ON-LINE DEHYDRATION, DEGASSING AND ULTRAFILTRATION OF TRANSFORMERS

FOR VERY HEAVY WORKING CONDITIONS

VACUUM SEPARATOR VS-06 A

ON POWER RECOVERY OF DIELECTRIC STRENGTH
LIFE EXTENSION OF TRANFORMER
REMOTE PROCESS CONTROL AND MONITORING
MINIMUM SUPERVISION AND/OR MAINTENANCE
EFFECTIVE REMOVAL OF GASES
DIELECTRIC REMOTE SCREENING
Easy SMS Monitoring of function

Fa. Ing. Altmann ARS Altmann Group, Machova 142, 344 01 Domazlice, Czech Republic, European Union
Tel:+420-379 738 778, Fax:+420-379 738 775, Cell phone:+420-602 362 157 email:altmann@iol.cz, www.ars-altmann.com;

Drying of transformers

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

The Vacuum Separator VS-06 serves for mobile and preventative use on transformers with more than 2 - 2.5% water content in the cellulose, with particle contamination and excess gases. The **quick restoration of safe dielectric conditions, life-extending features, and remote control** also form part of this concept. The system can be installed regardless of the size of the transformer.

Main features of VS-06

- **Moisture, gas and particles content are reduced to the level of a new transformer**
- **Quick restoration of dielectric strength of oil**
- **No impact on the insulating oil properties, no over-drying of the transformer**
- **No disconnection of the transformer under treatment, not even during the installation of the separator**
- **Installation and servicing with the minimum manpower**
- **Direct check of the dehydration efficiency by the volumetric measurement of separated water**
- **Remote monitoring & control of the drying & degassing processes and the permanent screening of the dielectric behavior of a transformer**
- **Application of advanced and patented technologies like "hydraulic piston" for vacuum building and "bubble bed" for moisture separation**
- **Effective removal of fault gases via stripping procedure**

HOW MUCH MOISTURE IS "TOO MUCH MOISTURE" ?

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

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

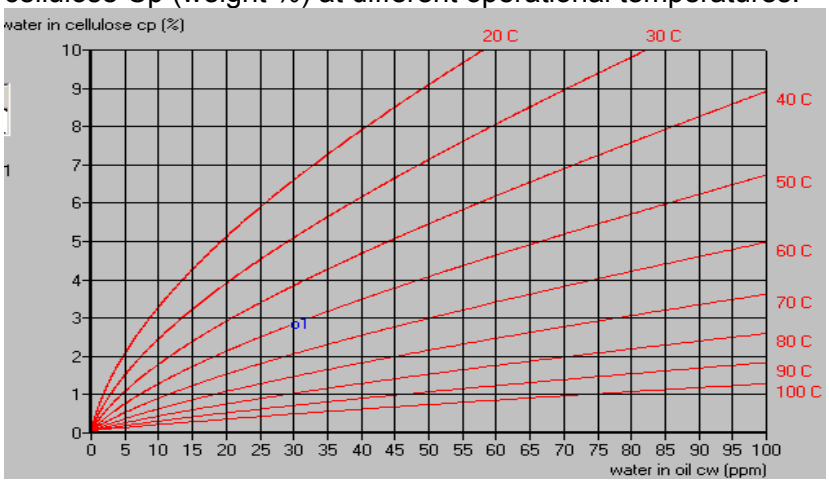

Fig.1 Moisture equilibrium chart (Nielsen diagram)

Example: **10MVA Transformer, 700 kg cellulose, 6000 kg oil**
Sampling temperature 50C, Qw = 30 ppm of water in the oil → Qp = **2.9%** weight percent of water in the cellulose.

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

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

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

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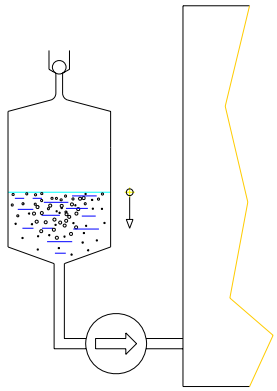
The effect of moisture on the transformer shows Table 1.

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

To avoid the deterioration of solid insulants, the moisture content should be kept under 2%. If the moisture level exceeds 2% , the transformer must be dried as a matter of preventive maintenance. For relevant information about moisture reading in situ and the impact of moisture in the dielectric behavior of a transformer See www.ars-altmann.com / SIMMS 2.2 or / News.

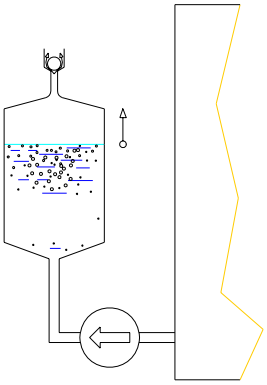
WHAT IS A LIQUID PISTON?

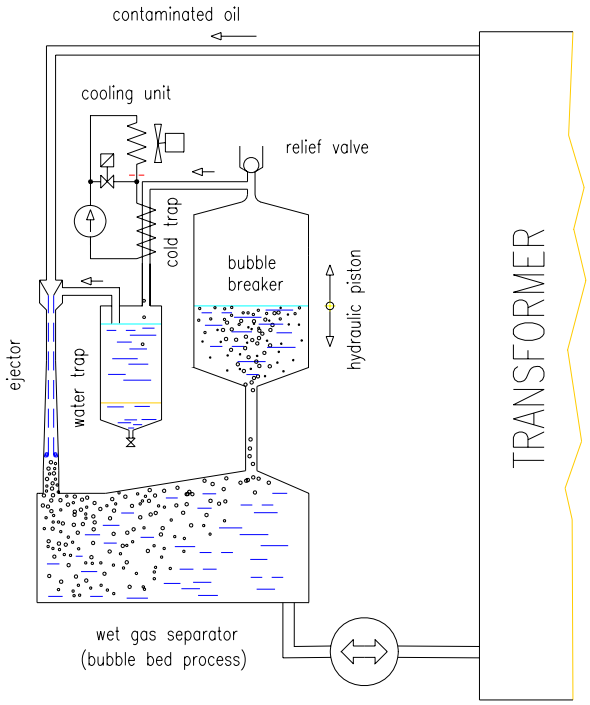
The Liquid Piston principle, which substitutes the vacuum pump, is created by the rising and falling of oil level, which is caused by the cyclic operation of the robust gear pump.



The first stage (***evacuation***) shows the picture on the left. The oil is drawn from the apparatus by the gear pump. The sinking oil level acts as a piston and creates the basic vacuum necessary to separate the gases and vapors from the oil

The second stage (***compression***) shows the picture on the right. The run of the gear pump reverses, and the rising oil level (upward motion of the liquid piston)gradually compresses the liberated gas-vapor mixture. When the pressure rises, first, the condensation of oil vapors occurs, and the **condensed light fractions automatically mixe back into the oil. Only this way is guaranteed that under on-line, long-term dehydration of a transformer that there is "no-impact on oil properties".** Subsequently, the gases are released via the non-return valve into the atmosphere. This process continues until the whole apparatus is filled with oil, then the gear pump is switched on into the direct run again, and the next vacuum stage begins.





HOW ARE VAPOURS AND GASES SEPARATED FROM OIL ?

Vacuum, appropriate temperature and large interfacial area are essential for efficient separation.

Contaminated oil from the transformer is adjusted to an optimum temperature, and the hot oil and the gas (previously separated from the oil) are mixed in a vacuum by the ejector to produce bubbles with a large interfacial area (bubble bed).

The intense diffusion of the moisture from the oil is enhanced by minimizing the partial pressure of the water vapor via **freezing-out of moisture from the gas before its mixing with the contaminated oil.**

Dissolved gases and vapors diffuse into bubbles, which are then agglomerated, collected and broken. The released water vapor is then collected in the form of ice in the freezing trap, and periodically defrosted and collected as a liquid in the water trap.

Note that only a simplified scheme is shown here for clarity.

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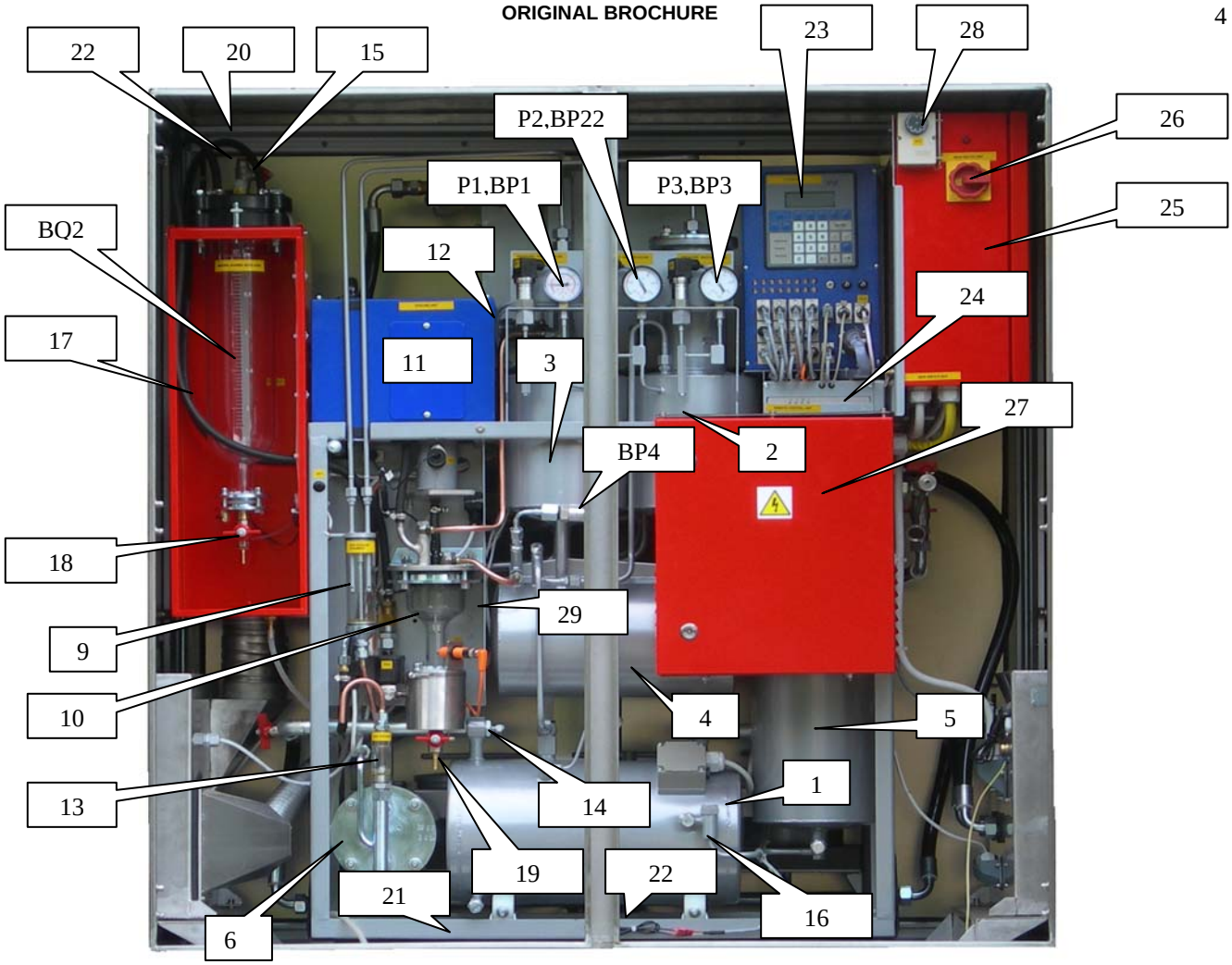

1	Hermetized pump	22	Oil leakage sensor
2	main vacuum chamber	23	Proces Control Unit AMIT 4001 A
3	wet gas accumulator	24	GSM Modem or Internet modem
4	wet gas separator	25	Main switch box
5	oil accumulator	26	Main switch …… QM1
6	collecting chamber	27	Autotransformer
7,8	Inlet, process ejector	28	Fan thermostat 2 (external cooling)
9	gas flow monitoring chamber	29	Water level sensor
10	batch unit		
11	cooling unit		
12	fan thermostat ST1		
13	exhaust valve		
14	throtle valve	P1	pump gauge
15	Water level sensor ext. water trap	BP1	pump pressure sensor
		P2	main chamber gauge
17	External water trap	BP2	main chamber pressure sensor
18	water removal cock	P3	collecting chamber gauge
19	Desluging cock	BP3	collecting chamber pressure sensor
20	Air bleed valve	BP4	throughflow pressure sensor
21	Oil sump		

Internal layout of main components in separator VS-06 (front door open)

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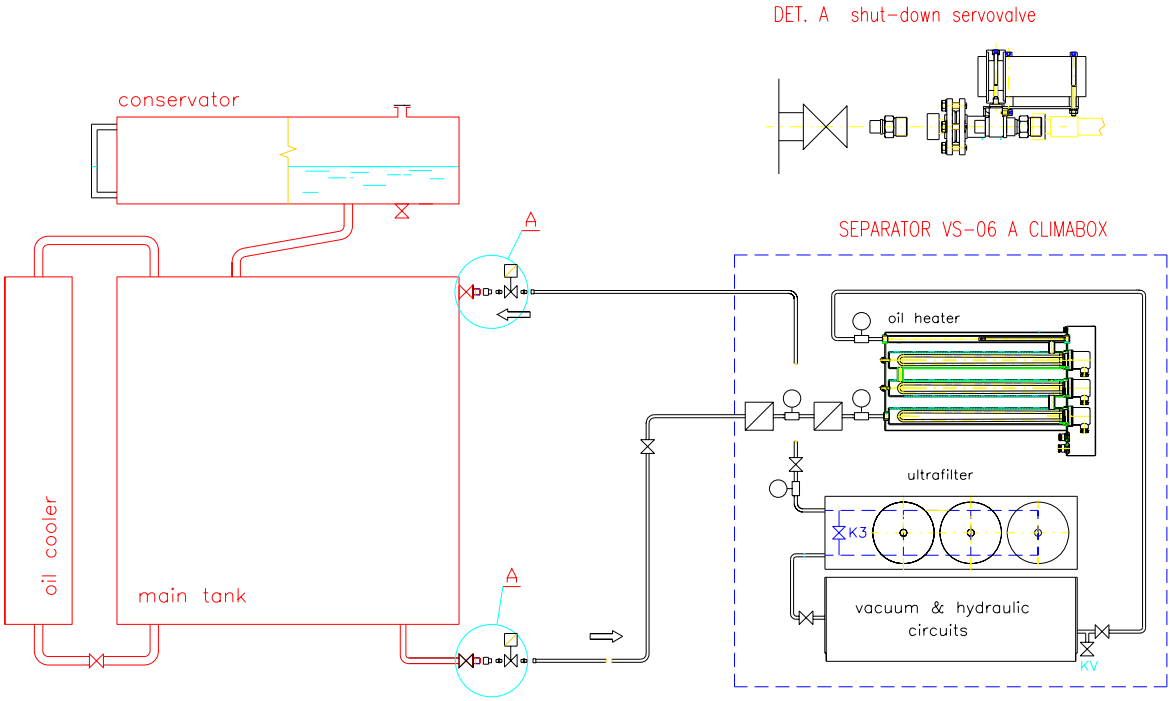
INSTALLATION



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

All treatment utilities (vacuum and hydraulic circuits, preheater, ultrafilter control circuits etc.) are installed in the moisture tight and internal air-conditioned CLIMABOX.
For detailed information See VS-06A CLIMABOX Operational Manual 2006

SPECIFICATION

Power supply voltage	400 V (or on request)
Power supply frequency	50 Hz (or on request)
Power consumption:	
without oil heater	850 W
with oil heater PO-01	6200 W maximum
Oil throughput	10 m^3 per day maximum
Outlet water content	10 ppm nominal , 4 ppm minimum
Outlet gas content	1% nominal, 0.3 % minimum
Outlet filtering grade	1 µm
Dimensions:	1600 x 1500 x 1000 (mm)
Weight – CLIMABOX version (separator, heater ultrafilter, external water trap etc.)	
Dry weight (without oil)	520 kg (+ autotransformer)
Operating weight (oil filled)	580 kg
Hydraulical connection	2 x flexible 1/2“ hose
Communication:	faxmodem, GSM modem, LAN link, Internet, SMS
Moisture reading :	Vaisala humidity sensor: on request

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Typical applications of the VS-06 Climabox

Indonesia:

Installation of VS-06 Climabox at block transformer
Improvement of Tx dielectric

Germany: 250 MVA Transformer

VS06 Climabox (and Online DGA)controlled life-extention of aged transformer

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