On-line Dissolved Gas Analysis

accord. to IEC 567/ASTM 3612

Online-Monitoring of transformers

Automatic on-line analysis of 11 gases

The analysis is done in 2 steps with high selectivity and accuracy fully compliable with laboratory procedure.

1. Degassing of the taken oil sample through vacuum extraction (acc. DIN/IEC 60567/567

2. Dissolved gas analysis through gas chromatography with TCD (thermal conductivity detector) , FID (Flame Ionization detector) and Methanizer

Both steps are synchronized by a micro-controller which guarantees a fast and reliable measurement routine.

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Vacuum degassing

A new invented vacuum degassing method (Patent pend. DE 102 52 652 4) degasses the oil sample multi-periodical. After extraction through a 4 step vacuum pump the gases are dosed into vacuum chamber and separated. The gases are evacuated from the vacuum chamber with a vacuum pump, therefore a very high sensitivity can be reached. The measuring principle is shown in fig, 1.
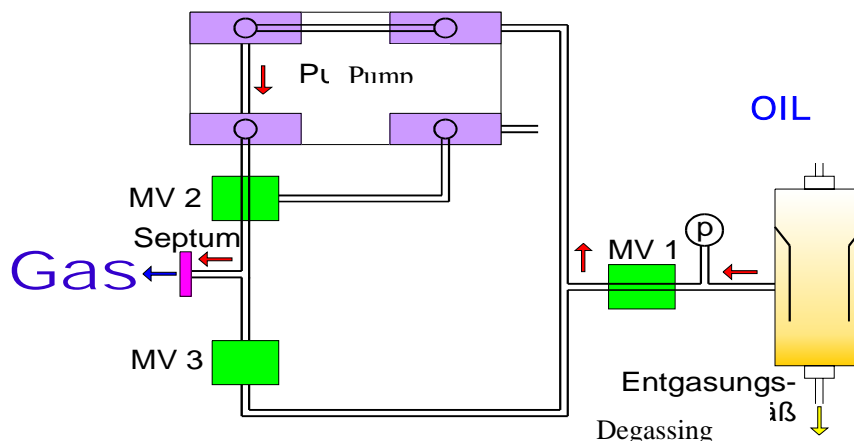
In and outlet of the oil sample as well as the switching valve are micro-processor controlled, a feedback of the oil into the transformer is possible. A linear pressure sensor measures the total gas content online which is a very important quality parameter for the characterization of the transformer load.

The injection of the gas sample into the gas chromatograph is via a fixed mounted and heated transfer pipe. An additional port for withdrawal of gas samples is installed.

Dissolved Gas Analysis with Mobil GC

The analysis of the dissolved gases is done after automatic injection in an automatic sample loop (6 port valve) of the gas chromatograph. The gas sample is separated in an inert gas stream into 11 components. This guarantees a high selectivity with no interference of other gas signals.

A capillary column (typ Carboxen 1010, length 30m x ID 0,32 mm) is used for the separation of the different compounds. Detection is carried out with a TCD (Thermal Conductivity Detector) and FID (Flame Ionization Detector). The compounds CO and CO_2 are converted with a methanizer for detection on the FID which guarantees a very high sensitivity.

The following parameters are monitored:

H_2, CO, CO_2, CH_4, C_2H_2, C_2H_4, C_2H_6, O, N, C_3H_6, C_3H_8

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Beside the analysis of the dissolved gases a monitoring of the Buchholz relay through a 2. injection port is possible. The monitoring of the Buchholz gases is done automatically. As soon as the relay releases, the measurement routine is interrupted and the relay gases are analyzed accordingly.

Control and Evaluation

The system is controlled by a micro-processor; a serial interface (RS 232) allows transferring the data to a remote computer.

The intervals of the analysis cycle can be freely defined by the operator (number of analysis/day or hour).

The system has 8 additional analog inputs (0 -1 V) for the measurement of other transformer parameters (Oil temperature, winding temperature, ambient conditions etc.) The connection of these external sensors is through relay contacts (N/C or N/O, to be specified by the customer).

Display of Results

All results are displayed in ppm, the sensitivity is as low as 0,1 ppm for certain hydro-carbons. Therefore, also new transformer oils and transformers after their periodic maintenance can be analyzed.

Beside the display of the results in ppm, all other operating conditions are registered online and stored in a data-base together with all other parameters.

The graphical display of the results is in real time on the monitor, in a table or/and as test report in a print file. The data can also be transmitted to a remote computer or a control center. All relevant data are stored in a measurement file.

The results are stored with other measurement parameters in the history (log. file). The history starts with the day of the commissioning. The trend is shown in a diagram (hour / day / week / month / year), the interval is 15 min (can be adjusted by the operator).

The integrated expert system will analyze even smallest deviations in the gas parameters.

A plausibility test ensures the accuracy and reproducibility of the test results (systemic comparison of the test results).

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Alarms

➢ Monitoring of all gas parameters (11 gases) exceeding of one parameter will activate an alarm and data will be send to an remote control system

➢ Trend analysis for predictive maintenance for each gas compound if increase goes beyond predefined levels (considering the temperature of the transformer)

➢ Interruption of power supply

➢ Status report of system with automatic self diagnostic function

➢ Export of all data and alert to a remote control system
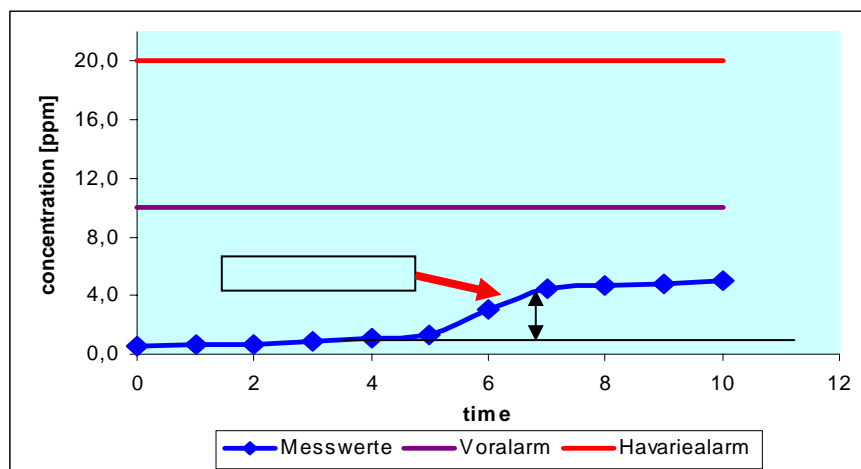
Example for monitoring modus (Parameters and Threshold values are freely selectable)

All threshold values can be individually selected for each gas components.

The trend analysis starts with the day of installation and is stored as an unbroken chain of evidence. The trend will show any irregularity above 0,5 ppm (for organic compounds 0,1 ppm on the FID channel).

The degree of degradation of the insulation of the transformer (decomposition of the insulation) can be displayed with a comparison of the different parameters on a time graph, an important criterion for prophylactic control of possible defects in the transformer.

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Technical Specifications:

Gas Chromatograph Mobil GC

- basic device with Windows control software for evaluating documentation and customer-specific settings
- thermal-conductivity detector (TCD) and flame ionisation detector (FID), Methanizer
- furnace cassette with separating column and temperature-programmed column heating system, separate heating for each column
- internal carrier and burning gas supply (argon/hydrogen for approximately 80 operating hours)
- 2 capillary columns for determination of **hydrocarbons C1-C3** with complete heating up to 300°C, 2. column for determination of **permanent gases (H2, N_2, O_2,)** with complete heating up to 300°C
- Automatic, controlled gas sample valve with exchangeable 0,2 ml - dosing capillary, integrated in basic device. The valve is suitable for high pressure applications. Ready for operation. The sample is pumped with an internal diaphragm pump (time controlled by software).
- Automatic, controlled 6-port-valve, integrated in basic device.
- The valve is suitable for packed as well as for capillary columns.
- degassing is carried out by means of a gas extraction syringe according to DIN / IEC 60567/567; the released gas is transferred to the GC by means of an injection syringe

For detection of 11 fault gases:

- H_2, CH_4, O,   N, CO, CO_2, C_2H_2, C_2H_4, C_2H_6, C_3H_6, C_3H_8

Detection ranges:

H_2	1 ppm
CO , CO_2, CH_4	0,2 ppm
C_2H_2, C_2H_4, C_2H_6	0,1 ppm
C_3H_6, C_3H_8	0,5 ppm
O_2, N_2	30 ppm

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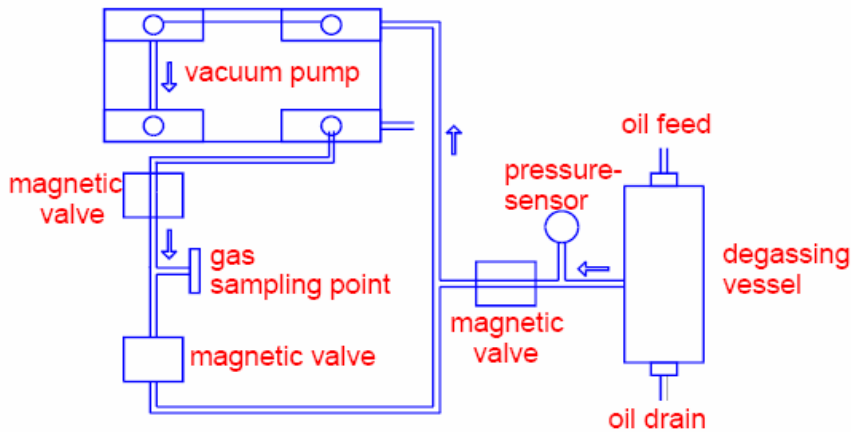**www.energy-support.de**

On-line Vacuum Degassing:

Vacuum gas extraction without Mercury use, fully compliable to existing methods of vacuum degassing with Töpler pump and Mercury. Preparation of gas samples for gas chromatographic applications and determination of total gas content.

- ➢ Less weight and small size
- ➢ High sensitivity and accuracy
- ➢ Easy to handle
- ➢ 100% comparable to Lab-degassing procedures
- ➢ Working without mercury
- ➢ Degassing according to DIN/IEC standard

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Principle of degassing procedure

vacuum pump

magnetic valve

gas sampling point

magnetic valve

pressure-sensor

magnetic valve

oil feed

degassing vessel

oil drain

oil filled dosing syringe

The oil sample is injected right into the evacuated degassing vessel by means of an oil filled syringe. The pressure sensor show the pressure increase, which correspond to the total gas content of the oil.

The dissolved gas is separated from the finely dispersed oil and pumped to the gas sampling point. After analysis oil sample flows off through the now opened oil drain. After degassing procedure, the extraction system is purged and ready to receive the next oil sample in less than 5 minutes.

All systems components that have sample contact and vacuum exposure are constructed from metal valves, tubings and fittings.
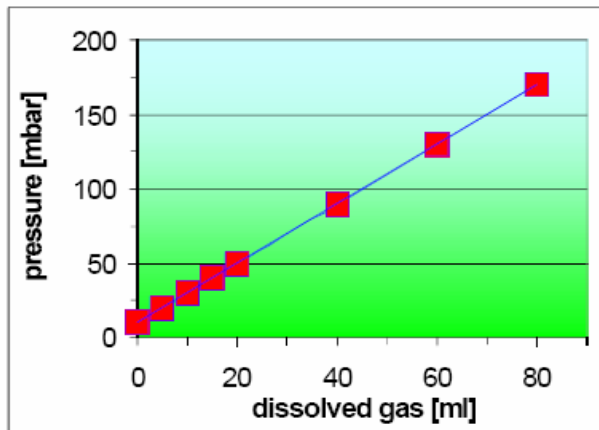
The diagram show the linear graph of pressure dependent on the dissolved gas content.

Degassing equipment include:
➤ four stage diaphragm pump
➤ vacuum extractor with oil dosing
➤ digital pressure measurement
➤ sluice for oil feed and oil drain
➤ automatic procedure for gas sampling and rinsing with vacuum-tight magnetic valves and fittings

Applications:
➤ **Insulating oil**
➤ **Mineral oil**
➤ **Engine oil**
➤ **Gear oil**
➤ **Hydraulic flluids**
➤ **Biodiesel**
➤ **Fuels**
➤ **Lubricating fluids**

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Weatherproof Housing for Analysis and Control Unit

➢ isolated steel housing 1200x 1200 x 500mm for degassing unit, gas chromatograph and sample conditioner for outdoor use.

➢ Wall thickness 2mm, welded. High stability, double door and key locking.

➢ EMC shielding according to valid standards

➢ Integrated control computer Steuerrechner (2,4 MHz, 256 RAM, 40 GB HDD, 40 fach CD-ROM, FDD, 15" Monitor, keyboard, Ethernet and Modem for remote monitoring

Option:

Online Moisture Content Measurement with Sensor FS 300

The moisture sensor FS 300 is ideal for online measurement of the absolut water content in transformer oil.

The continuous monitoring   of the water content is done with the determination of free water molecules in mineral oils by a capacitive sensor and the oil temperature. A micro-controller calculates through numeric interpolation the absolute water content in relation to the calibration list. The water content is displayed in ppm. The measuring range is 10 ppm to saturation of free water molecules in oil.

The calibration of the sensor is done with the well known Karl Fischer titration according to ASTM D 1744. This guarantees exact values for the measurement of absolute water content in oil.

Technical Data:
Measurement range: 10 ...10.000 ppm
Oil temperature: -20 ... + 65 °C
Operating pressure: up to 30 MPa
Weigth: 450 g
Connection: 5/8 –18 UNF
IP65

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