Rethinking Gas Analytics
Gas Applications for GPro 500 Analyzers

METTLER TOLEDO
Gas Applications eBooklet

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Catalyst Protection

The GPro 500 TDL analyzers are designed for ease of installation and low maintenance operation in a wide variety of process applications in the refining, petrochemical, and associated process industries. With a range of innovative process interface adaptations, they provide a truly flexible and cost-effective measurement solution.

This Applications eBooklet is intended as a convenient reference to a selection of the most common GPro 500 applications. The versatility of the analyzers means they are suited to an extensive assortment of processes, so what is presented here is not an exhaustive list. As new applications are realized, these will be added to the eBooklet.

Each page provides a brief overview of the application, a process diagram highlighting the installation location, and the rationale behind the measurement. Additional information, including typical gas stream parameters and tips on probe selection will assist in achieving the most suitable configuration to meet measurement requirements.

Find out more
www.mt.com/TDL
Direct Chlorination and Oxy-Chlorination

Process Control

Purpose
EDC (1,2-ethylene dichloride), alternatively known as 1,2-dichloro-ethane, is an important intermediate chemical in the manufacture of vinyl chloride monomer (VCM). There are two important oxygen measurement locations in a typical EDC plant. These are the direct chlorination and the oxy-chlorination process paths. An accurate, reliable and fast responding measurement is required in each case.

Direct chlorination
- Measurement in the feed pipe to ensure that impurities in the chlorine do not contain too elevated levels of O₂ (small amounts of oxygen inhibit secondary formation of undesired by-products).

Oxy-chlorination
- For preventing the O₂ concentration rising above the Limiting Oxygen Concentration (LOC). The goal is to improve product yield within safety limits (If the LOC is reached, purge gas is introduced to reduce O₂ levels).

Description
- Primary path is the direct chlorination (highly exothermic).
- The produced EDC is fed to the cracking unit, producing 50% EDC, 50% VCM (95% pure) and HCl by-product.
- After cracking, the VCM distillation separates the VCM from the unreacted EDC, going to recycle unit for further use.
- The HCl as a by-product is fully re-used for oxy-chlorination (exothermic) with oxygen as the feedstock.
- Complete conversion of input chlorine is reached when both reactions are in balance.

Process benefits of GPro 500
- A paramagnetic system is not fast enough; but more importantly, the gas is extremely corrosive and just a small droplet in the sample is fatal to an extractive system.
- The GPro 500’s probe design allow installation in the process itself, even closer to the process than other competing TDLs and without a slip stream installation.

Tips and hints
Typical nitrogen flow rate for process windows purging is 1 to 10 l/min.

Product recommendation
GPro 500 O₂; 290, 390, or 590 mm probe.

Click here for more information
**VCM Waste Gas Recovery**

**Safety Monitoring**

**Purpose**
To measure with high accuracy and reliability the O₂ concentration in the waste gas before the incinerator. A short response time is the most crucial feature required to rapidly detect if a critical O₂ concentration has been reached.

**Typical thresholds**
- 12 vol-% open N₂ bypass, 6 vol-% shutoff.

If an increased O₂ level is detected, the waste gas is re-directed through a bypass and mixed with N₂. When the O₂ concentration is low enough the gas is sent back to the incinerator.

**Description**
- Large volumes of waste gases containing VCM, O₂, and other components are generated during VCM production at different sections of the plant.
- For environmental reasons the gases must be further treated and recycled as much as possible.

**Waste gas incineration**
- O₂ is an important reactant in the production of VCM. O₂, when present in a certain concentration, creates an explosion risk. It is therefore crucial to monitor the O₂ concentration in the waste gas continuously before the incinerator.
- High O₂-containing waste gas must run through a bypass for inerting before incineration.

**Process benefits of GPro 500**
- Because of the harsh condition of the gas (highly corrosive) an extractive type analyzer is not suitable for this application.
- The response time is crucial: the faster the system can detect an increase in the O₂ concentration, the lower the safety margin that is required (high throughput).
- Large amounts of N₂ can be saved since less waste gas runs through the bypass for inerting.
- N₂ purge gas cools the waste gas stream, so a fast control loop helps to save energy.

**Process conditions**

| **Available insertion length** | > 1 m |
| **Temperature** | 0…30 °C |
| **Pressure** | 1 – 5 bar(a) |
| **Measurement range** | 0 – 21 vol.% |
| **Dust load** | Very low |
| **Required response time** | < 2 s |

**Tips and hints**
The smallest pipe diameter where the GPro 500 can be installed is DN100 (4").

**Product recommendation**
GPro 500 O₂: 290, 390, or 590 mm probe.

[Click here for more information]
**FCC Units**

**Combustion Optimization**

**Purpose**
To provide a fast, reliable O₂ reading that can be used to optimize combustion control. Measurement system must provide high availability despite the harsh conditions at the measurement location. Due to the high dust load in the CO boiler, O₂ measurement takes place after the ESD filter.

**CO combustion needs to be optimized for**
- maximum heat
- minimal emissions

To control the oxygen level, air is added.

**Description**
- Fluidized-bed catalytic cracking (FCC) is the most important and widely used refinery process for converting low value heavy oils into more valuable gasoline and lighter products.
- FCC yield is key to a refinery’s profitability.
- The catalyst is covered with coke from the cracking reaction which lowers its activity. Therefore, the catalyst is fed to the regenerator to recover its activity by burning off the coke with air.
- The flue gas leaving the regenerator contains a large quantity of CO. This is burnt to CO₂ in a furnace referred to as the “CO boiler” to reduce CO to acceptable levels and recover the available energy.

**Process benefits of GPro 500**

**Against extractive systems**
- Fast response times make the combustion control process more efficient, leading to higher energy output.
- High dust loads in the CO boiler make it difficult for extractive systems to perform reliably here.

**Against zirconia oxide probes**
- Longer lifetimes, less maintenance.

**Tips and hints**
Install the GPro 500 after the ESP filter for low dust conditions. Response time will be only slightly affected.

**Process conditions**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Available insertion length</td>
<td>2 – 4 m</td>
</tr>
<tr>
<td>Temperature</td>
<td>230 – 350°C</td>
</tr>
<tr>
<td>Pressure</td>
<td>Atmospheric</td>
</tr>
<tr>
<td>Measurement range</td>
<td>0 – 10 vol.%</td>
</tr>
<tr>
<td>Dust load</td>
<td>Low after filter</td>
</tr>
<tr>
<td>Required response time</td>
<td>&lt; 10 s</td>
</tr>
</tbody>
</table>

**Product recommendation**
GPro 500 O₂; 290, 390, or 590 mm probe, depending on process pipe diameter.
Thermal Oxidizer
Combustion Efficiency

Purpose
A thermal oxidizer should eliminate with maximum efficiency the Volatile Organic Compounds (VOCs) content of the incoming gas stream by burning the VOCs in a high oxygen content environment. It is important to control the combustion within the correct oxygen range using air. The measurement system must determine the O₂ concentration quickly and reliably on the output of the thermal oxidizer, despite the harsh conditions.

Description
• Thermal oxidation is often used to control emissions of VOCs from process industries.
• Oxidation breaks the molecular bonds of any HC to ultimately convert them to CO₂ and H₂O when the correct conditions are present.
• Thermal oxidation is capable of very high VOC destruction efficiency, but the fuel consumption and cost to heat the VOC-laden process can be severe.

• To ensure sufficient thermal oxidation with the lowest possible fuel consumption, it is crucial to measure the O₂ concentration accurately.

Process benefits of GPro 500
• Paramagnetic O₂ analyzer technology is considered much too slow. Also, the potential presence of various HCs can cause interference which is difficult if not impossible to compensate for.

Process conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Available insertion length</td>
<td>0.2 – 1 m</td>
</tr>
<tr>
<td>Temperature</td>
<td>350°C</td>
</tr>
<tr>
<td>Pressure</td>
<td>Balanced draft</td>
</tr>
<tr>
<td>Measurement range</td>
<td>12 – 12 vol.%</td>
</tr>
<tr>
<td>Dust load</td>
<td>1 – 20 mg/m³</td>
</tr>
<tr>
<td>Required response time</td>
<td>&lt; 2 s</td>
</tr>
</tbody>
</table>

Tips and hints
For higher accuracy (up to fourfold), user longer probes to increase optical path length.

Product recommendation
GPro 500 O₂; 290, 390, or 590 mm probe, depending on process pipe diameter.
Package Boilers
Combustion Efficiency

Purpose
Package boilers are “off the shelf” complete boiler systems usually of small to medium scale, used to generate steam for downstream plant use. Combustion measurement is normally used for monitoring only on these boilers.

Description
- The typical package boiler is a water tube boiler or flue and smoke tube boiler with a capacity of 5 to 20 t/h (average steam generation capacity). The most widely used fuels are heavy oil, light oil, and gas. They are used to generate steam for downstream utilization.
- Typical flue gas conditions encountered in the average package boiler are not extreme, with flue temperatures circa <300 °C.
- The typical installation point will be at the boiler or economiser outlet.

Process benefits of GPro 500
- The GPro 500’s NP filter probe design allow installation in the process itself, without the need for process side purge as is common with competing TDL analyzers.
- This is an ideal application for an in situ probe type TDL measurement, where the compact size, single flange entry and probe configuration allows direct installation in place of traditional ZrO2 or non-CO specific combustibles analyzers.

Process conditions
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>150 – 300 °C</td>
</tr>
<tr>
<td>Pressure</td>
<td>± 0.5 KPa</td>
</tr>
<tr>
<td>Measurement range</td>
<td>0 – 21 % O2</td>
</tr>
<tr>
<td></td>
<td>0 – 1 % CO</td>
</tr>
<tr>
<td>Dust load</td>
<td>&lt; 1 g/Nm³</td>
</tr>
<tr>
<td>Required response</td>
<td>&lt; 2 s</td>
</tr>
</tbody>
</table>

Tips and hints
Confirm potential dust loading so that the filter probe pore size can be better determined.
Confirm that the filter probe will not be exposed to condensation. The NP filter probe is designed for high, dry process conditions.

Product recommendation
GPro 500 CO, O2, 290, 390, or 590 mm NP filter probe.
**Power Generation**

**Combustion Control**

**Purpose**

O₂ and CO concentrations are measured to:

- minimize excess air
- maximize efficiency
- reduce emissions

**Conditions to be avoided**

- Fuel-rich burner conditions: CO levels increase as a precursor to hydrocarbon breakthrough.
- Burner flame-out: temperature and moisture drop, oxygen increases rapidly.
- Process tube leaks: moisture increases rapidly.

**Description**

Combustion control is a generic process to be found in many segments and applications:

**Power generation**

- Fossil fuel-fired power plants
- Gas turbines
- Co-generation plants

**Chemical and petrochemical**

- Waste incinerators
- Steam boilers
- DeNOₓ

**Oil and gas, refining**

- Waste incinerators
- Process heaters

**Process benefits of GPro 500**

- In situ measurement enables faster measurement compared to extractive paramagnetic O₂ technology and longer lifetime and reliability over zirconium oxide analyzers, providing lower maintenance, enhanced process control and higher efficiency.
- Ability to measure closer to the burner(s) zone (firebox) allows the identification of single faulty burners.

- Additional measurements available: temperature, moisture content (for wet/dry calculations).

**Tips and hints**

Use both CO and O₂ TDLs at the same location in order to allow in-sync measurements for trim control.

**Process conditions**

<table>
<thead>
<tr>
<th>Available insertion length</th>
<th>Wide ducts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>&gt; 350°C</td>
</tr>
<tr>
<td>Pressure</td>
<td>Balanced draft</td>
</tr>
<tr>
<td>Measurement range</td>
<td>0–10 vol O₂ %</td>
</tr>
<tr>
<td></td>
<td>0–20 vol ppm %</td>
</tr>
<tr>
<td>Dust load</td>
<td>Very high</td>
</tr>
</tbody>
</table>

**Product recommendation**

- GPro 500 O₂: 290, 390, or 590 mm probe, depending on process pipe diameter.
- GPro 500 CO: standard or filter probe.

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**Click here for more information**
**Process Heaters**

**Combustion Control**

**Purpose**
Process heaters are numerous in the refinery, petrochemical and chemical industries. They are extremely large consumers of fuel and therefore a primary target for combustion efficiency monitoring and control, where large fuel savings can be quickly realized.

**Description**
- A process direct-fired heat exchanger used to raise the temperature of a feed flowing through coils of tubes aligned throughout the heater in the convection and radiant section. Typical temperatures are 400 °C – 550 °C (800 – 1000 °F).
- CO is typically measured in the convection zone and used as a control signal to monitor for combustible gases breakthrough which occurs if the process heater has insufficient excess air.

**Process benefits of GPro 500**
- The GPro 500’s NP filter probe design allows installation in the process itself, without the need for process side purge as is common with competing TDL analyzers.
- This is an ideal application for an in situ probe type TDL measurement, where the compact size, single flange entry and probe configuration allows direct installation in place of traditional ZrO2 or non-CO specific combustibles analyzers.

**Process conditions**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>350 – 600 °C</td>
</tr>
<tr>
<td>Pressure</td>
<td>0.1 – 0.8 kPa</td>
</tr>
</tbody>
</table>
| Measurement range | 0 – 21 % O2  
|                 | 0 – 1 % CO   |
| Dust load       | < 1 g/Nm³   |
| Required response time | < 2 s      |

**Tips and hints**
Confirm potential dust loading so that the filter probe pore size can be better determined.
Confirm that the filter probe will not be exposed to condensation. The NP filter probe is designed for high, dry process conditions.

Look for potential opportunities for ESP filter protection downstream.

**Product recommendation**
GPro 500 CO; 290, 390, or 590 mm NP filter probe.
Heavy Oil or Gas-fired Power Generation
Combustion Control

Purpose
Power generation boilers are usually large scale installations which consume large quantities of fuel and as such often deploy combustion control rather than simple combustion monitoring to provide maximum combustion efficiency.

Description
• Heavy oil or gas is the usual fuel used and is used to generate stream in a continuous closed loop.
• This steam is in turned utilized to drive a steam turbine and generator set.
• O₂ and CO are typically measured after the economizer.
• Smaller cogeneration plants may use one measurement point, but larger electric power facilities will typically use multiple sample points.

Process benefits of GPro 500
• The GPro 500’s NP filter probe design allows installation in the process itself, without the need for process side purge as is common with competing TDL analyzers.
• This is an ideal application for an in situ probe type TDL measurement, where the compact size, single flange entry and probe configuration allows direct installation in place of traditional ZrO₂ or non-CO specific combustibles analyzers.

Process conditions
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>250 – 350 °C</td>
</tr>
<tr>
<td>Pressure</td>
<td>0.1 – 0.8 kPa</td>
</tr>
<tr>
<td>Measurement range</td>
<td>0 – 21 % O₂</td>
</tr>
<tr>
<td></td>
<td>0 – 1 % CO</td>
</tr>
<tr>
<td>Dust load</td>
<td>&lt; 1 g/Nm³</td>
</tr>
<tr>
<td>Required response time</td>
<td>&lt; 2 s</td>
</tr>
</tbody>
</table>

Tips and hints
Confirm potential dust loading so that the filter probe pore size can be better determined. Confirm that the filter probe will not be exposed to condensation. The NP filter probe is designed for high, dry process conditions.

Product recommendation
GPro 500 CO, O₂; 290, 390, or 590 mm NP filter probe.

Look for potential opportunities for ESP filter protection downstream.

Click here for more information
Fired Heaters
Combustion Control

Purpose
Fired heaters are used extensively through the refinery and chemical industries and are large consumers of fuel. Combustion efficiency is crucial to minimize fuel use, maximize production and maintain emissions below statutory targets.

Description
• A fired heater is a heat exchanger used to raise the temperature of a feed flowing through coils of tubes aligned throughout the heater in the convection and radiant section. Typical temperatures are 400 °C – 550 °C (800 – 1000 °F).
• CO is typically measured in the convection zone and used as a control signal to monitor for combustible gases breakthrough which occurs if the process heater has insufficient excess air.

Process benefits of GPro 500
• The GPro 500’s NP filter probe design allows installation in the process itself, without the need for process side purge as is common with competing TDL analyzers.
• This is an ideal application for an in situ probe type TDL measurement, where the compact size, single flange entry and probe configuration allows direct installation in place of traditional ZrO₂ or non-CO specific combustibles analyzers.

Process conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>350 – 600°C</td>
</tr>
<tr>
<td>Pressure</td>
<td>0.1 – 0.8 KPa</td>
</tr>
<tr>
<td>Measurement range</td>
<td>0 – 21 % O₂</td>
</tr>
<tr>
<td>Dust load</td>
<td>&lt; 1 g/Nm³</td>
</tr>
<tr>
<td>Required response time</td>
<td>&lt; 2 s</td>
</tr>
</tbody>
</table>

Tips and hints
Confirm potential dust loading so that the probe filter pore size can be better determined.
Confirm that the filter probe will not be exposed to condensation. The NP filter probe is designed for high, dry process conditions.

Product recommendation
GPro 500 CO, O₂; 290, 390, or 590 mm NP filter probe.

Look for potential opportunities for ESP filter protection downstream.

Click here for more information
Electrostatic Precipitators

Safety Monitoring

Purpose
To provide a very fast in-line measurement of CO to ensure explosive levels of combustible gas do not reach the electrically charged plates of the electrostatic precipitator (ESP), thus preventing the likelihood of an explosion within the ESP. Fast speed of response is required to ensure the ESP is shut down as soon as the CO level reaches 3%, typically.

Description
Electrostatic precipitators operate by generating a high voltage static electric field between a series of metal pipes and plates. The entrained particles are first passed between negatively charged plates causing the particles to become negatively charged. They then pass through positive or grounded plates and are deposited onto the plates’ surfaces. The plates are periodically vibrated by electrical or pneumatic rappers to remove the particles, which are collected and safely disposed of.

A well-managed ESP can remove up to 99.9% of particulate material. Therefore, ESPs offer an efficient, high performance and low maintenance filtration system without the need to maintain or replace filtration media. This results in greater process reliability and reduced operating costs.

Process benefits of GPro 500
- Fast response time (<2 sec).
- Elimination of risk of explosion in the ESP.
- Reduced incidence of unnecessary ESP shutdowns.
- ESP can operate safely for longer periods at higher CO levels.

Process conditions
- Available insertion length: 0.1 – 1 m
- Temperature: 40 – 200°C
- Pressure: 800 – 2000 mbar
- Measurement range: 0 – 3 vol.%
- Dust load: High > 500 mg/m²
- Required response time: < 2 s

Tips and hints
- Reduced unfiltered emissions and reduced environmental impact.
- Maintain statutory environmental compliance.

Product recommendation
GPro 500 CO; 290, 390, or 590 mm probe, depending on process pipe diameter.

Click here for more information
Flare Stacks

Header Inertization

Purpose
Flares are used to gather and eliminate waste gas which is otherwise not feasible to use or transport. They also act as a safety device to protect vessels or pipes from over-pressuring due to unplanned upsets. Flares must be continuously available, long-lasting, and able to perform in all emergency conditions.

Global Gas Flaring Reduction Initiative
• Gas flaring is generally considered as detrimental.
• Waste of resources (5% of natural gas output is flared).
• Contributes to greenhouse effect, acid rain, climate change.
• Negative visual impact.

Description
• For measuring the O₂ concentration in the gas stream going to the flare.
• Reliability is the most crucial feature required as the system must measure correctly despite a varying background of HCs.

• Air leakage into the system can cause an increase of the O₂ concentration and possibly lead to an explosion.
• The O₂ level is measured after the flare drum for safety.
• If O₂ value rises, the header is purged with nitrogen, CO₂, or even natural gas.

Process benefits of GPro 500
• In cases when no measurement is in place, O₂ measurement will improve flare safety.
• One problem with paramagnetic system is that the large amount of hydrocarbons interferes with the O₂. This interference is difficult if not impossible to compensate for due to the varying background of various hydrocarbons.

• The GPro 500 probe design allows for fast installation in DN100 pipes and short shutdown times in continuous flares.

Product recommendation
GPro 500 O₂; 290, 390, or 590 mm probe, depending on process pipe diameter.

Tips and hints
For spot checks without process interruptions, use the calibration tube for verification in less than 5 minutes.

Process conditions
- Available insertion length: > 1 m
- Temperature: 150°C
- Pressure: 1 – 5 bar(a)
- Measurement range: 0 – 10 vol.%
- Dust load: Very low
- Required response time: < 2 s

Mix with air for combustion here

Drum/knockout vessel

Flare

Liquid seal

O₂

Flare gas

Flare header

Click here for more information
Carbon Black Production

Fire Prevention

Purpose
If a fire begins inside the bag house, the CO levels will rise. To ensure such a dangerous fire is detected quickly, a fast response and reliable in-line detection of CO combustible gas at the bag house exit is required.

Description
Petroleum oil or coal oil is partially combusted in air in a pyrolysis reactor at high temperature (700 to 900°C). The reaction is stopped at a precisely controlled time, via water quenching, to obtain maximum yield. The hot off gas from the reactor, which contains some combustibles, is used first in the air preheater to heat the incoming air and then to heat the incoming feed stock to improve energy efficiency. The raw carbon black and effluent gas from the reactor pass to the main bag filter house where the carbon black is separated and collected, and the now cleaned combustible gas is used downstream.

Process benefits of GPro 500
• The GPro 500 analyzer ensures process safety due to its in situ installation, fast response, and dust tolerance, making it highly suited for this application.
• With the GPro 500 there is no need for alignment, purge gas demands are low, and maintenance is minimal.
• An extractive system is not suitable as the lag time between the tapping point and the analyzer can be several minutes, which is sufficient time for a fire to take hold.

Process conditions

<table>
<thead>
<tr>
<th>Available insertion length</th>
<th>0.1 – 1 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>100 – 200°C</td>
</tr>
<tr>
<td>Pressure</td>
<td>1000 – 1100 mbar</td>
</tr>
<tr>
<td>Measurement range</td>
<td>250 – 2000 ppm (v) CO</td>
</tr>
<tr>
<td>Dust load</td>
<td>up to 50 g/m²</td>
</tr>
<tr>
<td>Required response time</td>
<td>&lt; 2 s</td>
</tr>
</tbody>
</table>

Tips and hints
For particularly high dust loads, select a shorter probe in order to reduce transmission loss.

Product recommendation
GPro 500 CO; 290, 390, or 590 mm probe, depending on process pipe diameter.
Purpose
To provide a short response time so that if a critical O₂ level is reached, nitrogen is purged in order to avoid explosive conditions developing. The system must be able to measure O₂ concentration correctly, even with a large variation in the background gas composition (different types and concentrations of hydrocarbons). The analyzer must provide high availability despite the harsh conditions at the measurement location.

Description
• The gas produced in the Tanker Vapor Recycle plant contains combustible components and O₂ in varying concentrations.
• The combination of combustibles and O₂ are, under certain conditions, highly explosive. Therefore, the O₂ concentration must be monitored continuously.
• Air can be sucked in through leaks and increase the oxygen content above the LOC.

• The O₂ value is used to immediately start preventive measures (i.e. inerting with purge gas) if a critical level is reached.

Process benefits of GPro 500
• Paramagnetic O₂ analyzers have historically been used for this application.
• The problem with this technology is that the large amount of hydrocarbons interferes with the O₂ measurement and the presence of high water levels can severely damage the expensive paramagnetic cell.
• The hydrocarbon interference is difficult if not impossible to compensate for due to the varying background of various hydrocarbons.

Process conditions
<table>
<thead>
<tr>
<th>Available insertion length</th>
<th>approx. 1 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>&lt; 50 °C</td>
</tr>
<tr>
<td>Pressure</td>
<td>&lt; 2 bar(a)</td>
</tr>
<tr>
<td>Measurement range</td>
<td>0 – 10 vol.%</td>
</tr>
<tr>
<td>Dust load</td>
<td>&lt; 100 mg/m³</td>
</tr>
<tr>
<td>Required response time</td>
<td>&lt; 2 s</td>
</tr>
</tbody>
</table>

Tips and hints
Install the GPro 500 horizontally in the process pipe in order to avoid humidity build-up on process windows.

Product recommendation
GPro 500 O₂; 290, 390, or 590 mm probe, depending on process pipe diameter.
**Purpose**
The O₂ concentration at the inlet of the methanol vaporizer is a critical control parameter for yield optimization and process safety. Process optimization is achieved by operating at the highest O₂ level possible without exceeding the Lower Explosive Limit (LEL) of the gas stream. The O₂ monitoring system’s speed of response is a critical component for the ability to control the process.

**Description**
Based on the catalytic oxidation of methanol in the presence of excess air, the methanol-air mixture is kept below the lower explosion limit via dilution with a partial recycle of the nitrogen-rich exhaust gas. Methanol is pumped continuously from the storage tank and evaporated in a tubular heat exchanger, mixed with the oxidizing gas and preheated before being fed to the reactor. The reactor is filled with pellets of iron-molybdenum oxide catalyst. A highly efficient (> 92 %) exothermal oxidation reaction takes place. The formaldehyde-containing gas produced is cooled first in a steam kettle, and then in the tubular heat exchanger. The cooled gas is washed in a multistage absorption column with water (producing aqueous formaldehyde solution) or with urea solution (producing stabilized urea-formaldehyde solution).

**Process benefits of GPro 500**
- Compared to the traditional paramagnetic technology used for this application, the GPro 500 offers fast response, sample system free, direct in-process measurement.
- The fast speed of response and reliability of the measurement allows the process to run safely with higher levels of O₂, increasing product yield significantly. So benefits include: (1) increased product yield due to tighter O₂ process control, (2) fast O₂ measurement for safer plant operation, (3) extended catalyst life through running leaner O₂/methanol feedstock blend into the reactor.

**Tips and hints**
The unique SpectraID™ technology ensures better system reliability with line locking on three absorption lines.

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**Process conditions**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Available insertion length</td>
<td>0.1 – 1 m</td>
</tr>
<tr>
<td>Temperature</td>
<td>45 – 100 °C</td>
</tr>
<tr>
<td>Pressure</td>
<td>1 – 2.5 bar</td>
</tr>
<tr>
<td>Measurement range</td>
<td>5 – 10 Vol.%</td>
</tr>
<tr>
<td>Dust load</td>
<td>Low</td>
</tr>
<tr>
<td>Required response time</td>
<td>&lt; 2 s</td>
</tr>
</tbody>
</table>

**Product recommendation**
GPro 500 CO; 290, 390, or 590 mm probe, depending on process pipe diameter.

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**Click here for more information**
**Purpose**

Catalytic reforming is the process of converting low octane naphtha’s to higher octane compounds, collectively called "reformates". These high octane reformates are added to refined gasoline to increase its octane value.

The measurement and control of moisture in the hydrogen recycle gas is essential to ensure efficiency of the plant and protection of the expensive catalyst.

**Description**

- Typical levels of moisture in the H₂ recycle gas are between 10 – 20 ppm, lower than this and the catalyst will deteriorate whereas too high a level will strip chlorine from the catalyst, reducing its catalytic activity, reducing the reforming efficiency and increasing costs.
- Measurement is made before the compressor where the process pressure is lower and suitable for TDL measurement.

**Process benefits of GPro 500**

- Ceramic sensors are sensitive to the catalyst regeneration cycle due to presence of HCl, meaning they need protection during this phase of the cycle, increasing cost and maintenance and possible early failure.
- The GPro 500 TDL is not affected by the background gases present offering improved catalyst protection and reduced costs.

**Process conditions**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>30 – 50 °C</td>
</tr>
<tr>
<td>Pressure</td>
<td>*</td>
</tr>
<tr>
<td>Measurement range</td>
<td>0 – 100 vol. ppm</td>
</tr>
<tr>
<td>Dust load</td>
<td>Low, aerosols</td>
</tr>
<tr>
<td>Required response time</td>
<td>&lt; 2 s</td>
</tr>
<tr>
<td>Background gases</td>
<td>H₂ (80 %), C1 (8 %), C2 (5 %), C3 (4 %), C4 (2 %), trace HCl</td>
</tr>
</tbody>
</table>

* Due to large pressure variations on this process, always confirm pressure range with user

**Tips and hints**

When reviewing the application always check and confirm the expected levels of aerosols present in the flowing gas stream.

**Product recommendation**

GPro 500 H₂O; 290, 390, or 590 mm standard probe.

Alternative: non filter wafer cell or possibly extractive cell.
H₂O in Cl₂ (Tower Dryer Exhaust)
Catalyst Protection

Purpose
Wet Chlorine is corrosive to many plant materials downstream and also produces hydrates and hydrous iron chloride. For this reason the chlorine must be dried to prevent this corrosion. Tower dryers perform this drying process. The chlorine drying process needs to be controlled by an on-line measurement of moisture in chlorine gas.

Description
The drying system uses high concentration sulphuric acid to extract moisture from the chlorine gas after the chlorine cooler. The system typically consists of two or more packed towers operating in series, primary and secondary with possibly also a tertiary tower. In these towers chlorine gas is contacted with sulphuric acid in counter current flow where moisture present in the gas stream is transferred to the sulphuric acid liquid stream.

Process benefits of GPro 500
- Corrosive wet chlorine can be a challenge for other moisture measurement technologies, such as Al₂O₃, chilled mirrors and electrochemical sensors, due to corrosive sample causing sensor or mirror damage.
- Fast response compared to other moisture measurement techniques. Reduces possibility of “off-spec” wet chlorine reaching the chlorinator.
- The GPro 500’s design is unaffected by the process stream conditions.

Tips and hints
Consideration should be given to selection of suitable process adaptation materials. During upset conditions, wet chlorine is very corrosive, so if such conditions might exist, consider Hastelloy C or other alloys. Confirm with customer their preferred materials and seek guidance from the METTLER TOLEDO applications team.

Product recommendation
GPro 500 H₂O; 290, 390, or 590 mm standard probe.
Alternative: non filter wafer cell or possibly extractive cell.

Process conditions
| Temperature | ~ 50 °C |
| Pressure | * |
| Measurement range | 0 – 100 vol. ppm |
| Dust load | Low, aerosols |
| Required response time | < 2 s |
* Due to large pressure variations on this process, always confirm pressure range with user.
For more information go to

www.mt.com/TDL