MEREL

TRANSFORMER OIL GAS ANALYZER

Merel GE-567

Fully automated gas extraction unit based on Multi-cycle Mercury free Vacuum extraction method coupled by a pump and tube with Agilent GC system, according to international standards IEC 60567 and ASTM D-361.

Mercury free Toepler principle gives more extracted gases, because extraction is made in high vacuum. Transfer of gas from the pump to the GC is with very little dead volume witch could be measured and use for corrections. If the content of gas is too low to inject to GC, it could be automatically diluted with air or argon.

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DISSOLVED GAS ANALYSIS

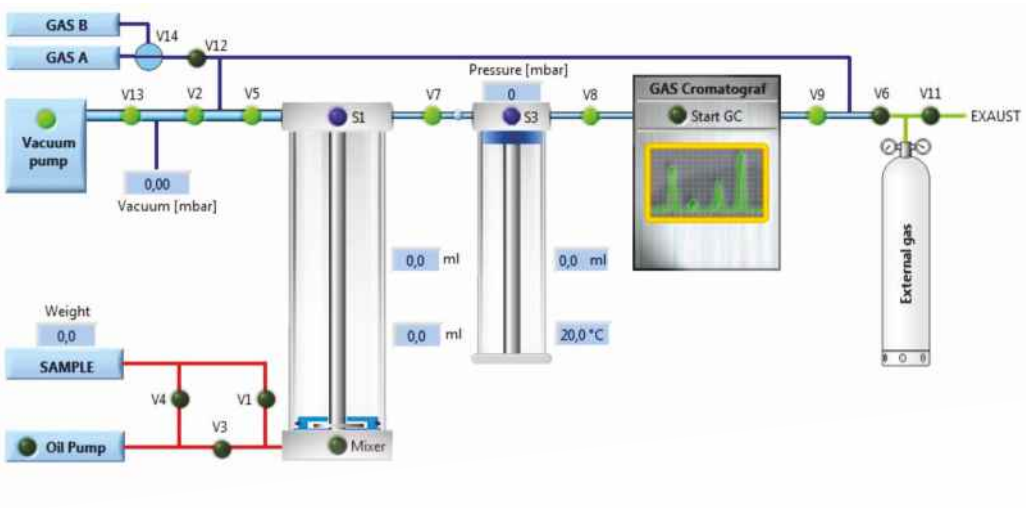
The gases that are of interest for the DGA analysis are the following:

- H_2 – hydrogen
- CH_4 – methane
- C_2H_4 – ethylene
- C_2H_6 – ethane
- C_2H_2 – acetylene
- C_3H_6 – propene
- C_3H_8 – propane
- CO – carbon monoxide
- CO_2 – carbon dioxide
- O_2 – oxygen
- N_2 – nitrogen
- TCG – total combustible gas content (H_2, CH_4, C_2H_4, C_2H_6, C_2H_2, CO, C_3H_6, C_3H_8)

Dissolved Gas Analysis (DGA) is a widely used technique to estimate the condition of oil- immersed transformers. Incipient faults within the transformer may be detected by analyzing the gases which are dissolved in the transformer-oil.

DGA is a diagnostic tool for detecting and evaluating of incipient faults in oil-immersed transformers. A fault is in this context defined as a process that causes abnormal dissipation of energy within the transformer. When a fault occurs in the transformer, the insulation system will undergo chemical degradation which leads to a production of various gases that dissolves in the oil. These gases are often referred to as key gases, and their concentrations can by various interpreting methods be related to different types of fault in the transformer.

PRINCIPLES OF OPERATION



DGA PROCEDURE

Today DGA technique is best performed in laboratory since it requires measuring instruments with high accuracy. One could summarize the DGA procedure in following four steps:

1. Sampling of transformer oil
2. Extraction of the gases from the oil
3. Analysis of the extracted gas mixture in a gas chromatography, GC.
4. Interpretation of gas data

1 The oil samples should preferably be taken in the moving oil so that the gas generated somewhere easily and rapidly is transported from the point of generation to the sampling point. Suitable locations are valves in the cooler/radiator circuit. To take samples from these locations is not always possible because of design limitations. Other places from which to draw samples are the cover, bottom valve, the conservator and from the Buchholz relay. In addition, it is very important that the sampling is made in such a way that the contamination of the sampling vessel is held at a minimum and that gas are not lost during sampling or transportation to the laboratory.

2 The removal of the gases from the oil can be accomplished by various methods:

- partial degassing (single-cycle vacuum extraction)
- total degassing (multi-cycle vacuum extraction)
- stripping by flushing the oil with another gas.
- by the headspace technique in which gases are "equalized" between a free gas volume and the oil volume.

TOGA analyzer Merel GE-567 uses total degassing method. The gas extractor is a fully automated vacuum degassing unit for extracting gas from transformer oil with multi-cycle Mercury free Vacuum extraction according to international standards IEC 60567 in ASTM D-361.

3 After extraction the extracted gas mixture is fed into adsorption columns in a GC where the different gases are adsorbed and separated to various degrees and consequently reaches the detector after different periods of time. In this way the gas mixture is separated into individual chemical compounds, identified and their concentrations in volume gas STP/volume oil is calculated and expressed in ppm. (STP=standard temperature and pressure).

4 When the different gases in the oil sample have been identified and quantified it remains to interpret the result. What have to be decide in order to evaluate the condition of the transformer is if the present amount of dissolved gases can be considered as abnormal or not. In the case where there is an abnormal gas production - trying to figure out the origin of the gas production, i.e finding possible fault causes.

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SOME KEY ATTRIBUTES

- The system fully complies with norm IEC 60567.
- Sample volume 10 to 250 ml.
- The possibility of measuring the low levels of gas under 0.5 ml / l.
- Free-setting of extraction parameters. (Define number of strokes and duration of each).
- "Dead volume" could be measured for diagnostic and (or) volume correction.
- The piston pump diagnostic with injection of 10 ml of air to verify the tightness of the piston.
- Export measurements-value in EXCEL
- View all operating parameters, including intermediate extraction with the announcement of the final result.
- The conversion of the normalized value of 1013.25 mbar and 20 °C
- All phases in extractions could be done manually in steps.
- Calibration of the scale, pressure sensor, temperature sensor and vacuum sensor is included in the SW.
- Buchholz gas analysis.
- Analysis of the external gas (cylinder).
- Use and hardware software leading manufacturer in the field of measuring / control equipment (National Instruments).
- The user interface could be translated to the local language.

TECHNICAL DETAILS

Transformer Oil Gas Analyzer system with Multi-cycle Mercury free Vacuum extraction

Auto-sampler

Oil sample volume:	10 – 200 ml
No. of positions:	20 / 125 ml

Gas extractor

Type of transformer oils:	new and used
Dual stage vacuum oil pump:	Ultimate pressure $2x10^{-3}$ mbar
Gas extraction cycles and times:	Set in software
Vacuum measurement/range:	1.3×10^{-3} mbar – 1333 mbar
Oil sample measurement/accuracy:	gravimetric / ± 0.05 ml
Gas volume measurement:	precision glass burette/precision pressure sensor – temperature compensated
Gas volume measurement corrected:	To standard atmosphere (1013.25 mbar / 20 °C)
Pressure sensor accuracy:	± 0.05 % @ 1013 mbar / 10-40 °C
Pressure sensor and balance calibration:	Performed in software
Extracted Gas volume range:	1 ml/l – 200 ml/l
Extracted Gas volume accuracy:	±10% @1 ml/l – 20 ml/l, ± 2% @ 20 ml/l – 200ml/l
Gas transfer and analyses:	Standard TGA GC instrument (loop volume 0.25 – 1.0 ml)
Power input:	115 – 240 VAC, 50 – 60 Hz
Power Input:	950 W
Dimensions (WxHxD):	440 x 1040 x 620 mm
Weight:	50 kg

MEREL

Laboratorijska in merilna oprema, raziskave in razvoj

Merel d. o. o.
Ob gozdu 25
SI-2352 Selnica ob Dravi
Slovenija

T +386 (0)2 229 73 90
F +386 (0)2 229 73 91
E info@merel.si
W http://www.merel.si