



Mettler-Toledo  
Process Analytics

pH, Dissolved  
Oxygen and  
Conductivity  
Measurement  
Solutions, Gas  
Analysis

## Best Practice Guide to Process Analytics in the Chemical Industry

METTLER TOLEDO

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METTLER TOLEDO's in situ measurement solutions for chemical and petrochemical plants have proven their reliability for many years. We never stop developing innovative product offerings, and now we have devised a unique portfolio of Tunable Diode Laser (TDL) gas analyzers to measure O<sub>2</sub>, CO and moisture. High reliability and low maintenance have made TDLs the gas analyzer technology of choice for many companies.

This eBooklet contains a collection of success stories from some of our many chemical and petrochemical customers. It highlights the different analytical measurement challenges they faced, and how METTLER TOLEDO solutions provided the answer.

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# Increase Your Chlorine Production with a Highly Durable pH Sensor

**Reliably measuring pH levels during chlorine production is very difficult to achieve consistently. For the first time, a METTLER TOLEDO sensor has removed the barriers to precise, long-term pH determination. Chemical group Solvay has noticed a “dramatic improvement” in pH measurement.**

## Widely used element

Chlorine is one of the most commonly used chemical elements, with uses ranging from water treatment to synthesis of PVC to silicon chip manufacture. Production can be achieved through a number of methods, but the membrane cell process, during which brine is electrolyzed in large cells, is becoming most common for environmental reasons.

## Harsh conditions for pH probes

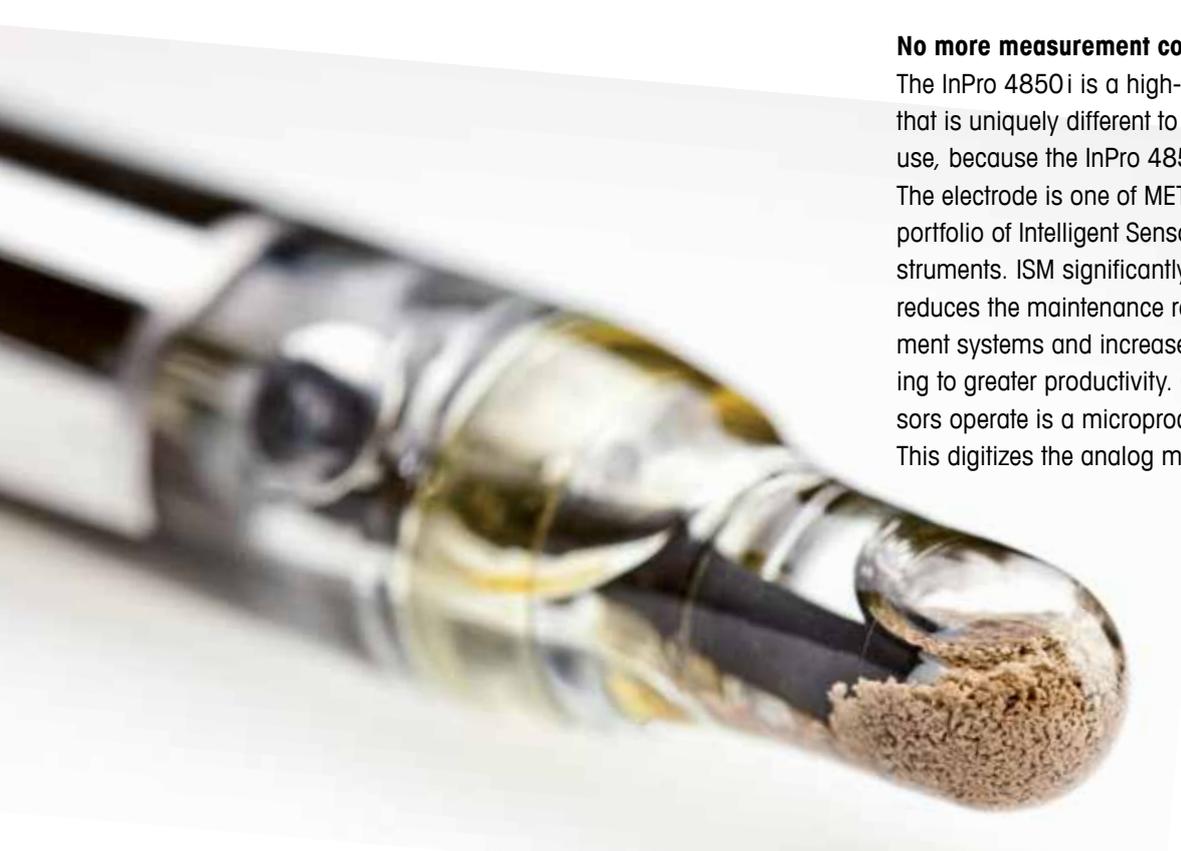
The pH level throughout the chlor-alkali process is crucial to maximizing yield and minimizing damage to the expensive membranes that are used in the electrolysis cells. The combination of chlorine in the electrolyzed brine, crystallized salt, precipitated impurities and elevated temperatures is very demanding on standard pH electrodes. To maintain reliable pH measurements requires regular cleaning and calibrating of electrodes, and even then sensors typically have a short lifetime.

## Sodium reference solves one issue but creates another

A more reliable alternative to conventional pH electrodes is probes with a hermetically sealed sodium (pNa) reference system. Because the brine concentration in the chlor-alkali process remains fairly static, these pNa/pH electrodes use the brine itself as a reference. And because the reference system is sealed from the process, there is no possibility of sensor poisoning from chlorine, or diaphragm clogging from salt or impurities. Unfortunately, there is a drawback to this design: pNa/pH electrodes output a very high impedance signal that is easily altered by surrounding electrical equipment. Additionally, the cable between sensor and transmitter acts like a radio antenna, which also affects the signal received at the transmitter and limits the length of cable that can be used. METTLER TOLEDO's InPro 4850 i sensor has solved this issue.

## No more measurement concerns

The InPro 4850 i is a high-quality pNa/pH electrode that is uniquely different to other probes for chlor-alkali use, because the InPro 4850 i outputs a digital signal. The electrode is one of METTLER TOLEDO's expanding portfolio of Intelligent Sensor Management (ISM) instruments. ISM significantly improves sensor handling, reduces the maintenance requirement for measurement systems and increases process availability, leading to greater productivity. Central to the way ISM sensors operate is a microprocessor in the sensor head. This digitizes the analog measurement signal which it



then exchanges with the transmitter. Because the signal is digital, it is unaffected by electrical interference and remains unchanged, even over very long cable runs.

By combining a sealed reference system with Intelligent Sensor Management's digitized signal along with ISM's other significant advantages, the InPro 4850 i provides unequalled measuring performance, requires little maintenance and is exceptionally durable.



InPro 4850 i  
pH electrode

**ISM<sup>®</sup>** **"Dramatic improvement," says Solvay**

With 17,000 employees and revenue of over 7 billion euros in 2010, Solvay is one of the world's major chemical companies. At their plant in Jemeppe, Belgium, Solvay produce chlorine through the membrane cell process.

Technicians were frustrated with the performance of their pH measurement equipment and were eager to try the InPro 4850 i electrode. Systems were installed

at a number of cells where the analyte exits. pH measurement is particularly problematic here as the brine still contains some chlorine which enters and poisons the reference system of conventional pH electrodes.

After a few weeks it was obvious to Solvay technicians that they had found the answer to their pH measurement difficulties. The InPro 4850 i sensors were operating flawlessly in the process and the digital ISM signals were unaffected by interference from surrounding equipment.

Neil Breton, Process Analytical Technologies Engineer at the facility is delighted with the electrodes' performance, "Changing to the InPro 4850 i has dramatically improved the reliability of our pH measurements. In the past, we were recalibrating some probes every week and changing them every two months. We are now simply checking them every two weeks. To this day, we have never suffered from probe failure."

[www.mt.com/pro-chlor-alkali](http://www.mt.com/pro-chlor-alkali)



# ISM Sensors Optimize Process Development in Titanium Dioxide Production at Kronos

**Titanium dioxide is the world's most widely used white pigment. For Kronos Titan, METTLER TOLEDO pH electrodes with their own diagnostic functions provide outstanding performance and a reduced maintenance requirement.**

## Global leader

Kronos Titan is one of the world's largest manufacturers of titanium dioxide, with gross sales of US\$ 1.1 billion in 2007. Two of six plants are located in Germany. In Nordenham, Kronos produces titanium dioxide using the sulfate process. In Leverkusen, along with the sulfate process, titanium dioxide is manufactured using the chloride process.

## Titanium dioxide – the premier white pigment

All white commercial products that are not chlorine bleached or naturally white contain the pigment titanium dioxide, without which day-to-day life would be inconceivable. The advantages of titanium dioxide include its absolute non-toxicity and exceptional physiological compatibilities.

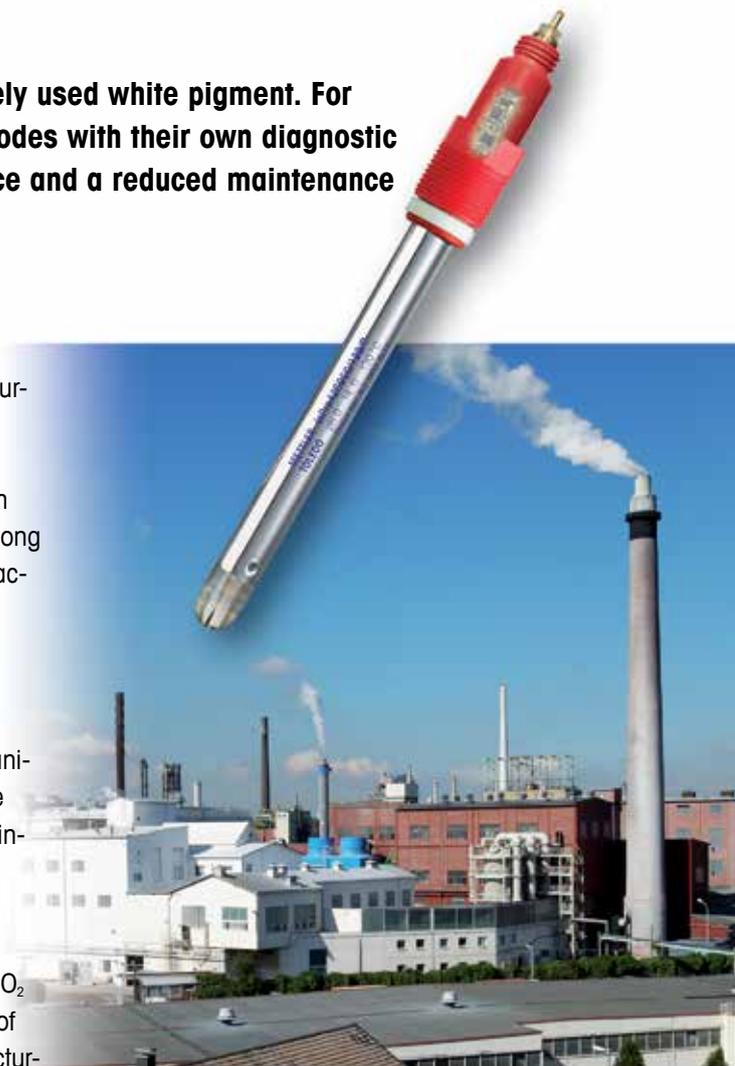
Kronos Titan in Leverkusen produces a variety of  $\text{TiO}_2$  pigments with specific properties for a wide range of applications. The principal consumers are manufacturers of wall and emulsion paints, suppliers to the automobile industry (vehicle paint), the cosmetics industry (e.g. dentifrice, sun screen), food manufacturers and the paper and plastics industries. Titanium dioxide is not only the most widely used white pigment, it is also used as a brightener for colored paints because of its outstanding dispersion factor.

## The technology center – production preliminaries

Kronos's R&D department operates a technology center in Leverkusen where, among other things, wet-chemical after-treatment methods are developed and tested for production applications. Here, the actual  $\text{TiO}_2$  pigment is provided with a treatment covering in order to specifically affect optical properties. The nature of this coating is governed by the subsequent area of application of the pigment. Kronos is continually developing the pigments and in the process takes into account specific customer requirements.

## Precise pH measurement despite high contamination potential

Mr Sebastian Kühnel is the PLT operations engineer at the technology center, where he uses METTLER TOLEDO weighing and pH measurement technology. Along with a PBA 430 weighbridge, an automatic dispensing system is used which is controlled by a Panther weighing terminal. pH measurement is done using three fully automatic EasyClean measuring, cleaning and calibration systems. The EasyClean 350e system is controlled by a pH 2100e transmitter and the EasyClean 400 systems by an M700 transmitter. All drive an InTrac 777 retractable housing that is moved automatically in the after-treatment process and can be withdrawn for cleaning or calibration/adjustment of the pH electrode.



The digital Intelligent Sensor Management (ISM) InPro 4260i electrode is used as the sensor. Automation of the measurement points increases accuracy and reliability of the measurements and frees personnel from time-consuming maintenance. Thanks to its special reference system, the InPro 4260i pH electrode is particularly well suited for use in pigment suspensions.

With electrodes using conventional ceramic junctions the tiny pores clog very quickly. This can result in unreliable measurements because contamination of the junction would cause undesirable diffusion potentials that would adversely affect the electrode potential and distort the measurement. The METTLER TOLEDO InPro 4260i pH electrode has a solid polymer electrode that eliminates the need for a ceramic junction. Instead, the reference system is in contact with the measuring medium by way of two open connections. Very fine particles that deposit there can be rinsed away again. This predisposes the InPro 4260i for use in applications that would quickly contaminate other types of electrode.

#### Digital ISM sensors optimize process development

The use of sensors with the solid XEROLYT polymer electrolyte represents a clear improvement in pH measurement. For two years now Mr Kühnel has been taking advantage of the rewards of digital sensor technology. Of particular interest to him is the fact that ISM sensors feature diagnostic functions that make possible quick and simple analysis of the cause in the event of sensor malfunction. The M700 transmitter's spider diagram shows at a glance an overview of the status of the pH electrode using its most important performance parameters. The requirement for maintenance operations such as electrode cleaning, calibration or replacement can be easily determined.

The Plug and Measure function reduces the expenditure for maintenance and service of pH measurement.

Further, ISM sensors indicate process discrepancies that previously were difficult to identify. For example, they feature

a temperature indicator that registers the maximum process temperature. Computation of the remaining life of a sensor by the integrated Dynamic Lifetime Indicator also provides information on unintended process conditions if the life of the electrode decreases at a faster-than-normal rate. The electrodes are evaluated, calibrated and adjusted by Kronos employees directly at a PC on which METTLER TOLEDO iSense Asset Management Software is installed. It makes it possible to manage sensors and to record and evaluate all important data.

#### Benefits of the measurement technology used

- InPro 4260i pH electrode with polymer electrolyte – outstanding measurement performance even in media with a high contamination potential.
- EasyClean cleaning and calibration systems – reduction of maintenance overheads thanks to automation of the measurement point.
- ISM – diagnostic tools for process optimization.

Mr Kühnel will report in a second article on how the life span of pH electrodes used in TiO<sub>2</sub> production was extended from half a day to two weeks by using ISM technology.

► [www.mt.com/InPro4260i](http://www.mt.com/InPro4260i)



EasyClean 400  
Cleaning and calibration system



InPro 4260i  
pH electrode

ISM®

## Reliable pH Measurement in Difficult Conditions Means Improved Product Quality for P & G

**For Procter & Gamble (P & G) in Italy, the quality of pH measurement equipment is very important. A METTLER TOLEDO ISM pH system provides precise determination and high repeatability, resulting in an increase in process analysis quality.**

Procter & Gamble is the world's largest producer of consumer goods, with annual revenues of over \$ 70 billion. Their Campochiaro (Campobasso) manufacturing plant in Italy is the bleach production base for their Ace brand.

Flavio Di Salvatore (FDS) works in the hypo-chlorite production module, where a METTLER TOLEDO pH measurement system with Intelligent Sensor Management (ISM) technology was recently installed. The system comprises an InPro 2000i pH electrode, M420 transmitter and InFlow 764 housing. We asked Mr Salvatore to describe the process and explain why P & G chooses METTLER TOLEDO.

MT: Mr Di Salvatore, would you please give a brief description of the production process you're involved with.

FDS: We have a vessel containing a chloride brine, the pH of which is regulated by adding doses of hydrochloric acid since part of this solution will be used to fuel the electrolysis process.

MT: And during this phase of production, which analytical parameter is most critical in terms of safety, quality and productivity?

FDS: pH measurement, considering the difficult conditions, is one of the most critical. Lack of control in this area could produce very negative consequences for the electrolyzer.

MT: So it would affect productivity and possibly system safety as well.

FDS: Yes, it certainly would.

MT: Before installing the METTLER TOLEDO system that you are currently using, what were your most frequently occurring analytical problems?

FDS: Previously, the quality of pH measurement was influenced by many factors. These caused difficulties in reproducing and repeating measurements and values.

MT: You mean between the process itself and analysis conducted by the lab?

FDS: Yes, exactly.

MT: What kind of improvements did you expect to obtain?

FDS: Given the system's issues, the objective was an increase in the reliability and quality of the analysis.

MT: What benefits have you noticed since installing the METTLER TOLEDO ISM system you are using?

FDS: The greatest benefit is that we have significantly increased the reliability and accuracy of the pH values. Another important achieved objective is that we can now control, over the medium period, the consistence and the solidity of this improvement, and results confirm that the improvement is constant.



Flavio Di Salvatore with InPro 2000i pH electrode and InFlow 764 housing

MT: So the main benefit is regarding the accuracy and repeatability of analysis during measurement.

FDS: That's exactly right.

MT: Are there economic benefits as well?

FDS: We have seen real gains in terms of precision, reliability and maintenance. This has produced an increase in quality and productivity. These results confirm without hesitation that investing in an ISM system was a good decision.

P&G is so satisfied with the performance of METTLER TOLEDO's pH measurement solution that they are planning on purchasing additional systems to cover all of their production at Campochiaro.

- ▶ [www.mt.com/ISM](http://www.mt.com/ISM)
- ▶ [www.mt.com/pro-pH](http://www.mt.com/pro-pH)



InPro 2000 i  
pH electrode



# Achieving High Product Quality in Cobalt Oxide Synthesis

**The demand for cobalt oxide is increasing worldwide. For a Chinese producer, accurately measuring pH in their process was problematic. METTLER TOLEDO's automated cleaning system improved reliability, thus making high product quality a certainty, even in harsh conditions.**

## Increasing demand

Located in Gansu Province, China, Jinchuan Group Limited is a large-scale, non-ferrous metallurgical enterprise, specialized in the production of nickel and cobalt materials. It ranks fourth in the world and first in Asia among nickel material providers.

With the popularization of portable electronic devices such as the notebook computer, mobile phone, PDA and MP3 player, and the rapid development of hybrid electric vehicles and pure battery-powered vehicles, the demand for chargeable lithium ion batteries is rising year on year. Cobalt (II,III) oxide ( $\text{Co}_3\text{O}_4$ ) is an important raw material in lithium ion battery production, the grade of which can directly affect the quality of the finished batteries.

## Wet synthesis

The production of  $\text{Co}_3\text{O}_4$  comprises two processes: wet synthesis and thermal treatment. The wet synthesis process directly affects the microscopic pattern and chemical composition of  $\text{Co}_3\text{O}_4$ .

Using a water bath, the reactor is kept at a stable temperature and the reactants are fed at a constant rate. A specially designed agitator is used to ensure the even-

ness of the product, and during the process pH must be maintained at a precise level. As the reaction progresses, cobalt hydroxide precipitates and is converted into  $\text{Co}_3\text{O}_4$  through heating.

## Monitoring system

The control of the cobalt hydroxide synthesis reactor is vital to successful wet synthesis. The temperature inside the reactor, the pH value and the mixing speed are major control parameters. The temperature and the mixing speed can be easily controlled by using the hot water tank circulation method and the general converter, respectively. However, due to the complexity of the precipitant solutions (which include acid, alkaline and ammonium) and given that the precipitation of cobalt hydroxide generated comprises micron level particles that easily adhere to and pollute the electrode, accurate measurement of the pH value is difficult.

Unreliable measurements can lead to reduced product quality, so to try and solve the problem Jinchuan Group trialed several solutions from a number of manufacturers. They finally decided that a METTLER TOLEDO system best met their needs.

The selected solution comprised the following:

### ro 4800 electrode:

Two electrolyte chambers and PTFE annular junction make it eminently suitable for use in applications where polluting materials and large changes in temperature are present.

### 2100 e transmitter:

Extremely stable and reliable unit which features autoCheck for continuous monitoring of the glass reference electrodes.



Cobalt oxide is an important raw material of rechargeable batteries

**InTrac 777 housing:**

The housing chosen is air-powered, retractable and includes a flushing chamber in which the electrode can be cleaned and calibrated. The InTrac 777 is equipped with a location detection feedback element so that its operating status can be determined remotely.

**EasyClean 300 cleaning/calibration system:**

In combination with the InTrac 777 housing the EasyClean 300 provides completely automatic electrode cleaning and calibration. Since installation at Jinchuan Group's facility, the EasyClean 300 has been superseded by the even more advanced EasyClean 350e.

**Installation and programming**

The METTLER TOLEDO system was interlinked with the PLC of the facility's Central Control Room (CCR) so as to constitute a fully automatic in-line pH measurement and control solution.

To meet the requirement of free-from-site operation, signals between the pH measurement point and the CCR are transmitted via hard wire, the pH value signals are sent via 4~20 mA signals, while the housing operation and the electrode location feedback are transmitted through the node signals.

The hardware configuration means that real-time monitoring of pH is conducted in the CCR. The status of the pH measurement system as well as the location information from the housing, and maintenance requirements, are also monitored so that use of the system becomes safer, easier and quicker.

During the cobalt hydroxide synthesis process, fixing the alkali flow and adjusting the acid flow are based on the pH value. Controlling the valve aperture through ad-

justment of a PID parameter in the PLC allows stable control of pH during the whole reaction process.

**Excellent results**

Engineers at Jinchuan Group report that the system runs very stably and reliably, and completely meets the design requirements. The operation of the automatic pH measurement and control system has proven far superior to the previous method, which relied on manual cleaning and calibration. Now, pH control precision during the synthesis process reaches  $\pm 0.02$  pH. This helps Jinchuan Group provide a strong guarantee of high product quality to their many customers, and helps them keep up with ever increasing demand.

**Best Practice**

**Save costs by switching to automatic sensor cleaning and calibration**

An automatic sensor cleaning and calibration system has many clear benefits:

- More efficient: Downtimes caused by insufficiently maintained sensors are eliminated
- Less inventory: Regularly maintained sensors have a longer lifespan
- Safer: No engineer exposure to hazardous media or high temperatures

 [www.mt.com/EasyClean](http://www.mt.com/EasyClean)



Automated cleaning and calibration system at Jinchuan Group



EasyClean 350e Automatic sensor cleaning and calibration system



InPro 4800 pH electrode

# Less Maintenance, Greater Process Safety

## Clariant Switch to Electrode Cleaning System

**Sensor maintenance is vital for ensuring your processes are running correctly. But what if a process allows only periodic access to a sensor? Automatic cleaning and calibration means sensor access at any time, no manual maintenance and improved process reliability. Just what Clariant wanted.**

### Specialty chemical manufacturer

Clariant is a world leader in specialty chemicals. There are more than 100 affiliated companies within the group, with around 22,000 Clariant employees at eleven production sites in Germany.

Clariant's Gendorf industrial park facility is located in the South Bavarian Chemistry Triangle at Altötting. There are 18 companies at that location and Clariant is the largest of them. The 900 employees and 70 trainees produce an approximate 800,000 tons annually of preliminary and intermediate chemical products.

The Gendorf Clariant product range includes starting and auxiliary materials for the manufacture of aircraft and runway de-icing agents, thermal conductor and brake fluids, for petroleum recovery and processing, and for cosmetics, body care, disinfection agents, and industrial and domestic cleaning agents.

### Tensides

Tenside production is also part of these primary and auxiliary products. Tensides are synthetic detergents found in washing products, rinses, shampoos and shower gels. They are comprised of a hydrophobic part consisting of hydrocarbons and a hydrophilic residue. Tensides deposit on dirt and grease particles with their hydrophobic part and raise it from the matrix, envelop it and disperse it. The hydrophilic part is oriented towards the water so that the dirt can be carried off by the water.

There are four types of tensides:

- cationically active tensides (positive charge)
- non-ionic tensides (no charge)
- amphoteric tensides (positive and negative charge on the same molecule)
- anionically active tensides (negative charge)



EasyClean 400 sensor cleaning and calibration system, and M700 transmitter

It is anionically active tensides that are manufactured by Clariant at Gendorf.

#### Automated electrode cleaning and calibration

During manufacture of their tensides, a pH measurement system is used that was initially installed with an insertion housing. The pH electrodes could not be cleaned or calibrated when needed but only when the process allowed it. In order to undertake the maintenance work, the electrode had to be unscrewed from the housing and this was only possible if the line was empty. Initially, maintenance was done once a month because it was a complicated procedure and the course of the process did not permit it more frequently.

Based on the fact that the exact pH value is extremely important for the quality of the tensides, Clariant decided to automate the measurement. A METTLER TOLEDO InTrac retractable housing became the basis for the automation of the measurement point, along with an EasyClean 400 cleaning and calibration system. This system means that the pH electrode can be exchanged if necessary, even in a running process.

EasyClean 400 takes over the previously labor intensive cleaning and calibration of the electrodes. Due to the availability of predefined and freely configurable programs, the system can be adapted to the individual requirements of the operation in which it is installed. The programs can be individually set for weekly intervals within which any weekday can be individually programmed, or a fixed interval can be used for continuous processes.

#### Longer electrode life

The system, which is controlled via the facility's process management system, has been running successfully at Clariant in Gendorf since January 2009.

Along with the advantages of having access to the electrode at any time, and that automation has minimized maintenance costs, process safety has increased due to frequent calibration of the probe. And with maintenance service that can be adapted both to the process conditions as well as the performance of the electrode and does not have to accommodate production sequences, the life span of the electrodes has been extended.

► [www.mt.com/EasyClean](http://www.mt.com/EasyClean)



M700  
Multi-parameter transmitter



EasyClean 400  
Cleaning and calibration system

# Less Complexity, Less Maintenance, Less Risk Laser-Based Oxygen Analyzer Does It All

**Paramagnetic oxygen analyzers used with sample extraction and conditioning systems measure reliably, but maintaining their performance can require a great deal of maintenance. For one of Brazil's major chemical facilities, switching to tunable diode laser (TDL) technology has simplified the measurement system, reduced maintenance, and increased process safety.**

## **Chemical company struggles with paramagnetic analyzer**

Brazil's chemical industry is the 7<sup>th</sup> largest in the world. But, over recent years demand has outstripped production and imports of chemicals have been growing. In order to reverse the trend Brazilian chemical companies are investigating how to increase productivity while at the same time reduce operating costs and maintain process safety. To help achieve this they are looking to technical advances in production equipment.

One chemical company operating in Brazil is part of a major international player in the global chemical industry. At a facility in Southern Brazil a paramagnetic analyzer with an extraction and conditioning system was being used to measure O<sub>2</sub> levels in the off-gas of an oxidation column. Although the system measured de-

pendably, it required frequent maintenance to keep it operational which involved taking the measurement off-line.

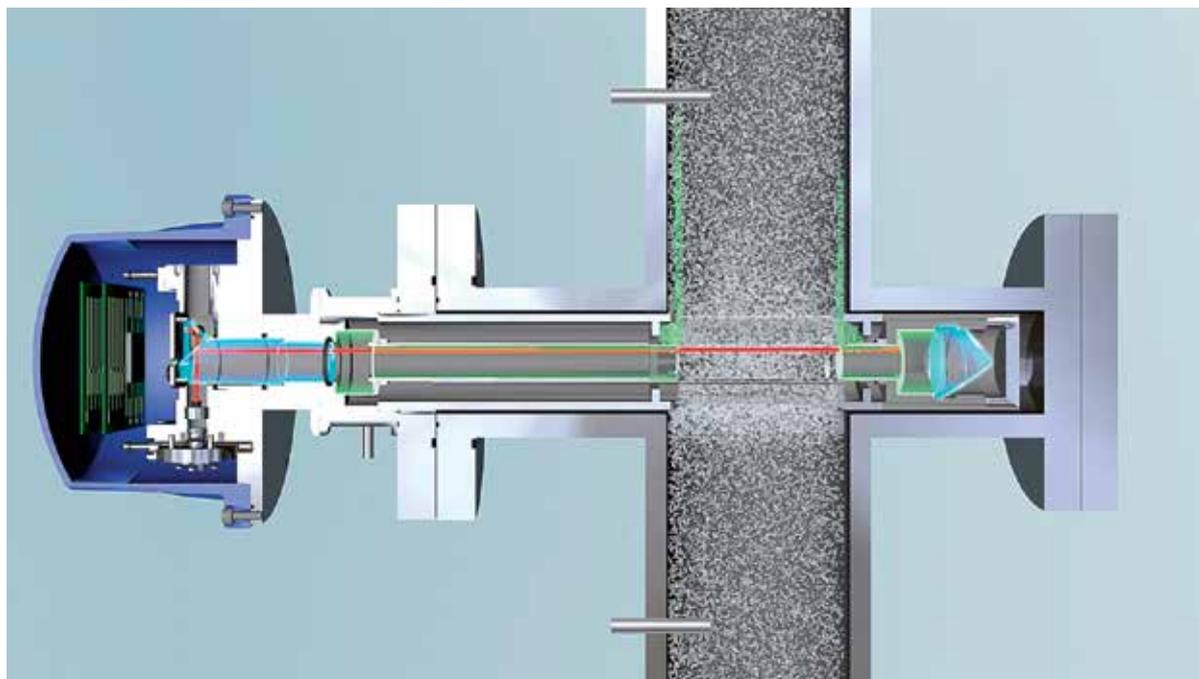
Also, there existed the possibility of catastrophic failure of the system as the measuring cell of these analyzers is rendered useless if moisture enters them. Such an event would lead to extended downtime of the process and a high cost to restore the measurement.

## **Tunable diode laser analyzers offer a major improvement**

The expense of regular maintenance and worry over system failure led to the company looking to replace the existing system with a tunable diode laser (TDL) solution. TDL analyzers are usually used in situ without the need for sample extraction or conditioning. They achieve very accurate measurement of the target gas by analyzing the absorption of laser light that passes through the gas matrix. Nitrogen is used as a purge gas to keep moisture as well as dust away from the analyzer's optical windows, and there is no possibility of moisture or dust entering the instrument.

Commonly, TDLs are of a cross-stack design, meaning that the unit that outputs the laser light is installed opposite the unit that receives and analyzes it. For this system to operate dependably the two parts must be very carefully aligned. Maintaining alignment can be difficult as changes in process temperature can cause the stack to warp, resulting in misalignment and a consequent drop in measurement integrity.





### **The GPro 500 TDL ticks all the boxes**

METTLER TOLEDO offers a TDL solution that not only eliminates the alignment problem, but also simplifies analyzer installation and maintenance. The GPro 500 series of O<sub>2</sub>, CO, and moisture analyzers uses a unique design whereby the laser light emitted from the sensor head travels down a probe that is open to the process gas and is returned by a retroreflector back through the gas to a receiver which is also within the analyzer's head. This design means that alignment of the analyzer is not required, even if the process involves a significant temperature ramp.

As sender and receiver are in a single instrument, only one flange needs to be installed into the duct, greatly simplifying installation. A range of unique process adaptations (such as the wafer cell for very narrow pipes) significantly increases the range of applications for the GPro 500 series.

### **Almost zero maintenance and low running costs**

Verification of the GPro 500 is necessary only once a year, on average. And as the analyzer can be detached from the probe (which remains installed in the process) there is no downtime associated with analyzer maintenance.

Compared with cross-stack TDLs, the running cost of GPro 500 analyzers is very low due to the probe's narrow diameter, meaning far less purge gas is required. Of greater importance to plant managers is the GPro 500's fast response (<2 seconds), which improves process safety by rapidly identifying any increase in target gas levels.

### **Trouble-free operation**

Satisfied that a GPro 500 O<sub>2</sub> analyzer would provide the accuracy and reliability needed, the chemical company installed a unit in the aforementioned oxidation column in late 2013. The company reports that it has been providing dependable, trouble-free oxygen measurement since then.

The success of the GPro 500 in this application encouraged the plant operators to install two further units: at the entrance of the oxidation column and in a hydrogenation process, and further installations are being considered.

Discover more about the GPro 500 at:

► [www.mt.com/chem23-TDL](http://www.mt.com/chem23-TDL)

# Trouble-Free Oxygen Measurement with a Unique Gas Analyzer

**When corrosive gases damaged their paramagnetic oxygen analyzer, a major producer of manufactured fibers required a better solution. The GPro 500 is not only providing them with almost instant measurements, its very low maintenance is a significant time and cost saving.**

## The first manufactured fiber

Rayon, first produced in the 1880s, is the world's oldest manufactured fiber. It is a natural-based material that is usually made from cellulose derived from wood pulp. Improvements in the rayon production process have led to variations on the fiber such as modal which, due to its greater absorbency, is widely used in towels and bedsheets.

One of the world's largest producers of modal is the Lenzing Group, an international organization headquartered in Austria. Lenzing (Nanjing) Fiber, located in the Liuhe district of Nanjing, China was developed with investments from the Lenzing Group and the Nanjing Chemical Fiber Co., Ltd. The Lenzing project is currently China's largest Austrian investment. Lenzing (Nanjing) Fiber mainly produces rayon and Lenzing Modal® for non-woven fabric and clothing manufacture.

## Oxygen in waste gas must be controlled

During fiber production, a significant amount of gas is produced. As it contains toxic combustibles such as hydrogen sulfide and carbon disulfide, the gas must be processed before it is vented to the atmosphere. During transportation by pipeline to the factory's waste gas processing unit, oxygen levels in the gas must be kept low to minimize the risk of explosion.

## Corrosive compounds damage paramagnetic analyzer

A paramagnetic oxygen analyzer was installed in the gas pre-treatment system. Conditioning equipment was also required to remove liquid, dust, and gases that could interfere with the paramagnetic analyzer's ability to measure reliably. Despite this treatment, engineers noticed the analyzer's performance deteriorating over time. Analysis showed that the corrosive gases were not being removed entirely by the conditioning equipment and that the analyzer's expensive motherboard was being damaged. Engineers therefore looked for a more robust measurement system.

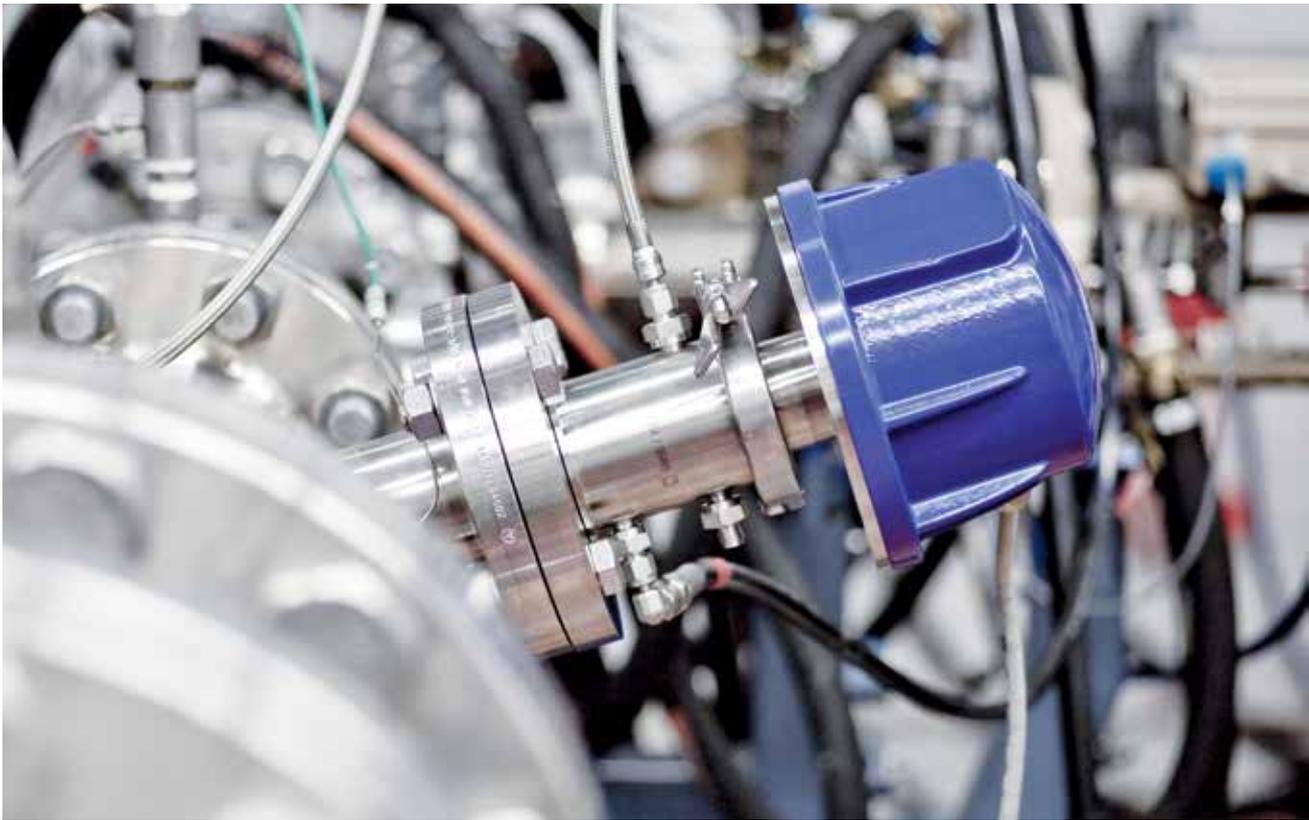


## Reliable tunable diode laser oxygen sensor

They were immediately drawn to tunable diode laser (TDL) technology as it is a non-contacting measurement technique, so there is no possibility of process gases entering the sensor body. The available TDL analyzers in the marketplace were investigated and the Lenzing (Nanjing) Fiber engineers became particularly impressed with the METTLER TOLEDO solution.

Most TDLs are composed of two parts: a unit that outputs a laser beam of a frequency equal to the absorption frequency of oxygen molecules; and a unit that receives the laser light, analyzes it, and calculates the oxygen level in the process. The two units require very precise alignment, which is not easy to achieve.

The METTLER TOLEDO GPro 500 sensor, on the other hand, features a probe that protrudes into the gas stream. A corner cube at the end of the probe directs the laser beam back to the receiver/analyzer in the sensor head. Alignment is never required and because the laser beam travels twice through the process gas, measurement accuracy is very high. Also, the sensor has no moving parts. This means the analyzer requires



no maintenance other than occasional cleaning of its optical windows and annual verification.

**Unique process adaptations**

The GPro 500 is available with a series of unique process adaptations that replace the standard probe. These adaptations greatly increase the range of applications suitable for the GPro 500. Lenzing (Nanjing) Fiber installed a GPro 500 with a sampling cell adaption. This has allowed them to use the GPro 500 along with their existing sample conditioning equipment. In addition, installation was conducted without any interruption to the gas treatment process.

Lenzing (Nanjing) Fiber are more than satisfied with their decision: "The analysis capability of the GPro 500 meets all our requirements. Furthermore, it's superior to the paramagnetic analyzer in terms of response speed and maintenance."

► [www.mt.com/TDL](http://www.mt.com/TDL)

GPro 500 oxygen sensor with sampling cell adaption



# Improved Flare Safety in Butadiene Production

**Oxygen ingress in flare systems can have catastrophic consequences, particularly when the exhaust gas itself is highly flammable. To prevent accidents, reliable oxygen measurement is vital. For a butadiene producer, a METTLER TOLEDO solution is succeeding where others failed.**

## LG Chemical joint venture

Ningbo LG Yongxing Chemical Co., Ltd is a joint venture between South Korea's LG Chemical Co. Ltd. and China's Ningbo Yongxing Chemical Investment Co. Ltd., the largest producer of acrylonitrile butadiene styrene (ABS) resin on the Chinese mainland.

One purpose of the joint venture is to supply Yongxing Chemical Investment with butadiene, a petrochemical intermediate that in a polymerized form is an essential raw material in ABS production.

## Highly flammable intermediate

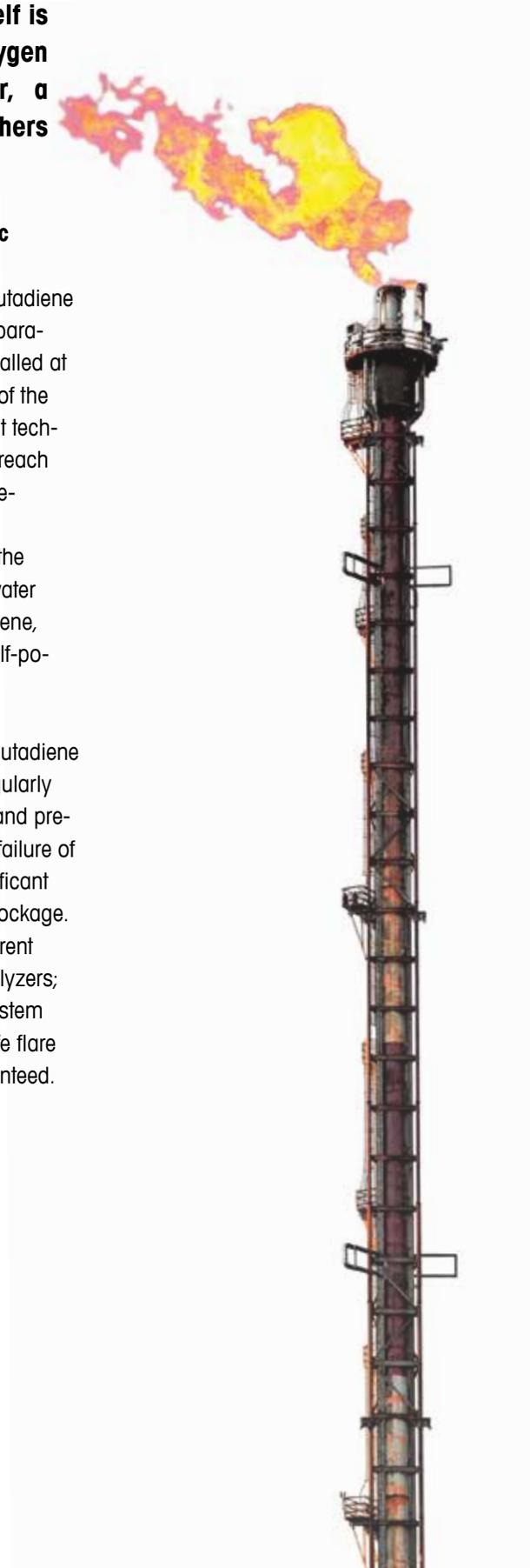
Butadiene is extremely flammable and is also a potential health and environment hazard. Hence, in butadiene production plants, off-gases produced during start up and shutdown are sent to a flare for safe destruction before release. The oxygen content of the exhaust gas must be carefully controlled, as too much could result in explosive combustion or the formation of popcorn polymer within the flare stack or main header.

## Troublesome paramagnetic analyzer

For oxygen monitoring in butadiene exhaust at LG Yongxing, a paramagnetic analyzer was installed at the flare. Due to the nature of the paramagnetic measurement technique, before gas samples reach the analyzer they require pre-

treatment. At LG Yongxing, the waste gas contains 10% water vapor along with the butadiene, which has a tendency to self-polymerize.

Condensed water and the butadiene popcorn polymer would regularly block the sampling tubing and pre-treatment filter, resulting in failure of the measurement and significant maintenance to clear the blockage. In addition, there is an inherent delay in sampling-type analyzers; therefore, even when the system was working correctly a safe flare process could not be guaranteed.





**GPro 500 sensor showing key features**

### **Cross-stack tunable diode laser technology has problems**

In the hope of obtaining more dependable measurements, engineers removed the paramagnetic system and installed a tunable diode laser (TDL) analyzer.

TDLs exploit the absorption of laser light by the target gas to determine gas concentration. The technology is largely immune to the presence of water vapor and background gases, and as a result, TDL analyzers offer a very stable measurement and high reliability. However, the pipeline to the flare at LG Yongxing is only DN300 which is too narrow for typical, cross-stack TDLs (separate laser source and receiver units that must be carefully aligned). This necessitated installation of the TDL in an expansion chamber attached to a sample line.

Due to the volume of the chamber, nitrogen purging, which is used to keep the TDL windows free from dust and moisture, was not practical; consequently, equipment for sampling, filtering, and pre-treatment had to be installed upstream of the analyzer. Once again, the pre-treatment equipment proved to be problematic. Despite daily maintenance, failures in the sampling and pre-treatment system meant oxygen measurement was frequently unavailable.

### **Probe-design TDL is the answer**

Determined to find a better solution, LG Yongxing having heard of our GPro™ 500 oxygen sensor contacted METTLER TOLEDO. The GPro 500 is a TDL device, but

unlike most is not of a cross-stack design: Instead, the GPro 500 features a probe at the end of which is a three-sided, reflective prism (corner cube) which directs the source laser beam back to the receiver in the sensor head. This design allows installation of the GPro 500 in pipes as narrow as DN100. In addition, installation is much simpler as no alignment between source and receiver is required.

Maintenance of the sensor is minimal, amounting to verification approximately every 12 months and occasional cleaning of the windows. The predictive diagnostics of METTLER TOLEDO's Intelligent Sensor Management (ISM®) technology continuously monitor the optical path quality and determine the cleaning requirement.

### **Reliable, in situ measurements**

Satisfied with the GPro 500's design, simple installation, low maintenance, and absence of sampling or conditioning equipment, LG Yongxing installed a unit in the flare pipeline. Since its installation nine months ago, the GPro 500 has required no maintenance and suffered no failures, and is providing accurate, real-time oxygen measurements for safeguarding flare operations.

If you need to ensure flare operation safety at your facility, go to:

► [www.mt.com/TDL](http://www.mt.com/TDL)

# Preventing Explosions

## Demands In Situ, TDL Oxygen Sensors

**At a Brazilian metal treatment plant, oxygen levels in a vapor extraction system must be continuously monitored to provide early warning of a potentially explosive gas mixture. A comparison of technologies shows that only an in situ, tunable diode laser sensor provides the required speed of response.**

### Metal treatment produces hazardous vapors

One of South America's major metal producers operates a facility in Brazil where they run a surface treatment procedure to harden steel. The process generates a great deal of organic vapors including benzene, toluene, naphthalene, ammonia, and phenol all of which pose a hazard to human health and the environment.

These gases are extracted from the production process equipment by fans and piped to a treatment plant. Typically, oxygen is not a component of the gas mixture itself, but enters in air through pipe connections and valves. To prevent the gas mixture posing a fire and explosion risk, the oxygen level in the piping must be continuously monitored.

### Paramagnetic analyzer is far from ideal

Real-time measurements are required to allow for corrective action before the oxygen level exceeds safe limits. However, the paramagnetic analyzer the plant had been using gave engineers problems. The analyzer needed sample extraction and conditioning equipment to remove

moisture and dust that would otherwise damage the analyzer's measurement cell. This equipment caused a delay in O<sub>2</sub> determination that, on occasion, led to an explosive gas mixture being present in the piping.

Further, the extraction and sampling equipment required regular maintenance, meaning it was often offline, leaving the plant without an oxygen measurement. In addition, the hydrocarbons in the gas mixture would sometimes interfere with the measurement, resulting in uncertainty as to the actual O<sub>2</sub> level.

Plant engineers began looking for a more reliable system that would also be low in maintenance. After becoming aware of our GPro 500 tunable diode laser (TDL) oxygen sensor, they contacted METTLER TOLEDO.

### Tunable diode laser technology

TDL technology is a relatively new class of gas analyzer that is gaining acceptance across the process industries. TDLs work on the principle of laser absorption spectroscopy: A focused and tunable laser beam passes through the gas stream to a receiver. The laser scans a very narrow part of the electromagnetic spectrum where absorption lines that are characteristic of the gas species to be measured, exist. Analysis of the surface area of the absorption lines (or peaks), allows determination of the concentration of the target gas.

TDLs for monitoring oxygen, carbon monoxide, and other gases are growing in use in many industrial processes because they measure in situ and therefore do not require sample extraction or conditioning equipment. They are also largely immune to the presence of dust, moisture, and background gases in the gas stream.

### Cross-stack TDLs require tricky alignment

Most TDLs are of a cross-stack design comprising separate sender and receiver units. Such TDLs require a pipe diameter that is wide enough to allow the laser to pass through a sufficient quantity of gas in order that a reliable measurement is obtained. The pipe diameter of the metal treatment plant's vapor extraction





GPro 500 oxygen sensor

system prevented the use of such a configuration. Even if the diameter had been sufficient, installation of such TDLs demands precise alignment of the two units, and time consuming and costly realignment may be periodically required.

**No alignment worries with probe-design TDL**

METTLER TOLEDO developed the GPro 500 TDL oxygen sensor to surmount the path length and alignment issues. The GPro 500 has both laser source and receiver in the same unit. The laser passes down a probe, at the end of which a corner cube directs the beam back to the receiver. Not only does this means that there is no alignment necessary, it also provides a more accurate oxygen measurement because the laser crosses the gas stream twice.

Two other features of the GPro 500 also appealed to the treatment plant's engineers: When the unit needs calibrated (approximately once per year) the sensor

head can be removed while the probe is left in situ, so there is no danger of gas escaping from the vapor extraction system. Intelligent Sensor Management (ISM<sup>®</sup>) predictive diagnostics in the unit provide constant assurance of the sensor's condition, so engineers can be confident in the sensor's measurements.

**Robust, reliable, and precise**

A GPro 500 was duly installed in the extraction system piping. Since its commissioning, the GPro 500 has required no maintenance and suffered no failures, and is providing accurate oxygen measurements for safeguarding organic vapor extraction. Due to the plant owners' satisfaction with the sensor, they now are planning on installing GPro 500s in their other Brazilian facilities.

Find out more about reliable, low-maintenance oxygen monitoring, at:

► [www.mt.com/O2-gas](http://www.mt.com/O2-gas)



**METTLER TOLEDO** CH 8600 Grand  
Made in Switzerland

Oxygen Gas analyzer Model GPro™  
GPro500-AT 6 KA 4404 290\_D12 ST AX  
P. no.: 30033663 S. no.: 2290001  
IP 65 NEMA 4X CE 1238

Ambient temperature range: -20°C to +50°C  
Power input: 24 VDC, 5 W see Operating Instructions

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SEV 12 ATX 0114

# Oxygen Analysis Made Easy with Powerful In-line TDL Sensors

**When it comes to process safety for protecting the environment, people, and assets, only the best equipment will do. METTLER TOLEDO's new O<sub>2</sub> solution offers the convenience and ease of use of an in-line sensor, and the performance of a powerful gas analyzer. With the GPro™ 500, oxygen measurement is simpler and more reliable than ever before.**

METTLER TOLEDO's GPro 500 represents a revolution in oxygen sensors. Packed with state-of-the-art technology it offers exceptional measuring performance and easy installation, and requires little or no maintenance.

Tunable Diode Laser (TDL) gas analyzers are a significant improvement over extractive analysis systems. METTLER TOLEDO has combined TDL technology with our long-standing expertise in industrial application

analytical instrument design. The result is a probe that delivers the convenience of an in-line sensor and the level of measurement performance of a top-line analyzer.

Find out more at:

► [www.mt.com/o2-TDL](http://www.mt.com/o2-TDL)

## Your benefits



### No sample extraction or conditioning required

GPro 500 measures in situ and does not require costly and breakdown-prone sampling equipment.



### Minimal maintenance

Other than yearly verification and occasional cleaning of the optics, no other maintenance is necessary.



### Simple installation

Other TDL sensors are of a cross-stack design that causes installation difficulties. GPro 500 needs only one flange and no alignment.



GPro 500 TDL oxygen sensor

# Resilient Conductivity Sensor Succeeds in Harsh Acidic Process

**Maintaining the correct concentration during the wet sulfuric acid process relies on constant control of sulfur trioxide hydration. Conductivity measurement is ideal for monitoring purposes, but only METTLER TOLEDO inductive conductivity sensors can tolerate the conditions. For a Brazilian company implementation has meant lower production costs.**

## **Sulfuric acid production requires constant monitoring**

A global player in the chemical industry operates a production site in Brazil where large quantities of sulfur trioxide are produced. The compound is used at the plant as a prime material in the manufacture of other products. The  $\text{SO}_3$  is generated in a continuous process, and at times when it cannot be used elsewhere at the facility it is washed with water to produce sulfuric acid which is subsequently sold to other companies.

Control of  $\text{H}_2\text{SO}_4$  concentration is vital as too weak a solution cannot be sold and too strong a solution means overuse of  $\text{SO}_3$  and a reduction in profit margin. Due to the exothermic nature of the reaction it is not practical to dilute a highly concentrated solution in a later process. Likewise, it is not worth the production costs involved in making weak solutions stronger. Therefore, successful production involves continuous monitoring of the  $\text{H}_2\text{SO}_4$  as it is generated.

## **Inductive conductivity sensors for harsh environments**

Determination of acid concentration by in-line conductivity measurement is ideal for this application; however, most sensors are unable to withstand the extremely acidic, high temperature process conditions. The chemical company was looking for a precise and process-tolerant measurement system that would provide continuous concentration data. Their research identified solutions based on inductive conductivity sensors as being most suitable. Company engineers decided on a METTLER TOLEDO system comprising the InPro 7250 inductive conductivity sensor with perfluoralkoxy (PFA) coating, and M420 Cond Ind transmitter.



The InPro 7250 sensors have been designed specifically for measurement in such applications. As there is no electrode in direct contact with the process liquid, they are not affected by media that would foul traditional contacting probes. In addition, the sensor's PFA coating is highly resistant to aggressive chemicals.

The M420 Cond Ind is a 2-wire transmitter with Ex approval for hazardous area use. Among its features is a sulfuric acid curve function; this provides accurate concentration measurement across wide conductivity and temperature ranges.

## Reliable sensor improves productivity

For our customer the METTLER TOLEDO system and subsequent control of the  $\text{SO}_3$  feed means  $\text{H}_2\text{SO}_4$  concentration can now be maintained within the desired range. Sulfuric acid that is either too weak or too strong is no longer produced, reducing waste of  $\text{SO}_3$  and increasing the plant's productivity. The success of this application has led to the installation of other systems at additional units in the plant.

► [www.mt.com/InPro7250](http://www.mt.com/InPro7250)



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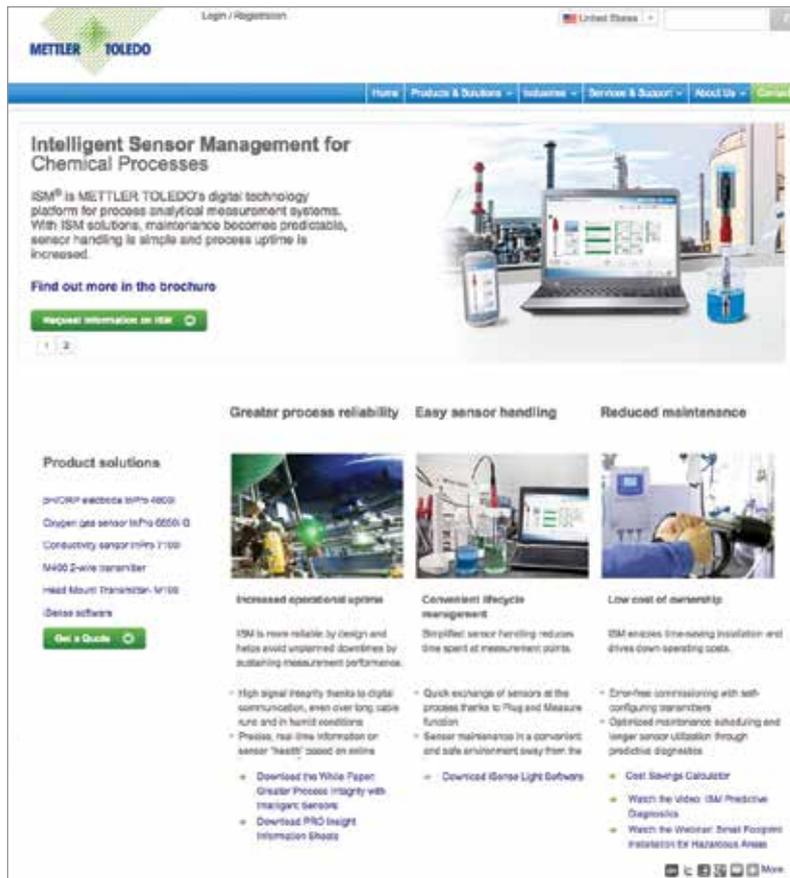
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