Instruments for Measurement of Dissolved Carbon Dioxide and Oxygen in Beverages

Lab and At-line
In the production of alcoholic and non-alcoholic beverages, it is essential to check and control the CO$_2$ and O$_2$ content of the product both during the production process and after bottling.

The CO$_2$ content strongly influences the taste of beverages and is a considerable cost factor in beverage production. Precise measurement of the carbon dioxide ensures consistent taste and cost-efficient dosing.

A high level of dissolved O$_2$ in beverages has a negative impact on the taste and shelf life of the beverage. The continuous monitoring of the oxygen content ensures product safety and consistent beverage quality.

**The best instrument for your application**

Whether directly at the production line, in the laboratory or as part of a larger beverage analyzing system, Anton Paar provides the best instrument for your measurement application. The range includes instruments for measuring dissolved oxygen and dissolved carbon dioxide without being influenced by other dissolved gases such as air or nitrogen.

**Have it all: CO$_2$ and O$_2$ combined**

Anton Paar’s new instrument, CboxQC, combines the fast measurement of CO$_2$ and O$_2$ in one measuring cycle – available for portable use at-line as well as in a stand-alone version for the laboratory. For the utmost flexibility, the instruments’ new and robust design is small, compact and lightweight.
**Laboratory measurement**

<table>
<thead>
<tr>
<th>CarboQC</th>
<th>CarboQC ME</th>
</tr>
</thead>
<tbody>
<tr>
<td>CboxQC</td>
<td>CarboQC ME with Option O₂</td>
</tr>
</tbody>
</table>

**System module**

integrated in PBA Generation M measuring systems

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**The inventor of accurate CO₂ measurement**

Anton Paar is the inventor of the Multiple Volume Expansion method, which is the most accurate way of selectively measuring dissolved CO₂ in beverages. This patented method provides the most reliable CO₂ results and avoids the shortcomings of other conventional methods of CO₂ measurement. Maximum precision is ensured with the MVE method.

Measuring dissolved oxygen using a new optical O₂ sensor via luminescence quenching creates a new technological dimension of measurement.

**World leader in analytical measuring instruments**

Besides years of experience in the field of dissolved CO₂ and O₂ determination, Anton Paar is also the leader in density and concentration measurement, providing complete beverage analysis systems for the laboratory and production process.

**Close to you**

With a global network of subsidiaries and sales partners, Anton Paar is always close to your site. Local Anton Paar specialists are on call to give quick and competent after-sales support, regular maintenance and service.
At-line Instruments from the Measurement Experts

Direct at-line measurements - whether from process lines, tanks, kegs or casks - provide the assurance that your production process is under control and allow you to verify the CO₂ and O₂ results measured by process equipment.

**Fully protected for harsh environments**

Anton Paar’s at-line series of instruments are built to operate for years under rough conditions. The robust and leakproof housings keep humidity out of the electronics and stop any spills entering the instrument.

**Quick to finish: saves you time and money**

By measuring CO₂ and O₂ in only 90 seconds, Anton Paar’s CboxQC At-line saves you valuable working time and therefore money.

**Portable measurement: 10 hours on the go**

CarboQC At-line and CboxQC At-line are portable and provide a battery life of up to ten hours. The battery is quickly recharged for continued operation. For the utmost flexibility, the instruments’ new design is small, compact and lightweight.

**Low-carbonated beverages? No problem!**

With a measuring range from 0 to 20 g/L, Anton Paar’s CO₂ meters not only measure highly carbonated beverages, but also samples with low CO₂ levels with outstanding accuracy.

**Continuous control of CO₂ and O₂? Data Logger!**

Using the CO₂ and O₂ Data Logger function you define the interval for continuous measurements from the line or tank. With a memory capacity of 500 measurement results, including timestamp and sample ID, Anton Paar’s at-line instruments are prepared for a long working day.
O₂ determination: simple, accurate and ready for measurement anywhere!

The highly accurate determination of dissolved oxygen is based on the optochemical sensor’s very fast response time and ideal temperature behavior. This leads to stable and precise results in less than 50 seconds. Durability and minimal maintenance are the prominent features that make the long-lasting optical sensor stand out.

Easy to use, easy to read

The color display makes sure you see your measuring results clearly, even in dark surroundings. Due to the intuitive user interface standard operations can be performed easily. The eight large keys enable operation of the instrument even when wearing protective gloves.

Get started fast with RFID

Equipped with an RFID interface option, the instruments enable you to quickly and conveniently change the method and sample ID automatically, by just reading an RFID tag. Whether using RFID or manual settings, the instruments ensure full traceability.

Teams up with process instrumentation

The at-line instruments are the ideal complement to Anton Paar’s process instrumentation, such as the Carbo 510 online CO₂ analyzer and Cobrix 5 inline beverage analysis system for °Brix, Diet and CO₂ monitoring.
Using Anton Paar’s laboratory solutions for dissolved gas measurement allows you to perform reliable QC on finished packages and run measurements for product development with the highest accuracy.

**High accuracy, more benefit**

The patented CO₂ measuring method is not influenced by other dissolved gases such as oxygen and nitrogen, is rapid, and needs only minimum sample volume. Together with a new reliable optochemical oxygen sensor the results achieve the highest level of repeatability:

- CO₂ repeatability s.d.: up to 0.005 vol.
- O₂ repeatability s.d.: ±2 ppb

**Low sample amount? No problem!**

The very low sample volume of around 100 mL provides reliable CO₂ and O₂ results, even out of very small packages.

**PFD filling device - the perfect complement**

Using Anton Paar’s CO₂ and O₂ instruments in combination with a piercing and filling device means easy handling. Just press ‘Start’ and the sample is transferred to the measuring chamber without any loss of CO₂ and O₂. Reliable results can therefore be guaranteed.

**TPO quick check? For sure!**

Quality control of the Total Package Oxygen is in great demand. By measuring dissolved oxygen the TPO value can be calculated via Anton Paar’s free software AP-SoftPrint or by connecting to a DMA Generation M system.
Fast and wireless

For fast and simple documentation, Anton Paar’s dissolved gas meters print your measuring results or stored data on the optional Bluetooth printer.

Easy checks – reliable results

Anton Paar’s CO$_2$ and O$_2$ meters are supplied factory-adjusted and can be used right from the start. The periodical recommended system check implemented in the instruments’ quick access area guides you through the CO$_2$, O$_2$ and tightness check carried out with deionized water and nitrogen.

Correct filling for correct results

Correct results strongly depend on the right filling under pressure: the new series’ integrated FillingCheck™ feature automatically detects filling errors.

Talks the same language

The user interface is clearly arranged and you intuitively find your way through the menu. Preprogrammed methods and measuring units, automatic service reminders and numerous wizard features help you in your everyday work.

Works through power outages

Voltage fluctuations or power outages are no threat for the new series of instruments. They automatically switch to battery-operated mode for up to 10 hours. You can continue your measurements as planned without losing any data, time or money.

Modular options for the future

With the stand-alone instruments you have the option to connect an Anton Paar DMA Generation M density meter in the future and therefore build your own measuring system for complete beverage analysis such as PBA-B, PBA-S/SI and PBA-SD.
Which beverage parameters do you need to determine? Combine a CarboQC ME module with a wide range of Anton Paar instruments to get the beverage analysis you need in one measuring cycle, with minimum sample preparation required. This teamwork brings quick and efficient results and saves space in the lab.

**Accuracy that speaks for itself**

The CarboQC ME provides fast and accurate information on the selective amount of CO₂ dissolved in a beverage sample using Anton Paar’s patented Multiple Volume Expansion method.

**O₂ measurement completes the team**

Option O₂ with CarboQC ME allows the simultaneous determination of the dissolved O₂ and dissolved CO₂ contents in beverages within one measuring cycle. The Option O₂ is the perfect complement for Anton Paar’s beverage analysis systems such as PBA-S/SI/SD and PBA-B Generation M.

**A strong partner**

Parameters such as density are influenced by dissolved CO₂. Knowledge of the true CO₂ content can be used to fully compensate the influence. This means that the density of a carbonated beverage can be fully CO₂-corrected. No more degassing required!

**Stability for years**

As the measuring module is permanently connected to the density meter and does not have to be disconnected or moved, it has a high level of system stability. This gives you reliable results over a long working life.

**Fit for the future**

Combining a CarboQC ME module with a DMA Generation M density meter and PFD is a secure investment which allows you to add further modules in the future. Whether you require an Alcolyzer, the Option O₂, automatic sample changer or other modules at a later date, Anton Paar’s modular concept allows you to create a measuring system to exactly suit your requirements.

<table>
<thead>
<tr>
<th>Standard configuration</th>
<th>PBA-B</th>
<th>PBA-S</th>
<th>PBA-SI</th>
<th>PBA-SD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Master instrument</strong></td>
<td>DMA M</td>
<td>DMA M</td>
<td>SDA M/P</td>
<td>DMA M/SDA M/P</td>
</tr>
<tr>
<td>CarboQC ME</td>
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<tr>
<td>Alcolyzer Beer ME</td>
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<tr>
<td>DietQC™ ME</td>
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<tr>
<td>PFD</td>
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</tr>
<tr>
<td><strong>Options</strong></td>
<td></td>
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</tr>
<tr>
<td>pH ME</td>
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<tr>
<td>Option O₂</td>
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<td></td>
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<tr>
<td><strong>Options for the corresponding system</strong></td>
<td></td>
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<tr>
<td>Color Option for Alcolyzer Beer ME</td>
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<tr>
<td>HazeQC ME</td>
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<tr>
<td>Xsample 510 instead of PFD</td>
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</tbody>
</table>
All results at a glance

The combined system provides the utmost convenience: The CO₂ and O₂ values are automatically transferred to the master instrument. Measured data are displayed on the DMA M density meter screen along with all other measured parameters. Just press a button to print these results as one report.
The Multiple Volume Expansion (MVE) method was invented and patented by Anton Paar (AT 409673, GB 237 3584, US 6,874,351). It determines the true dissolved CO₂ content in beverages.

**How does it work?**

The short answer is: MVE is a selective method. By expanding the measuring chamber twice, only the CO₂ content is determined and the effect of other gases - such as nitrogen and oxygen - is eliminated. In more detail the method works as follows:

1. The measuring chamber is completely filled with sample and sealed.
2. The volume of the measuring chamber is expanded. Equilibrium is generated and pressure and temperature are measured.
3. The measuring chamber volume is further expanded, equilibrium is generated and pressure and temperature are measured again.
4. The two pressures and temperatures are used for CO₂ determination and dissolved air compensation.

**Why does it work?**

The patented Multiple Volume Expansion method makes use of the fact that the solubility of air in beverages is much lower than that of CO₂. Due to the difference in solubility, when expanding the volume of the measuring chamber, the partial pressure of air decreases much more than that of CO₂. The difference between the equilibrium pressure and temperature results measured at the first and second volume expansions of the measuring chamber is used to determine the amount of dissolved air and mathematically calculate and compensate for this amount. The result is the true CO₂ concentration in the beverage.
Why do CO₂ results differ depending on the measuring method used?
The answer lies in the way the measurement is influenced by the following factors:

- **External environmental influences**
  - Altitude & weather

- **Method-dependent influences**
  - Snifting
  - Compensation tables
  - Incomplete equilibration

- **Sample-dependent influences**
  - Dissolved air in the sample
  - Package size

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**Altitude & weather**
Environmental factors affect CO₂ measuring instruments. Anton Paar’s CO₂ meters have an integrated absolute pressure sensor for accurate correction.

**Snifting**
Snifting is generally performed with traditional pressure/temperature (p/T) methods for compensating dissolved air when measuring CO₂ in bottles or cans. Snifting means briefly opening and closing the package in order to release the overpressure in the headspace to the ambient pressure. During snifting, some carbon dioxide is also lost from the beverage which leads to falsified results. To eliminate the influence of snifting, Anton Paar’s CO₂ meters use the Multiple Volume Expansion method, which delivers CO₂ results which are not affected by the air or nitrogen content.

**Compensation tables**
Tables are used to compensate the effects of snifting. However, as snifting is affected by many external factors, it is impossible to know whether the tables are compensating too much, not enough or correctly for the snifting effects.

**Incomplete equilibration**
Incomplete equilibration causes the CO₂ measurement to deliver results which are different than the actual CO₂ content.

**Dissolved air in the sample**
Traditional pressure/temperature (p/T) methods do not differentiate between the partial pressure of air and the partial pressure of CO₂ measured in the beverage. Pressure measurement is assumed to be a one-to-one measure of carbon dioxide alone, which is incorrect. This effect is also seen when using instruments which apply single expansion of the measuring chamber.

**Package size**
Traditional p/T methods determine the CO₂ content indirectly by measuring temperature and pressure right out of the gas phase in the headspace. Depending on the type of package, the headspace sizes vary, which affects the amount of CO₂ measured. Anton Paar’s CO₂ meters directly determine the CO₂ content out of the liquid phase.
The continuous monitoring of the oxygen content with an instrument that remains unaffected by other dissolved gases is indispensable for beverage analysis. Anton Paar presents a new dimension of measuring dissolved oxygen in beverages.

**How does it work?**
Anton Paar’s oxygen meter uses an optochemical sensor for fast and highly accurate determination of dissolved oxygen. The principle of measurement is based on the effect of dynamic luminescence quenching by molecular oxygen. The new way of measurement in this sensor allows measuring while liquids are flowing through the cell. It is not a stationary measurement.

**What makes Anton Paar’s measurement of oxygen unique?**
The pressure-resistant, high-resolution optical oxygen sensor correctly measures all kinds of beverages. The fast response time and ideal temperature behavior of the sensor allow excellent measurement stability within a few seconds, even when measuring cold samples.

This means the measuring principle guarantees results based on the repeatability of ± 2ppb and reproducibility of ± 4ppb as well as multiple measurements even out of small sample packages. The sensor has a long working life and requires minimal maintenance.

The sensor characteristic shows a response time of less than 20 seconds when changing from water to beer at 4 °C to 7 °C.
Automatic Filling of up to 18 Samples

Filling CarboQC and CboxQC in the laboratory

PFD Piercing and Filling Device
Fill samples reliably and safely directly out of PET bottles, glass bottles or cans into the measuring chamber using the PFD. No sample preparation, such as degassing or filtering, is needed. PFD pierces the bottle closure or the base of the can and transfers sample from the package using a compressed gas. No dissolved CO₂ or O₂ is lost.

- gas spring for safety shield ensures operator safety
- easy cleaning due to removable safety shield
- stability guaranteed by clever design and high-quality materials

SFD Sparkling Wine Filling Device
For transferring wine and sparkling wine samples, the SFD filling device is available. SFD pierces the cork of the wine bottle and inserts a sample tube. The sample is transferred under pressure without loss of CO₂. The SFD Filling Device can be used with both plastic and traditional corks.

- full operator protection
- for all sizes, from small bottles to magnum bottles
- sample transfer directly from the bottle

Filling CarboQC ME and CarboQC ME + Option O₂ in a modular system

To fill a modular system including a CarboQC ME (e.g. Anton Paar’s PBA systems), you can connect a PFD or SFD for single samples or use an Xsample 510 package sampler.

Xsample 510 Package Sampler
The Xsample 510 fills samples from up to 18 different types of bottles or cans fully automatically and cleans the measuring cells between measurements.

- high sample throughput – optional bar code reader
- fully automatic filling and cleaning
- easy handling - high safety standard - robust design
## Specifications

<table>
<thead>
<tr>
<th>CarboQC At-lineCO2 At-line</th>
<th>CboxQC™ At-line</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Measuring range</strong></td>
<td></td>
</tr>
<tr>
<td>CO₂</td>
<td>0 g/L to 12 g/L (0 vol. to 6 vol.) at 30 °C (86 °F)</td>
</tr>
<tr>
<td>O₂</td>
<td>--</td>
</tr>
<tr>
<td><strong>Temperature</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Pressure</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Repeatability s.d.</strong></td>
<td></td>
</tr>
<tr>
<td>CO₂</td>
<td>--</td>
</tr>
<tr>
<td>O₂</td>
<td>--</td>
</tr>
<tr>
<td><strong>Pressure</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Resolution</strong></td>
<td></td>
</tr>
<tr>
<td>CO₂</td>
<td>--</td>
</tr>
<tr>
<td>O₂</td>
<td>--</td>
</tr>
<tr>
<td><strong>Temperature</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Sample volume</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Measuring time per sample</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Power supply</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Rechargeable battery type</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Maximum at-line operation</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Interfaces</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Data memory</strong></td>
<td></td>
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<tr>
<td><strong>Options</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Available accessories</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Protection class</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Dimensions (L x W x H)</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Weight</strong></td>
<td></td>
</tr>
</tbody>
</table>

¹ Valid for measuring range < 200 ppb
² Valid for measuring range < 1000 ppb
³ Valid for measuring range < 1000 to 2000 ppb
⁴ Valid for measuring range < 2000 to 4000 ppb

### Sample filling

<table>
<thead>
<tr>
<th>PFD piercing and filling device</th>
<th>SFD piercing and filling device for sparkling wine and wine bottles</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Filling mode</strong></td>
<td>Pressurized filling from closed packages</td>
</tr>
<tr>
<td><strong>Compressed gas supply</strong></td>
<td>6 ± 0.5 bar (87 ± 7 psi) relative</td>
</tr>
<tr>
<td></td>
<td>Glass bottles: 1 L</td>
</tr>
<tr>
<td></td>
<td>Cans: 0.5 L</td>
</tr>
<tr>
<td></td>
<td>PET bottles: 3 L</td>
</tr>
<tr>
<td><strong>Package types and maximum allowed volume of packages to be measured</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Maximum height with piercing head in highest position</strong></td>
<td>1020 mm (40.2 in)</td>
</tr>
<tr>
<td><strong>Ambient temperature for operation</strong></td>
<td>0 °C to +40 °C (+32 °F to +104 °F)</td>
</tr>
<tr>
<td><strong>Dimensions (L x W x H)</strong></td>
<td>190 mm x 270 mm x 670 mm (7.5 in x 10.6 in x 26.4 in)</td>
</tr>
<tr>
<td><strong>Weight</strong></td>
<td>10.1 kg (22.3 lbs)</td>
</tr>
<tr>
<td><strong>Power supply</strong></td>
<td>--</td>
</tr>
<tr>
<td><strong>Interaces</strong></td>
<td>--</td>
</tr>
</tbody>
</table>

⁵ Depending on the diameter of the package
### Laboratory

<table>
<thead>
<tr>
<th>CarboQC</th>
<th>CboxQC™</th>
<th>CarboQC ME</th>
<th>CarboQC ME + Option O2</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 g/L to 12 g/L (0 vol. to 6 vol.) at 30 °C (86 °F)</td>
<td>0 g/L to 12 g/L (0 vol. to 6 vol.)</td>
<td>0 g/L to 20 g/L (0 vol. to 10 vol.)</td>
<td>0 g/L to 20 g/L (0 vol. to 10 vol.) &lt; 15 °C (59 °F)</td>
</tr>
</tbody>
</table>

- 0 ppm to 4 ppm
- 0 ppm to 10 ppm

-3 °C to 30 °C (27 °F to 86 °F), acc. ± 0.2 °C

<table>
<thead>
<tr>
<th>Temperature: °C, °F, K</th>
<th>CO₂: g/L, vol., kg/m³</th>
<th>CO₂: g/L, vol., kg/m³</th>
</tr>
</thead>
<tbody>
<tr>
<td>O₂: mg/L, ppm, ppb, % sat., µg/L</td>
<td>Temperature: °C, °F, K</td>
<td>O₂: mg/L, ppm, ppb, % sat., µg/L</td>
</tr>
<tr>
<td>Ar/N₂ Index: ppm, mg/L</td>
<td>Package pressure: bar, psi, mbar, kPa</td>
<td>Ar/N₂ Index: ppm, mg/L</td>
</tr>
<tr>
<td>Package pressure: bar, psi, mbar, kPa</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- 0.01 g/L (0.005 vol.)
- 0.05 g/L (0.025 vol.)
- 0.1 g/L (0.005 vol.)
- 2 bar, psi, mbar, kPa

- 0.1 ppm to 4 ppm
- ± 2 ppb
- ± 4 ppb
- ± 20 ppb

- ± 2 ppb
- ± 10 ppb
- ± 20 ppb

- ± 4 ppb, ± 10 ppb, ± 20 ppb

- less than 20 seconds at 25 °C, from air to nitrogen

### System

<table>
<thead>
<tr>
<th>100 mL</th>
<th>100 mL</th>
<th>approx. 150 mL</th>
<th>min. 150 mL (when filling similar samples)</th>
</tr>
</thead>
<tbody>
<tr>
<td>55 seconds</td>
<td>90 seconds</td>
<td>approx. 90 seconds</td>
<td>approx. 2 minutes</td>
</tr>
</tbody>
</table>

### Xsample 510

- Automatic package sampler
- 100 measured results
- 258 mm x 201 mm x 170 mm (10.2 in x 7.9 in x 6.7 in)
- 250 kg (551 lbs)
- AC 100-240 V, 50/60 Hz
- 1 x USB for PC, 1 x RS-232 for printer/AP-SoftPrint/DMA Generation M
- 1 x CANopen in, 1 x CANopen out
- 2 x CAN

### Additional Information

- Glass bottles: 0.33 L, 0.5 L
- Cans: 0.25 L, 0.33 L, 0.5 L
- PET bottles: 0.5 L, 1 L, 1.5 L, 2 L, 3 L
- 0 °C to +35 °C (+32 °F to +95 °F)
- 900 mm x 750 mm x 1200 mm (35.4 in x 29.5 in x 47.2 in)
- 75 kg (165.3 lbs)
- AC 100-240 V, 50/60 Hz
- 258 mm x 201 mm x 170 mm (10.2 in x 7.9 in x 6.7 in)
- 250 kg (551 lbs)
- AC 100-240 V, 50/60 Hz
- 1 x RS-232, 1 x S-BUS, 1 x CANopen in, 1 x CANopen out
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Instruments for:
Density and concentration measurement
Pneumetry
Viscometry
Sample preparation
Microwave synthesis
Colloid science
X-ray structure analysis
Refractometry
Polarimetry
Petroleum testing
High-precision temperature measurement

Specifications subject to change without notice.