>(time)</td>
</tr>
</tbody>
</table>

- click on ↑ to change the **date**, enter required date via AMIT keyboard and confirm it by ENTER
- click on ↓ to change the **time**, enter required time via AMIT keyboard and confirm it by ENTER
- for return click on key F1
3.2 Startup - Procedure

To start the separator switch the main switch **QM1** on the position I (ON).

The first STARTUP after the first installation of the VS-06 by a new client *(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 VS-06 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** (VS-06 works only for limited time-period defined by the contract conditions - usually for 30 days). Then its VS-06 is automatically switched off and display shows Alarm M. For detailed information concerning the VS-06 restart see Chapter 5 Alarms.

- **for permanent operations** (the client obtains this specific password immediately after the fulfilment of contract conditions. When it is entered the ADT works permanently).

The **APT display (23)** shows „date“ and „time“ for checking. You have 5 sec for zero setting of values for **T** (total time of dehydration), **MWC** (total amount of separated water until this time in ml) and **MW** (total water volume in the external water trap in ml).

```
VACUUM SEPARATOR
  VS-06
  "date"  "time"
ZERO SETTING - ENTER
```

When the separator is connected to a new transformer for a new dehydration process, the values for **T** (time of dehydration), **MWC** (total volume of separated water), **MW** (actual water volume in the water trap) need to be set to zero.
By pushing ENTER all the registers for T, MWC and MW are set to zero. The display confirms the procedure as follows:

<table>
<thead>
<tr>
<th>VACUUM</th>
<th>SEPARATOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>VS-06</td>
<td></td>
</tr>
<tr>
<td>MWC = MW = 0</td>
<td></td>
</tr>
<tr>
<td>T = 0</td>
<td></td>
</tr>
</tbody>
</table>

When we need to conserve the old values for T, MWC and MW, (continuing the dehydration of the transformer in cure, after shut-down of main switch) - do nothing - only wait ca 5 sec and separator will start to work again with the earlier values.

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

```
SEPARATOR START UP
VACUUM PROCESSING
IN OUTLET SECTION
P1 = P1   P2= P2 (kPa)
```

If pressure P1 in his section decreases below the preprogrammed absolute pressure [P1MIN], then the servovalve YV3 will open automatically, but the sampling cock is still closed.

**Attention**: If the pressure P1 will not decrease below [P1MIN] level, then the Startup procedure will remain in the first step. The vacuumizing of the outflow section is not successful and the outflow servovalve remains in closed position.

The **AMIT Terminal** reports that the desired vacuum is reached and demands the opening of the upper valve (cock) on the transformer main tank

```
OUTLET SECTION
ON VACUUM  P1 = P1
OPEN UPPER VALVE(S)
AT MAIN TANK
```

And the oil from the main tank will flush this section. The flush of oil from the transformer continues automatically until the whole separator is filled with oil. The **AMIT Terminal** will report:

```
GAS COMPRESSION
```

```
P1 = P1   P2 = P2 (kPa)
```

If pressure P2 exceeds preprogrammed absolute pressure [P2AUTO] and gases are expelled from main chamber and gas accumulator, the **AMIT Terminal** will report Gas Exhaust. This is visible as a stream of gas-bubbles in the glas of the control chamber (9) and then in the plexi glas extension of the exhaust valve (13)

```
GAS EXHAUST
```

```
P1 = P1   P2 = P2 (kPa)
```

If the hydrostatic head of the transformer is lower then ca. 1.5 m of the separator, then the filling of the separator is too slow. Automatically the separator pump switches on reverse ON-OFF to force the oil into the separator.
The **AMIT** terminal will report the end of this step and the automatic transition to the next step

**VACUUM PROCESSING**
**IN INLET SECTION**

\[
P_1 = P_1 \quad P_2 = P_2 \text{ (kPa)}
\]

If pressure \( P_2 \) in the separator and in the suction section decreases below the preprogrammed absolute pressure \( P_{2\text{MIN}} \), then the servovalve YV4 will open automatically. The **AMIT Terminal** will report:

**INFLOW SECTION**
**ON VACUUM**
**OPEN BOTTOM VALVE(S)**
**AT MAIN TANK**

The whole inlet section is flushed by the oil from the transformer and **AMIT Terminal** will report the end of startup procedure:

**STARTUP FINISHED**
**SEPARATOR READY**
**FOR TRANSFORMER**
**DRYING**

**PCD** – computer control of the separator will automatically start main hydraulic-vacuum cycle.
3.3 Separation of moisture and gases

The VS-06 separator provides moderate vacuum, moderate heat and large interfacial surface, needed to separate gases and vapours from the oil.

All procedures are fully automatized and remote controled, local operator action is not necessary.

3.4 Water removal - Procedure

Water removal procedure from water trap (17) can be effected any time by pushing F3 key on AMIT Terminal.

The AMIT Terminal will report start of water removal procedure accustically and on display:

| WATER REMOVAL ON PRESSURE EQUALIZATION, WAIT |
| P2 = xxx kPa |

CAUTION  The water removal cock (18) can be opened only if pressure equalizition is indicated. Then a water removal procedure is realized, and cock (18) must be closed again.

| OPEN BOTTOM COCK OF WATER TRAP DRAIN OFF WATER PUSH ENTER |

After pusching ENTER separator goes back to normal separation process.

3.5 Oil sampling procedure

Oil sampling procedure can be started any time by pushing F5 key on AMIT Terminal.

The AMIT Terminal will report this status as:

| OIL SAMPLING ON WAIT FOR PRESSURE EQUALIZATION |

CAUTION Sampling cock situated under main switch box can be opened only if pressure equalization (PRESSURE OK ) is indicated. When a sampling procedure is made, cock must be of course closed again.

| PRESSURE OK SAMPLING FINISHED ? YES - ENTER |

After pusching ENTER separator goes back to normal separation process.

3.6 Shutdown - procedure
Separator VS-06 can be any time shut down by:

- main switch QM1
- key K2

3.6.1 Main switch
When main switch QM1 is setted OFF in ca 10 sec are closed both servo valves YV3 and YV4. This way is separator quickly a safely disconnect from oil filling of transformer.

When QM1 is setted ON is separator automatically started again

Computer controlled shut-down procedure is initialized by key F2.
Display offers us two procedures

```
FOR SHORT-TERM SHUTDOWN - PUSH F7
FOR LONG-TERM SHUTDOWN - PUSH F8
```

3.6.2 Short-term shutdown
After click on F7 display shows

```
SHORT-TERM SHUTDOWN ON
WAIT
```

and standard sequence Water removal 3.4 is started at first.

Using of Water removal procedure as internal procedure of Short-term shutdown is necessary especially under very low surrounding temperatures.

When is this procedure finished goes separator back to normal Short-term shutdown procedure.

```
SHORT-TERM SHUTDOWN FINISHED
FOR START TURN OFF/ON MAIN SWITCH QM1
```

3.6.3 Long-term shut down
When water content in the transformer decreases under desired level is dehydration process stopped and separator is transported and connected to another wet transformer.

Separator should be transported without oil and therefore following procedure is used
After pusshing of F2 is following display shown again

```
FOR SHORT-TERM SHUTDOWN - PUSH F7
FOR LONG-TERM SHUTDOWN - PUSH F8
```

and after pusching F8 is displayed

```
SHUTDOWN FOR
```
TRANSPORTATION ?
YES - ENTER

and sequence of another instructions and mesages are the same as by SHORT-TERM procedure.
When WATER REMOVAL is finished and on the display is indicated

LONG-TERM SHUTDOWN
ON
VACUUM PROCESSING ON
WAIT

and servo valve YV4 closes immediately and stops oil inflow in the separator. The pump is turned on, vacuum is built up and this process continues until separator is emptied.
When proper vacuum is reached, the pump turns off and this state is reported as

CLOSE BOTTOM COCK
OF TRANSFORMER
DISMOUNTE VALVE YV4
PUSH ENTER

DISMOUNTING OF SERVOVALVE HAVE TO BE ALWAYS CARRIED OUT WITHOUT DISENGAGE OF HOSE only by unscrew of female screw – See following Fig.
Only this way remains the hose under vacuum and separator shut-down is not disturbed !!
THIS PROCEDURE IS THEREFORE VALID FOR DISMOUNTING BOTH SERVO VALVES

after click on ENTER servo valve YV4 opens and the inflowing air is forcing the oil from hose H1 and preheater PO-01 back into separator.
End of this process is reported as

OIL EXHAUST FINISHED
CLOSE COCK K-IN
DISMOUNT HOSE H1
PUSH ENTER

and then follows the next procedure for oil-discharging from outflow section.
Beggin of this process is indicated as

```
LONG-TERM SHUTDOWN
ON
VACUUM PROCESSING ON
WAIT
```

and

```
CLOSE UPPER COCK
OF TRANSFORMER
DISMOUNTE VALVE YV3
PUSH ENTER
```

after pushing of ENTER is servo valve YV3 (dismantled by unscrew of female screw from upper cock of transformer) opened and air from surrounding forces out the oil from hose H2 and ultrafilter back into separator.

End of this process is reported as

```
OIL EXHAUST FINISHED
CLOSE COCK K-OUT
DISMOUNT HOSE H2
PUSH ENTER
```

and end of long-term shut-down is reported as

```
LONG-TERM
SHUT-DOWN FINISHED
TURN OFF
MAIN SWITCH QM1
```

Long-term shutdown od separator is finished when QM1 is switched OFF and power supply cable is dismantled.

**CAUTION!** Separator should be transported in vertical position only!

### 3.8 On-line volume measuring of separated water

The quantity of separated water is measured by volume, and is stored in the PCD AMIT. From there remote collecting of these data is possible at any time.

At the later stage of the defrosting procedure, water droppps will fall by gravity from the cooling chamber (11) down into the bottom of the glass cylinder of the batch unit (10). When the level of this collected water reaches the water sensor (BQ1), a signal as (ca 20 ml of collected water) is passed on to the PCD control unit, and the separator goes to the batch procedure.

The batch procedure is reported on the AMIT Terminal as:

```
WATER BATCHING
ON
WAIT FOR
FLUSHING
```

The gear pump will run on reverse, and if the pressure P2 exceeds the preprogrammed pressure level [P2AUTO], the flusching valve (20 See function diagram on Fig. 3.) will be opened, and water (and oil) will be pumped from the batch unit into the water trap (21).
The batching unit will be flushed twice in order to remove the last water residua, before the whole batching procedure is finalized.

From the time interval between the last and the present batch procedure, and the volume of transported water, PCD calculates the water removal efficiency $MWT$ (ml/24 hod) of separator.

3.9 Stripping procedure: Effective removal of fault gases from the oil
The standard separation of gases and moisture under relatively low temperature and vacuum fully satisfies the basic rule of any on-line transformer treatment "no-impact on oil properties".

Unfortunately this specific process cannot effectively remove heavy fault gases (as CH2, C2H4, C2H2, C2H6 etc) from a transformer oil inventory especially by treatment of hermetized transformers.

The VS-06 is therefore equipped with stripping valve situated on batch unit See picture below

and, under defined conditions, repeatedly injects a small amount of air into the separator to boost its separation capability.

The stripping process automatically starts as soon as P2-level decreases under predefined P2ST-level and it is finished if the P2-level increases over mentioned level.

The setting in situ via AMIT keyboard: by double click on key F1 and re-writing of P2ST-, DTS1 (servovalve ON) a DTS2-parameter (servovalve OFF) in the Parameter Table REM. The stripping kit isn’t standard part of VS-06 and has to be extra ordered.

Chapter 4. Protections
The separator VS-06 is designed and built specifically 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 separator system consists of hermetically sealed hydraulic and condensation circuits and at the rear side is situated the external heater and ultrafilter (See Fig.1 and Fig 4). All these parts are hydraulically connected to the leakage tube in the bottom of the CLIMABOX. Any oil spill in the separator system will be collected in this leakage tube. In the unlikely event of spill, leakage sensor BQ3 (16 - See Fig.3 and bottom picture) mounted in the lowest part the drip tray of the CLIMABOX will then generate oil loss alarm. Immediatedly the separator is stopped, and the servo valves shut-off.

Thus, in 10 seconds of detecting oil-spill, the transformer will be hydraulically isolated from the separator by closing down of the two servo valves YV3 and YV4.

The oil-leak alarm is indicated acustically and on the display of the AMIT Terminal.

After the detecting and sealing of leakage (and drying of container of leakage sensor BQ3 See (F4,16) and the photograph picture showing disassembled sensor), reset the separator by switching main switch QM1 OFF and ON.
Hydraulic and vacuum chambers of separator, heater and ultrafilter are protected against overpressure in two levels:

- PCD controls the pressure $P_1$ and $P_2$, and will recognize if these values will exceed the allowed limits $[P_{1MAX}] / [P_{2MAX}]$. If this happens, the separator is automatically shut off, and this state is indicated acoustically and on the display.

If pressure $P_1$ on the pump exceeds $[P_{1MAX}]$, acoustical alarm is generated, and display on AMIT Terminal will indicate:

```
OVERPRESSURE  P1
ALL VALVES & COCKS
ON OUTFLOW ARE OPEN ?
RESET BY QM1 OFF/ON
```

If pressure $P_2$ in the main chamber exceeds $[P_{2MAX}]$, acoustic alarm is generated, and display on AMIT Terminal will indicate:

```
OVERPRESSURE  P2
CHECK SENSORE BP2
BY MEANS GAUGE P2
RESET - QM1 OFF/ON
```

4.3 Overfill of external water trap, and discharge of external water trap
If water level in the water trap exceeds allowed level, then the water level sensor BQ2 will be activated and separator is shut down. **AMIT Terminal** will display:

| WATER TRAP FULL FOR DISCHARGING PUSH F3 |

Manual water removal from water trap can be made any time under normal operation of the separator, if one simple condition is fulfilled:

The pressure P2 has to be below 100 kPa during the whole removal procedure in order to rule out any unwanted oil-spill.

**Manual water removal procedure:**
- check the pressure level P2
- remove cap of air bleed valve
- slowly open the air bleed valve
- slowly open the discharging cock and discharge all water from water trap
- close both cocks
- close air bleed valve with cap

**ATENTION !**
When the separator is shutted-down and the ambient temperatures are deep below 0°C, the water from the external water trap has to be completely removed.
Chapter 5. **Alarms**

All vital functions of separator are continuously observed, recognized and supervised by PCD. ALARM is generated and indicated if PCD recognizes, that measured parameters will exceed preprogrammed and given criteria or the contract conditions as not fulfilled.

ALARM is indicated on AMIT Terminal and acoustically:
ALARM is transmitted to the supervisor by remote PC – See Manual **VS-06 Remote Control**.

5.1 **STARTUP - ALARM**

<table>
<thead>
<tr>
<th>WRONG VOLTAGE OR</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROTATION DIRECTION</td>
</tr>
<tr>
<td>TURN QM1 OFF , REPAIR</td>
</tr>
<tr>
<td>TURN QM1 ON</td>
</tr>
</tbody>
</table>

5.2 **BATCH UNIT - ALARM**

This alarm indicates, that the water sensor **BQ1** of batch unit (F3,BQ1) is continuously under water. PDS evaluates this as choked internal batch filter and the separator is automatically shut off.

**AMIT Terminal** displays:

<table>
<thead>
<tr>
<th>BATCH UNIT CHOKED</th>
</tr>
</thead>
<tbody>
<tr>
<td>FOR START</td>
</tr>
<tr>
<td>TURN QM1 OFF AND ON</td>
</tr>
</tbody>
</table>

The filter is situated in the lower part of batch unit. After Shut-Off of the separator, empty the batch unit by opening the desluging cock, and open the nut of internal filter. The filter can be easily cleaned with brush, solvent and pressurized air. See picture in Chapter 3.7

5.3 **Alarm M**

This alarm indicates the expiration of contract defined payment conditions.

The **AMIT terminal** displays:

<table>
<thead>
<tr>
<th>ALARM - M</th>
</tr>
</thead>
<tbody>
<tr>
<td>CALL FOR SERVICE</td>
</tr>
</tbody>
</table>

If contract conditions are fulfilled (proper settlement is performed) fy. Altmann will send you the 4-digit Password which enables permanent operation of VS-06.

The restart of VS-06:

- Main Switch QM1 OFF/ON
- during the first display VS-06, click on Key F4 (you have ca 3 seconds to do it)
- click on button "Up"
- enter the PASSWORD:
- click on ENTER
- new restart by QM1 OFF/ON
Chapter 6. **Maintenance**

The VS-06 Separator requires minimum maintenance. Nevertheless, it is recommended that a regular maintenance schedule be established as described in the following sections.

### 6.1 Cleaning of internal surfaces of glass chambers

By dehydration of wet transformer with heavy aged oil is necessary regular cleaning of all glass chambers and cylinders. The cleaning is provided by serviceman of producer or other authorized person.

### 6.2 Input filters – Check & Replacement

Intensity of inflow of oil in separator is computer controlled. If the actual volume of delivered oil decreases under given limit (under setting point of flow indicator BQ4 → BQ4 is OFF), is this evaluated as a fault and indicated on display of APT as ALARM:

```
INFLOW TO LOW
FOR CHECK & REPLACE
INPUT FILTERS
PUSH F4
```

Now is computer asking which filter we want check or replace

```
FILTER INSERTS
REPLACEMENT -
FOR INLET FILTERS - F1
FOR OUTLET FILTERS - F2
```

Because we have trouble with oil inflow the key F1 is used.

```
INLET FILTERS
CHECK & REPLACEMENT
VACUATION
WAIT
```

Suction side of separator is provided with two filters - first stage drum (metal cloth) rough filter (See Position 2 on Fig.4) and second stage fine (car) filter (See Position 3 on Fig 4). Both are situated on rear side of separator and have to be checked or replaced together.

To avoid the oil loss is the whole check & removal procedure made under proper vacuum in the separator.

Inlet filter removal procedure always begins with checks of drum (rough) filter.

End of vacuumation procedure is indicated as

```
UNSCREW CAP OF
ROUGH FILTER AND
CHECK HIS CHOKING
```

After checking and cleaning of rough filter we get following display

```
ROUGH FILTER OK ?
YES – ENTER
```
if is rough filter closed with cap again we can confirm it by ENTER

and replacement procedure of fine filter (See Position 3 on Fig.4) is performed

**UNSCREW FINE FILTER**
**SCREW ON NEW FILTER**

As fine filter normal car filter can be used See Table

<table>
<thead>
<tr>
<th>Alternative Inlet Filters</th>
</tr>
</thead>
<tbody>
<tr>
<td>FIAAM FT 5044</td>
</tr>
<tr>
<td>FRAM PH 4854</td>
</tr>
<tr>
<td>MANN &amp; H W 950/4</td>
</tr>
<tr>
<td>PUROLATOR PER 316 - OC 105</td>
</tr>
</tbody>
</table>

And computer asks if the procedure is finished

**INLET FILTERS CHECKED & REPLACED ?**
**YES - ENTER**

and after pushing ENTER goes back to STARTUP Procedure

### 6.3 Replacement of filter inserts of ultrafilter

The degree of choking of filter inserts of ultrafilter is computer controlled.

If pressure loss of ultrafilter exceeds given level is this evaluated as Overpressure Alarm and after checking sequence described in Section 4.2 it is indicated as

**ULTRAFILTER CHOKED**
**FOR REPLACEMENT PUSH F4**

After pushing of F4 PCD asks again what filters we want check or replace

**FILTER INSERTS REPLACEMENT -**
**FOR INLET FILTERS - F1**
**FOR OUTLET FILTERS - F2**

We confirm our decision by pushing F2

**OUTFLOW FILTERS CHECK & REPLACEMENT ULTRAFILTER VACUATED WAIT**

To avoid the oil loss the whole check & removal procedure have to be made under proper vacuum in the ultrafilter and separator.

Proper underpressure is indicated as
VACUUM OK, UNTIGHT
LIGHTLY ALL CENTRAL
SCREWS - WAIT
OIL EXHAUST IS ON

Under these conditions (all central screws are slightly untight), atmospheric air slowly and uniformly forces oil from all chambers of ultrafilter back into vacuum in the separator. The end of this procedure is indicated as

LIFT OFF ALL CAPS
REPLACE FILTER INSERTS
IF ALL REPLACED
PUSH ENTER

After pressing ENTER goes PCD back into STARTUP procedure.
### Electrical circuits

Power Circuit diagram is shown on Fig. 8

<table>
<thead>
<tr>
<th>Name</th>
<th>Function</th>
<th>Designation</th>
<th>Qty</th>
<th>Producer</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MAIN SWITCH BOX</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>QM1</td>
<td>Main switch</td>
<td>3LD2103-OTK53</td>
<td>1</td>
<td>Siemens</td>
</tr>
<tr>
<td>QF1</td>
<td>Heater breaker</td>
<td>5SX2 316-6</td>
<td>1</td>
<td>Siemens</td>
</tr>
<tr>
<td>QF2</td>
<td>Motor pump breaker</td>
<td>3RV11-1CA10</td>
<td>1</td>
<td>Siemens</td>
</tr>
<tr>
<td>QF3</td>
<td>Power supply unit breaker</td>
<td>5SX2 116-6</td>
<td>1</td>
<td>Siemens</td>
</tr>
<tr>
<td>KM1</td>
<td>Motor pump contractor-direct run</td>
<td>3RT1016-1BB42</td>
<td>1</td>
<td>Siemens</td>
</tr>
<tr>
<td>KM2</td>
<td>Heater contractor</td>
<td>3RT1016</td>
<td>1</td>
<td>Siemens</td>
</tr>
<tr>
<td>KM3</td>
<td>Motor pump contractor – reverse run</td>
<td>3RT1016</td>
<td>1</td>
<td>Siemens</td>
</tr>
<tr>
<td>FU1</td>
<td>Transformer</td>
<td>T2,5A, 5x20</td>
<td></td>
<td>GES Electronics</td>
</tr>
<tr>
<td>FU2</td>
<td>Cooling</td>
<td>T4,0A, 5x20</td>
<td></td>
<td>GES Electronics</td>
</tr>
<tr>
<td>FU3</td>
<td>Servo valve Belimo</td>
<td>T1,0A, 5x20</td>
<td></td>
<td>GES Electronics</td>
</tr>
<tr>
<td>FU4</td>
<td>Power supply 24DVC</td>
<td>T5,0A, 5x20</td>
<td></td>
<td>GES Electronics</td>
</tr>
<tr>
<td>FU5</td>
<td>Modem</td>
<td>T1,0A, 5x20</td>
<td></td>
<td>GES Electronics</td>
</tr>
<tr>
<td>FU6</td>
<td>Fan</td>
<td>T2,5A, 5x20</td>
<td></td>
<td>GES Electronics</td>
</tr>
<tr>
<td><strong>HERMETIZED GEAR PUMP</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M1</td>
<td>Gear pump motor</td>
<td>1LA7080-4AA11</td>
<td>1</td>
<td>Siemens</td>
</tr>
<tr>
<td>GS1</td>
<td>Frequency changer</td>
<td>Micromaster 420</td>
<td>1</td>
<td>Siemens</td>
</tr>
<tr>
<td><strong>HEATER</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EH1,1-1,3</td>
<td>Heating rod</td>
<td>14011/06</td>
<td>3</td>
<td>Eltop</td>
</tr>
<tr>
<td></td>
<td></td>
<td>400V, 7500W</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ST1</td>
<td>Thermostat</td>
<td>TH160.2</td>
<td>1</td>
<td>Elfetex</td>
</tr>
<tr>
<td><strong>COOLING UNIT</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M3</td>
<td>Compressor (standard version) or</td>
<td>GD36AA, 230v</td>
<td>1</td>
<td>Electrolux</td>
</tr>
<tr>
<td></td>
<td>tropical climate over 40C</td>
<td>YB-645 GTD</td>
<td></td>
<td>Mitsubishi</td>
</tr>
<tr>
<td>YV1</td>
<td>Solenoid valve</td>
<td>HM2, 230V</td>
<td>1</td>
<td>Castel</td>
</tr>
<tr>
<td>ST0</td>
<td>Thermostat</td>
<td>F/2000</td>
<td>1</td>
<td>PRODIGY</td>
</tr>
<tr>
<td>M2</td>
<td>Fan motor</td>
<td>4656 N</td>
<td></td>
<td>Pabst</td>
</tr>
<tr>
<td><strong>AC/DC Supply</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------------------</td>
<td>------------------------------------------------------</td>
<td>------</td>
<td>------------------------------</td>
<td></td>
</tr>
<tr>
<td>TM1 Transformer</td>
<td>51265-P1S2</td>
<td>1</td>
<td>NT MAGNETICS</td>
<td></td>
</tr>
<tr>
<td>VD1 rectifier</td>
<td></td>
<td>1</td>
<td>Altmann</td>
<td></td>
</tr>
<tr>
<td>TM0 Autotransformer (special order - only for insulated grids)</td>
<td>TAC 35052-0010</td>
<td>1</td>
<td>Elektrokov Znojmo</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>AIR CONDITIONER</strong></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>M4 Fan</td>
<td>7450 ES</td>
<td>1</td>
<td>Pabst</td>
</tr>
<tr>
<td>ST 01 Thermostat</td>
<td>F/2000</td>
<td>1</td>
<td>PRODIGY</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>CONTROL &amp; SUPPLY UNIT</strong></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>PCD Proces Control Unit</td>
<td>ART 4000F</td>
<td>1</td>
<td>AMIT</td>
</tr>
<tr>
<td>KA1,3,4 Power switch – compressor, water batch, oil input Belimo</td>
<td>3TX7004-1MBO</td>
<td>3</td>
<td>Siemens</td>
</tr>
<tr>
<td>KA2 Power switch - defrost</td>
<td>3TX7004-3AC03</td>
<td>1</td>
<td>Siemens</td>
</tr>
<tr>
<td>KA5 Power switch – oil output Belimo</td>
<td>3TX7002-1FB02</td>
<td>1</td>
<td>Siemens</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>COMMUNICATION UNIT</strong></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Modem</td>
<td></td>
<td>1</td>
<td>US Robotics</td>
</tr>
<tr>
<td>or GSM Modem</td>
<td>TC35i Terminal</td>
<td>1</td>
<td>Siemens</td>
</tr>
</tbody>
</table>

Process sensors 4-20 mA

| BP1 Pressure sensor       | DMP331 0 – 6 b                                       | 1    | BD Sensors                  |
| BP2,3,4 Pressure sensor   | DMP331 0 – 2.5b                                      | 1    | BD Sensors                  |
| BT1 Temperature sensor    | Flexitemp 60 -50 +60°C                              | 1    | JSP Jicin                   |
| BT2,3 Temperature sensor  | TG5 0 – 100°C                                       | 1    | APO Elmos                   |

ON/OFF sensors

| BQ1 Batch unit (water level) | WLS1                                           | 1    | Altmann                      |
| BQ2 Water trap (water level) | WLS1                                           | 1    | Altmann                      |
| BQ3 Leakage sensor          | RSF54Z100RC                                     | 1    | Cynergy 3                    |
| FV1 Rotation direction/Voltage check & Reading relay | 3Ug4615-1CR20                                 | 1    | Siemens                     |

Lighting switch

| S1 Limit switch            | HL408                                            | 1    | GES Electronics              |
Fig. 8  Power circuit diagram
Chapter 8 - Remote Control

8.1 Program installation

Program OPTIM D3L - delivered CD disk - contains the main program for the remote (and in situ) control and the monitoring of VS-06 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 necessary.

After click on the Connect the modem is started and the connection realized. The operational data separator are transferred at three time levels and summoned under auxiliary toolbar.
8.4 Data Transfer Button

- last seven days (button Days)

- last 24 hours (button Hours)

- last 240 min. (button VirtualOn-Line)
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 from the Data Transfer 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.

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

For detailed data evaluation See Section 12 and 13.
Click on button **Archive** opens a data table which contains all **Days** data from the beginning of 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.

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
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<td>12.25</td>
<td>0.00</td>
</tr>
</tbody>
</table>

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

![Phone Directory](image)

Click on **NEW** to define the connection with a newly installed separator - a new „card“ of the telephone directory will appear.

![New Item](image)

It is possible to write down in the **new record** very carefully all desired data concerning given transformer 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 ....)
- 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 **Ano** (Yes) or you can go back to **Telephone Directory** by click on **Ne** (No).

### 8.9 Save

Click on **Save** will store data Days, Hours, Virtual-On line a Parameters of a given separator into a time-specified file.

### 8.10 Open

This command opens time-specified files and shows them under Optim A environment (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 separator

After setup you can start proper communication between your PC and the separator 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 6 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:

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MWT</td>
<td>water removal rate (ml/24 day)</td>
</tr>
<tr>
<td>MWC</td>
<td>total amount of water removed from a particular transformer (ml)</td>
</tr>
<tr>
<td>TTS</td>
<td>temperature of the transformer derived from oil temperature inflowing into the separator (°C)</td>
</tr>
<tr>
<td>T1S</td>
<td>temperature of freezing trap (°C)</td>
</tr>
<tr>
<td>P2S</td>
<td>averaged vacuum of separation process [kPa]</td>
</tr>
<tr>
<td>CWS</td>
<td>water content in inflowing oil [ppm] (if humidity sensor is installed)</td>
</tr>
</tbody>
</table>

8.13 Parametric process control

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

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

**ATTENTION!!**

Except for the temperature T2MAX (the required output temperature of the preheater) and P2auto (the required pressure of oil for automatic restart), no change of parameters is advisable. 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 [Archive](#) and this step will be confirmed showing the panel!

![Transformer dehydration record](image)

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

![Graphical output](image)
and TTS (transformer temperature)

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 the dehydration target has to be defined.

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 separator (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 easily exceed 30 ppm limit and the dielectric strength of oil drops relatively quickly under 40 – 50 kV/2.5mm.

If the moisture sensor is installed, follow always its on-line reading. The Cw-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 Cw-reading isn’t available:

- check at first both actual values of water content in the oil (Cw-value) and dielectric strength of the oil (Ud-value).
  - If the Cw-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 Cw-value is about 20 – 25 ppm is reached
  - If the Cw-value is about 30 ppm, decrease the temp. ca 5 C, check the result
  - If the Cw-value is substantially over 30 ppm, the temp. has to be immediately decreased until the allowed Cw-level is reached and simultaneously the Ud-level will be over 30 kV/2.5mm.

To make the whole procedure easier, the on-line reading of the Cw-value is recommended – the installation of a proper moisture sensor in the separator is very simple.

- check daily water removal rate MWT and the transformer temperature TTS on your PC
- when MWT is between 50 – 120 ml/day (and TTS is virtually constant) and the dehydration process is OK operate the transformer at this temperature until the output decreases below 50 ml per day (or any lower output the operator chooses )
- when MWT drops to less then 50 ml/day, increase the transformer temperature TTS about 5 – 7°C .
- when MWT exceeds 120 ml/day decrease the temperature TTS about 2-5°C
- Repeat the preceding steps as many times as necessary to reach the maximum operating temperature of the transformer. (usually 65- 85°C)
Chapter 9  The advanced evaluation of the effectivity of transformer treatment

For a better understanding of the long-term trends of dehydration effectivity of the VS-06 and a change of the dielectric behaviour of the transformer within the treatment two new procedures are used:

- the DDL (Dehydration and Degassing Log)
- the DSL (Dielectric Strength Log)

Both procedures can be started by clicking on the DDL or the DSL buttons in the Main window. By clicking on the DDL it shows:

- 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, P2S, Qw) are shown on the screen.
and by clicking on the printer icon (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 DDL procedure is shown

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

A new kind of assessment 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 Qw-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 strength 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:

- 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 (U_d, 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

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 \(U_{\text{d},t}\)-value has to be compared with the \(U_{\text{d},\text{lab}}\)-value at the same sampling time (the time when the oil for the lab \(U_{\text{d}}\)-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 \(U_{\text{d},\text{lab}}\) value(s) and other lab values have to be entered into the Verification Table:

For example: the sampling of oil was performed 19.4 2011 at 16.00.

By clicking on the pre-defined date, here 19.4 2011, the day is marked (by the blue colouring of the row). To enter the lab data the Edit row button is used.
Clicking on the OK button then gives the requested result(s), which is shown in the Verification Diagram in the bottom part of the window.

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° 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.