Transformer Monitoring
Overview of modular system components

Transformers are crucial for failure-free and stabilized operation of high-voltage power transmission. Transformer failures or disruptions can result in costly power outages or even in the total loss of expensive plant assets. Moreover, transformers are the most cost-intensive single component asset in high-voltage power transmission and should therefore be supervised with special care.

Analysis of the gases dissolved in power transformer oil is recognized as the most useful tool for early detection and diagnosis of incipient faults in transformers. The cost effectiveness of online dissolved gas analysis (DGA) and control systems are gaining importance worldwide.

With its comprehensive product range for the online monitoring of transformers, MTE offers both the extension of the transformer lifetime and the contribution to a more secure high-voltage power transmission.
Advantages of MTE’s solutions for Transformer Monitoring

- Permanent online monitoring of the transformer condition
- Early warning
- Less risk of expensive power outages
- Reduced on-site inspections
- Maintenance free system
- Extending transformer life time due to improved preventative maintenance and faster reaction time in case of failures
- Modular system components and extension packages for the specific customer requirements
- Easy and fast mounting on the operating transformer (HYDROCAL 100x and Offshore versions)
- Approved solutions with more than 5’000 supplied units
MTE offers a broad range of products and solutions for the online gas-in-oil monitoring of transformers. With its individual and modular system components MTE provides the optimal customer oriented solution for utilities, industries and transformer manufacturers.

<table>
<thead>
<tr>
<th>Product</th>
<th>HYDROCAL 1001+</th>
<th>HYDROCAL 1003</th>
<th>HYDROCAL 1004 genX</th>
<th>HYDROCAL 1005</th>
<th>HYDROCAL 1008</th>
<th>HYDROCAL 1009</th>
<th>HYDROCAL 100x-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas-in-oil analysis</td>
<td>H₂, CO, CH₂, C₂H₂, C₃H₆ (individual)</td>
<td>H₂, CO, C₂H₂, C₂H₆ (individual)</td>
<td>H₂, CO, CH₄, C₂H₂, C₂H₆ (individual)</td>
<td>H₂, CO, CH₄, C₂H₂, C₂H₆ (individual)</td>
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<td>H₂, CO, CH₄, C₂H₂, C₂H₆, C₃H₆ (individual)</td>
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<tr>
<td>Moisture in oil analysis (H₂O)</td>
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<tr>
<td>Transformer monitoring inputs / outputs</td>
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<td>✓</td>
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<td>HYDROCAL MS-7 2)</td>
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<tr>
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<td>✗</td>
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<tr>
<td>Monitoring of multiple transformers</td>
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</tbody>
</table>

1) Special version with corrosive protection for the installation on offshore platforms
2) Extension packages (options)

The HYDROCAL 1001+ is a permanently installed composite gas in oil sensor for the Total Dissolved Combustible Gases (TDCG) analysis of the key fault gases Hydrogen (H₂), Carbon Monoxide (CO), Methane (CH₄), Acetylene (C₂H₂), Ethylene (C₂H₄) and Ethane (C₂H₆).

To detect an even wider range of potential transformer faults, the HYDROCAL 1001+ analyses additionally the content of Moisture (H₂O) in the transformer oil.

The HYDROCAL 1001+ is a fully integrated (6 key fault gases and Moisture in oil) compact and cost effective device used in particular for early transformer fault detection and preventative maintenance.

**Key advantages:**
- Cost effective and comprehensive monitoring of 6 fault gases
- Measurement of Moisture (H₂O) in the transformer oil
- Easy and fast installation while the transformer is operating
- Compact and resistant design for long lasting usage
- ETHERNET and RS 485 interfaces to support MODBUS®TCP proprietary communication
The HYDROCAL 1003 is an online transformer monitoring device for the dissolved gas analysis (DGA) of the key fault gases Hydrogen (H₂) and Carbon Monoxide (CO).

In addition, water contamination deteriorates the performance of the oil as high moisture content increases the risk of corrosion and overheating.

The HYDROCAL 1003 reacts on this issue and provides its users the analysis of Moisture (H₂O) in the transformer oil to achieve an even higher safety standard.

Key advantages:
- Easy to mount on the operating transformer without any operational interruption
- ETHERNET (Option), RS 232 and RS 485 interfaces to support MODBUS®RTU/ASCII, DNP3 proprietary communication and IEC 61850 protocols
- Option: Offshore version

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The new HYDROCAL 1004 genX is the first truly maintenance free multi-gas online DGA solution combining proven near infrared (NIR) measuring technology with vacuum protected membrane extraction.

As Hydrogen (H₂) is involved in nearly every fault of the isolation system of power transformers and Carbon Monoxide (CO) is a sign of an involvement of the cellulosic / paper isolation the presence and increase of Acetylene (C₂H₂) further classifies the nature of a fault as overheating, partial discharge or high energy arcing.

Key advantages:
- Maintenance free system
- Easy to mount on the operating transformer without any operational interruption
- Advanced software (on the unit and via PC) with intuitive operation by 7” color TFT capacitive touchscreen, power consumption and energy data from any smart phone, tablet or notebook PC
- ETHERNET and RS 485 interfaces to support MODBUS®RTU/ASCII, MODBUS®TCP, DNP3 proprietary communication and IEC 61850 protocols

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The HYDROCAL 1005 is a permanently installed multi-gas-in-oil analysis system with transformer monitoring functions. It individually measures Moisture in oil (H₂O) and the key gases Hydrogen (H₂), Carbon Monoxide (CO), Acetylene (C₂H₂) and Ethylene (C₂H₄) dissolved in the transformer oil.

Especially the presence and increase of Acetylene (C₂H₂) and Ethylene (C₂H₄) further classifies the nature of a fault as overheating, partial discharge or high energy arcing.

The HYDROCAL 1005 offers as a compact transformer monitoring system by the integration of other sensors present on a transformer (HYDROCAL MS-7 and / or bushing monitoring ZVCM-1001 extension packages).

Key advantages:
- Easy to mount on the operating transformer without any operational interruption
- ETHERNET and RS 485 interfaces to support MODBUS®RTU/ASCII, MODBUS®TCP, DNP3 proprietary communication and IEC 61850 protocols
- Option: Offshore version
The HYDROCAL 1008 is a permanently installed multi-gas-in-oil analysis system with transformer monitoring functions. It individually measures Moisture in oil (H₂O) and the key gases Hydrogen (H₂), Carbon Monoxide (CO), Carbon Dioxide (CO₂), Methane(CH₄), Acetylene (C₂H₂), Ethylene (C₂H₄), and Ethane (C₂H₆) dissolved in the transformer oil.

Key advantages:
- Easy to mount on the operating transformer without any operational interruption
- ETHERNET and RS 485 interfaces to support MODBUS®RTU/ASCII, MODBUS®TCP, DNP3 proprietary communication and IEC 61850 protocols
- Option: Offshore version

The HYDROCAL 1008 offers as a compact transformer monitoring system by the integration of other sensors present on a transformer (HYDROCAL MS-7 and / or bushing monitoring ZVCM-1001 extension packages).

The HYDROCAL 1009 is a permanently installed multi-gas-in-oil analysis system with transformer monitoring functions. It individually measures Moisture in oil (H₂O) and the key gases Hydrogen (H₂), Carbon Monoxide (CO), Carbon Dioxide (CO₂), Methane(CH₄), Acetylene (C₂H₂), Ethylene (C₂H₄), Ethane (C₂H₆) and Oxygen (O₂) dissolved in transformer oil.

Key advantages:
- Easy to mount on the operating transformer without any operational interruption
- ETHERNET and RS 485 interfaces to support MODBUS®RTU/ASCII, MODBUS®TCP, DNP3 proprietary communication and IEC 61850 protocols
- Option: Offshore version

Oxygen (O₂) can be a sign of excessive ageing or leakages within the sealing of hermetic transformers.

The HYDROCAL 1009 is MTE’s most comprehensive transformer monitoring system, which can be even expanded with different extension packages (HYDROCAL MS-7 and / or Bushing Monitor ZVCM-1001).

The HYDROCAL 100x-3 is a multi-gas-in-oil analysis system for the monitoring of a bank of three single phase transformers located close to each other.

The wall mounted system individually measures Moisture in oil (H₂O) and the key gases Hydrogen (H₂), Carbon Monoxide (CO), Carbon Dioxide (CO₂), Methane(CH₄), Acetylene (C₂H₂), Ethylene (C₂H₄) and Ethane (C₂H₆) dissolved in the transformer oil utilising a smart sampling system that samples oil from each tank via three separate oil channels.

It furthermore serves as a compact transformer monitoring system by the integration of other sensors present on a transformer.

Key advantages:
- Cost efficient monitoring of three transformer tanks with one of the HYDROCAL 100x-3
- ETHERNET and RS 485 interfaces to support MODBUS®TCP, DNP3 proprietary communication and IEC 61850 protocols
- Permanent (online) monitoring of multiple transformers
Offshore versions and extension packages

The HYDROCAL Offshore (1003, 1005, 1008 and 1009) transformer monitoring systems are specially designed for the harsh conditions (salt water, corrosion) on offshore platforms (e.g. wind mill parks). Special painted housing with no window and the application of chrome nickel and stainless steel ensures the reliability and the persistence of the device. The specific functions and the gas-in-oil analysis (range of fault gases) remain the same as in the standard versions of the HYDROCAL 1003, 1005, 1008 and 1009.

Key advantages:
- Special design for offshore applications:
  - Housing without window painted in C5M
  - Back plate with 2 cable glands M20 (chrome-nickel steel, IP 68, corrosion-free and acid-resistant)
  - Back plate, oil entrance and housing screws made of stainless steel V4A
- Easy to mount on the operating transformer without any operational interruption

The HYDROCAL MS-7 is an extension package to the HYDROCAL 1003, 1004 genX, 1005, 1008 and 1009 that measures 3 oil temperatures (top oil, bottom oil & tap changer oil), ambient temperature, load current, load voltage and the tap changer position of a transformer.

With this solution MTE addresses the issue that thermal conditioning is one of the most important means to detect transformer problems and to avoid transformer outages.

In conjunction with its proven HYDROCAL units, MTE offers a complete transformer monitoring system in one package.

Key advantages:
- Complete on-line transformer monitoring extension package with direct integration into HYDROCAL 1003, 1004 genX, 1005, 1008 and 1009 hardware, firmware and into HydroSoft
- Individual measurement of top oil temperature, bottom oil temperature, ambient temperature, tap changer oil temperature, tap changer position, load current and load voltage

The Bushing Monitor ZVCM-1001, which is an extension package to the HYDROCAL 1004 genX, 1005, 1008 and 1009 is a permanently installed on-line bushing monitoring system. It continuously measures up to six leakage currents, tests the power factor and the capacitance values. Moreover, the bushing monitoring system, which has been developed in cooperation with ZTZ Services, monitors the condition of bushings, the capacitance coupled voltage transformers (CCVT’s) and the free standing CT’s.

By providing this additional value, MTE answers the fact that bushing failures are considered as one of the major causes for transformer outages.

Key advantages:
- Complete on-line transformer monitoring and bushing monitoring system in conjunction with HYDROCAL 1004 genX, 1005, 1008 and 1009
- No more off-line testing and shutting down of the transformers to measure the capacitance and the dissipation / power factor
- Simultaneous measurement of up to six bushing leakage currents
- Compatibility to various transformer test taps and bushing types
The following MTE leaflets for Transformer Monitoring are available:
HYDROCAL 1001+ / 1003 / 1004 genX / 1005 / 1008 / 1009
HYDROCAL 1003 Offshore / 1005 Offshore / 1008 Offshore / 1009 Offshore
HYDROCAL 1005-3
HYDROCAL 1008-3
HYDROCAL MS-7
Bushing Monitor ZVCM-1001