Real-Time Measurement for Unparalleled Safety and Control

Analyzer solutions to reduce process downtime, ensure safe operation, and optimize production efficiency in refinery operations.
Crude oil is processed into useful fuel such as gasoline, petroleum naphtha, diesel fuel, lubricants, asphalt base, heating oil and kerosene at petroleum refineries all over the world. The conversion of crude oil into useful end products requires many processes, such as hydrocracking, hydrotreating, distillation, and sulfur recovery, just to name a few. Refinery operators need to ensure safe operation while maximizing process efficiency to optimize final product quantity and quality. AMETEK Process Instruments supports refinery operators with these goals through our robust line of process analyzers.
Oxygen (O2) control is needed for the combustion process. The unburned carbons in the form of carbon monoxide (CO) represent an explosion hazard which is both a safety concern and an indication of inefficient combustion. A well-controlled combustion process will also improve environmental control by reducing nitrogen oxide (NOx) emissions. Reliable identification of low-combustion O2 in a fired heater or boiler is critical to the effectiveness of the Burner Management System, for proper control and safety.

Continuous Catalytic Regeneration (CCR) is part of the catalytic reforming process in a refinery where hydrogen and naphtha feed are reacted to create desired end products. The catalyst used in the reaction is continuously flowing through the reactors and then regenerated. The efficiency of the regeneration process impacts the yield and quality of the end products.

Key considerations:
- Optimize combustion efficiency and minimize emissions
- Dynamically adjust quantity of air required for combustion to minimize excess air losses
- Minimize combustible losses and prevent occurrence of an explosive atmosphere

Key considerations:
- Maximize catalyst life by minimizing thermal damage to catalyst
- Optimize operation of CCR for production and quality of final product

PRODUCT SOLUTIONS

WDG-V, WDG-VC and WDG-VCM
The WDG-V combustion analyzer has been designed to provide an additional layer of safety with the measurement of excess O2, combustibles, and methane (CH4) and by using these measurements to ensure the safe operation of the Burner Management System.

AMEVision display unit for WDG-V
AMEVision displays up to eight units, provides and communicates trend data, maintenance and troubleshooting information via Modbus or Ethernet LAN.

AMETEK ADVANTAGE
- Real-time combustion control
- Certified SIL safety control
- Easy to operate
- Low cost of ownership
- Worldwide service

PRODUCT SOLUTIONS

WDG-IV UOP/RP
The WDG-IV UOP/RP was designed in conjunction with UOP CCR process requirements for meeting the purpose of low level O2 measurement during the regeneration cycle in which coke deposits are removed from the catalyst by oxidation. The WDG UOP/RP analyzer has a specially treated zirconium oxide cell which is used to survive the destructive effects of halogen-oxidation.

The sensor uses a nitrogen-operated aspirator to draw a sample of gas from the catalyst regenerator. A portion of this gas passes over the zirconia sensor. Because the aspirator gas contains no O2, the sample can simply be returned to the process.

AMETEK ADVANTAGE
- Real-time control to extend the life of the catalyst
- Easy to integrate into a process control loop
- Dual safety valves for servicing

PRODUCT SOLUTIONS

Find the right solution for your refinery application
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Catalytic reforming is a chemical process used to convert petroleum refinery heavy naphthas, having relatively low octane value, into high-octane liquid products called reformates. The catalyst used in the reforming process can be inactivated by hydrogen sulfide (H₂S), so it is important to measure H₂S concentrations and reduce catalyst replacement expenses. Water (H₂O) must also be measured, to reduce the formation of acids that can cause corrosion and damage to catalytic reformer units.

**PRODUCT SOLUTIONS**

5100HD (single or dual laser)
For over a decade, and at installations around the globe, the AMETEK 5100HD TDLAS analyzer has provided continuous and accurate measurement of components of interest to refinery operation teams. Using sealed reference cells for continuous on-line analyzer verification, the 5100HD offers low maintenance, high specificity, sensitivity and fast-response speeds in many refinery applications. The 5100HD may be configured to include multiple lasers and cells in an oven which can be run at temperatures up to 150°C (302°F), to simultaneously measure multiple components in one stream, or independently analyze one component in two different streams.

**AMETEK ADVANTAGE**
- AMETEK 5100HD utilizes TDLAS that responds to concentration changes in seconds versus minutes
- Laser line lock verification system ensures the 5100HD is measuring the wavelengths of interest
- Uptime is maximized, as the sample being analyzed never contacts the laser source or measurement sensor

Key considerations:
- Fast measurements of H₂O and H₂S, to minimize potential damage to equipment or catalyst
- Accurate measurement of the components of interest, that are typically present at ppm levels
- Maximum uptime of the measurement system
- Remote access to measurement system data and operational status

**PRODUCT SOLUTIONS**

FlarePro
The FlarePro provides fast and accurate BTU content measurements, even when confronted with widely changing flare gas streams. Field testing has shown that the FlarePro mass spectrometer provides more detailed and relevant data faster than gas chromatography.

**AMETEK ADVANTAGE**
- Real-time British Thermal Unit (BTU) analysis allows for rapid adjustment and control of the flare
- Ambient air monitor of BTEX
- Single analyzer monitors multiple measurement points

Key considerations:
- No carrier gas or column to changes
- Real-time analysis
- Dynamic range from parts per million (ppm) to % level
- Measure hydrogen content
- No electrochemical cells to replace

**PRODUCT SOLUTIONS**

Promaxion mass spectrometer
Traditional Gas Chromatographic (GC) needs carrier gas and replacement of columns. The Promaxion does not require carrier gas or columns and results are in real-time (seconds) rather than the five to 15 minutes that a GC will take.

**Promaxion, integrated in a shelter with a sub-ambient pump and flowmeters, for measurement of C₆H₆ in ambient air.**

**AMETEK ADVANTAGE**
- AMETEK Promaxion mass spectrometer provides more detailed and relevant data faster than gas chromatography
- No carrier gas or column changes
- Real-time analysis
- Dynamic range from parts per million (ppm) to % level
- Measure hydrogen content
- No electrochemical cells to replace (ambient air)
Catalytic reforming

Proper moisture balance in feedstocks and hydrogen recycle streams must be maintained to optimize product yield and catalyst life. Measurement reliability is greatly complicated by the presence of compressor oils and high boiling point hydrocarbons in the stream. The reformer process typically requires accurate and rapid results despite variations in moisture content from 10 to 25 parts per million (ppm).

APPLICATIONS

Moisture in olefins

Ethylene (C2H4) polymerization catalysts are extremely sensitive to trace (H2O). H2O decreases catalyst activity and may turn the catalyst black, leading to discoloration of the virgin polymer. Accurate, reliable, and rapid sub-1 ppm moisture analysis is required.

PRODUCT SOLUTIONS

5000

The 5000’s accuracy, reliability, and fast response are not affected by normal reformer contaminants such as compressor oils and high boiling point hydrocarbons. The on-board moisture generator verifies measurement accuracy for optimum product yield. Readings are absolute and provable, not just trends.

5100HD

Based on tunable diode laser absorption spectroscopy (TDLAS), the 5100HD TDLAS analyzer can continuously and accurately measure ppm moisture concentrations in catalytic reformer feed streams. TDLAS analyzer measurements are not impacted by contaminants like heavy hydrocarbons or oils, as the wavelength of interest is highly selective to water (H2O). If the dual laser option is selected, the 5100HD can also measure ppm levels of hydrogen sulfide (H2S) in the reformer feed gas.

AMETEK ADVANTAGE

- Online verification of the analyzer eliminates downtime due to calibration
- Fast response to both wet-up and dry-down changes in the moisture content
- Excellent accuracy at low moisture concentrations

Key considerations:

- Ability to quickly detect upsets at low moisture concentrations
- Capability to rapidly respond to dry down condition following a process correction
- Low maintenance and calibration costs
- Low lower detectable limit

PRODUCT SOLUTIONS

5000

The 5000’s quartz-crystal sensor does not promote unsaturated hydrocarbon polymerization, a common problem with electrolytic moisture sensors. Exceptional response speed and precision in the sub-1 ppm moisture range ensures consistently high product quality. The on-board moisture generator verifies measurement accuracy.

3050-DO

The 3050-DO is good for applications that require very low moisture content (0.02 to 100 ppm). Accurate sub-ppm level moisture can be achieved using the 3050 moisture analyzer. The online National Institute of Standards and Technology (NIST) traceable moisture generator provides verification capability and, if needed, calibration.

5100HD

Based on tunable diode laser absorption spectroscopy (TDLAS), the 5100HD TDLAS analyzer can continuously and accurately measure ppm moisture concentrations in catalytic reformer feed streams. TDLAS analyzer measurements are not impacted by contaminants like heavy hydrocarbons or oils, as the wavelength of interest is highly selective to water (H2O). If the dual laser option is selected, the 5100HD can also measure ppm levels of hydrogen sulfide (H2S) in the reformer feed gas.

MEASURES: H2O

Find the right solution for your refinery application
Moisture in natural gas

Natural gas is common feedstock for on-site production of hydrogen using steam methane (CH₄) reformers and for production of ethylene. Natural gas is also a common fuel used for process heaters within various refinery process units. Fast responding, accurate moisture readings are required to ensure the quality of the natural gas meets the process specifications.

APPLICATIONS

PRODUCT SOLUTIONS

3050-OLV

The 3050-OLV has online verification and a permeation tube that allows for verification and calibration of the analyzer. The 3050-OLV is desirable when accurate low ppm values are required.

AMEVision display unit for 3050 series

AMEVision displays up to eight units, provides trend data, maintenance and troubleshooting information, and communicates via serial, Modbus, 4-20 mA, or Ethernet LAN. A verification or calibration can be initiated remotely as well.

5100HD

Moisture in natural gas stream concentration levels can be analyzed from ppm to percent. The measurement of moisture is not impacted by any amines, glycol, methanol, hydrogen sulfide (H₂S) and/or methyl mercaptans present in the natural gas stream. To reduce maintenance requirements, each 5100HD includes a sealed reference cell to enable the ability to line-lock the laser, and an integrated sample conditioning system that removes any particulates or liquids.

AMETKE ADVANTAGE

- Multiple sensor technologies ensures the proper performance fit for your application
- Proven QCM moisture analyzers deliver verified performance at low moisture concentrations
- TDLAS-based analyzers feature integral laser line-lock verification, delivering accurate measurements

5100HD

Oxygen (O₂) measurement is typically carried out in the process line where the oil/water headspace is suctioned to one of two thermal oxidizers or flares. When O₂ level exceeds the safe limit of operation, a nitrogen purge of the tank headspace is initiated to keep O₂ at safe levels. By measuring the O₂ concentration in the headspace, nitrogen consumption can be optimized to keep the operating costs low while ensuring safe plant operation.

Key considerations:

- Fast analysis of O₂ to immediately alert operations of a potential safety risk
- Accurate analysis of O₂, that is free of interference from the volatile components and water that may be present in the headspace
- Analyzer must comply with area safety requirements
- Minimal maintenance – keep workers out of the field

AMETEK ADVANTAGE

- The 5100HD TDLAS responds to concentration changes in seconds versus minutes
- Integral laser line-lock verification system ensures the 5100HD is measuring the wavelengths (and components) of interest
- The 5100HD is certified for use in many hazardous locations, including those regulated by ATEX, CSA, IECEx, NEC and other agencies
- Using an Ethernet connection, the web-browser based software provides remote data and maintenance access

PRODUCT SOLUTIONS

MEASURES: O₂, H₂O

Find the right solution for your refinery application
EPA regulation 40 CFR Part 60, sub part J, paragraph 60.105 requires the measurement of post-combustion hydrogen sulfide (H₂S) in refinery fuel gas as a measure of the sulfur dioxide released to atmosphere in the combustion process. The 5100HD tunable diode laser absorption spectroscopy (TDLAS) analyzer directly measures the H₂S concentration over the typical full-scale range of 0 to 300 parts per million (ppm). For process upset or flaring events, the 5100HD can also be configured with a second sample cell to measure sample streams that can contain up to 100% H₂S.

**Key considerations:**
- High reliability due to long life cycle of solid state lasers
- High specificity for H₂S as an analyte
- 5100HD TDLAS analyzers are suited to refinery process conditions
- Significant savings using a TDLAS analyzer over a Process Gas Chromatograph (PGC) for refinery fuel gas applications

**AMETEK ADVANTAGE**
- Field-proven on subpart J(a) H₂S in flare gas applications (0 to 300 ppm)
- On-line verification (H₂S reference cell) assures accurate results at low concentrations
- Direct measurement of H₂S, no scrubber, no consumables
- Low maintenance: No carrier or hydrogen flame detector gases, no columns, no dilution, no switching
- Suitable for an ambient temperature range of -20 to 50°C (-4 to +122°F)

**PRODUCT SOLUTIONS**

**5100HD**
The 5100HD TDLAS uses a direct measurement technique, providing continuous H₂S measurement quickly and accurately. Other “laser analyzer” manufacturers use scrubbing techniques to establish a zero background, that not only interrupts measurements for up to 20 minutes per hour, but also fails to address the fact that refinery fuel and flare gas hydrocarbon concentrations are frequently changing. To ensure the 5100HD continues to measure accurately, a sealed reference cell is integrated and a line-lock verification is constantly used. If required, the laser module can be changed in the field in less than one hour. Products from other TDLAS manufacturers must be returned to the factory for this type of repair.

**CABINETS, SHELTERS & HOUSES**

**AMETEK ADVANTAGE**
- Proven track record in design and manufacture of sample systems and analyzer shelters
- In-house project engineering expertise from design to manufacture to factory acceptance testing
- Full after-sales support for installation and commissioning

To ensure accurate and reliable process measurements, a representative sample of the process fluid must be delivered to the analyzer. A well-designed sample conditioning system will consider filtration, temperature, pressure, flowrate and environmental conditions. Installations may require a full analyzer shelter including analyzers, sample systems, calibration gases, HVAC controls, and power distribution.
1. ACID FEED GAS

**MEASURES:** H\textsubscript{2}S, Total HC, CO\textsubscript{2}, H\textsubscript{2}O, NH\textsubscript{3}

Sulfur recovery feed gas analysis has been widely applied using a variety of analytical techniques and combination of discrete analyzers to quantify the key components. What is required is a real-time (< 5-seconds) analysis of the important combustion components (ammonia (NH\textsubscript{3}), hydrocarbons and other optional organic compounds specific to the Claus reaction furnace chemistry). Hydrocarbons are typically present in low concentrations, but are fast moving and have a significant combustion air requirement. Hydrogen sulfide (H\textsubscript{2}S) is the major component and is normally slow moving in terms of compositional change. NH\textsubscript{3} is present in sour water stripper gas and has to be accounted for if present. Carbon dioxide (CO\textsubscript{2}) is a relative minor contributor to air demand but can easily be included in the matrix analysis.

**IPS-4**

In order to quantify all of these components a combination of ultraviolet (UV) and near-infrared (NIR) measurements are required. The AMETEK IPS-4 Dual Range Analyzer provides these capabilities in a single analyzer.

2. START-UP OXYGEN

**MEASURES:** O\textsubscript{2}, CO\textsubscript{2}

During start-up and shut-down, any time a Sulfur Recovery Unit (SRU) transitions from ambient temperature through fuel gas warm-up to the introduction of acid gas, measurement of oxygen (O\textsubscript{2}) stoichiometry is critical. Historically, operators have manually taken samples using a portable electrochemical-type O\textsubscript{2} analyzer. While giving more or less satisfactory results, the requirement for more stringent operating limits, hazard exposure and the non-continuous nature are reasons to consider a permanent solution. A fixed system that draws a continuous sample during the operational transition period, without intervention from operations or analyzer maintenance, can be rationalized. Paramagnetic analyzers have also been used to make this measurement but the technology is relatively fragile and the analyzers fail frequently. In contrast, tunable diode laser absorption spectroscopy lifetimes are typically in excess of ten years and there are no sensitive elements of the analyzer in contact with sample, a particular advantage in this application.

**S100HD**

End users that also want to measure carbon monoxide during start-up can do so when a second analytical bench is added to a S100HD. Continuous NH\textsubscript{3} measurement is also possible with the S100HD, after the reactor furnace or first condenser.

3. SULFUR PIT/TANK GAS

**MEASURES:** H\textsubscript{2}S, SO\textsubscript{2}

In many sulfur recovery units, produced sulfur is stored in liquid form in sulfur pits. Operators are increasingly aware that sulfur pits present potential danger to plant personnel and overall plant safety. It is therefore critically important to monitor H\textsubscript{2}S in the vapor space of sulfur pits to ensure that it remains below the Lower Explosive Limit (LEL) (4.3% by volume). Additionally, the presence of rising concentrations of sulfur dioxide (SO\textsubscript{2}) in the sulfur pit vapor space provides an early indication of smoldering fires. Therefore, on-line, continuous monitoring of SO\textsubscript{2} can enable detection of such fires before they get out of control.

**888 Sulfur Pit**

Measures H\textsubscript{2}S in the vapor space above the sulfur pit at the measurement point, eliminating the need for expensive sample lines or environmentally controlled shelters. Substantial cost savings are recognized, while the safety critical measurement of H\textsubscript{2}S is performed continuously and accurately. SO\textsubscript{2} is simultaneously analyzed in the 0-1% concentration range, for customers requiring this measurement.

**930 H\textsubscript{2}S**

Field-proven as one of the industry’s most reliable instruments for monitoring H\textsubscript{2}S and SO\textsubscript{2}, where a remote mounted analyzer is desired, the 930 uses AMETEK proprietary high-resolution NDUV technology in a dual beam, multiple wavelength configuration. Resolution better than 0.02 nm is provided by high intensity, line source lamps.

The unit samples the vapor space gas using proven ASR Probe technology. The sampling system has a sulfur knockout at the probe to eliminate entry of excess sulfur vapor or liquid into the system. The sample is then transported through an electrically traced sample line.

Find the right solution for your refinery application
4. TAIL GAS

**MEASURES: H₂S, SO₂, COS, CS₂**

The primary online analytical measurement in the Claus sulfur recovery processes is hydrogen sulfide (H₂S)/sulfur dioxide (SO₂) in the tail gas for ‘trim air control’ of the air to acid gas ratio. AMETEK has an installed base of over 2,000 active tail gas analyzers based on two distinct types. The close-coupled (no sample line) 888 mounts directly on the pipe and does not require a climate-controlled shelter. The 900 ADA, an extractive (sample line) type for installation in an analyzer house should be used in extreme climates or if the sample point location is compromised due to piping design.

**888**

The successor of the 880-NSL uses field-proven and highly reliable UV technology to accurately monitor the H₂S and SO₂ concentrations in sulfur recovery tail gas without expensive sample lines or an environmentally controlled shelter. This compact, rugged analyzer mounts directly on the process pipe, eliminating the complexity and safety issues of fiber optic coupled photometers.

**900 ADA**

The Tail Gas-Air Demand Analyzer was designed to meet these demanding analytical requirements when the customer desires a remote-mounted analyzer. Used in conjunction with the Advanced Sulfur Reduction 900 sampling probe and heated transfer lines, the 900 ensures maximum data availability for optimum operation of the sulfur recovery process.

5. TGTU REACTOR OUTLET

**MEASURES: SO₂, H₂**

The analyzer requirements are to measure residual hydrogen (H₂) at the outlet of the reduction reactor as well as the SO₂ at the inlet of the quench tower. The H₂ measurement is to maintain excess H₂ after the reduction reactor, typically 2 to 4%, which ensures complete reduction of SO₂ to H₂S. Insufficient H₂ causes SO₂ breakthrough to the amine solvent which will react to form heat-stable salts and degrade the amine. The 931/932 analyzers are used to measure SO₂ and H₂ after the reduction reactor.

**931**

Uses AMETEK’s proprietary high-resolution UV technology in a dual-beam, dual-wavelength configuration and no-moving-parts design. Instead of using a filter/chopper wheel to alternate between measure and reference wavelengths, the 931 uses a fixed optical configuration and pulsed ultraviolet (UV) lamps. This design leads to increased light throughput, reduced noise levels, and reduced maintenance. The dual-beam configuration, combined with the reference measurement, ensures low noise performance with minimal baseline and span drift.

**932**

Uses AMETEK’s proprietary high-resolution UV technology in a dual-beam design and incorporates a filter wheel that allows the measurement of up to five components.

6. TGTU ABSORBER INLET

**MEASURES: H₂S, H₂**

After cooling and quenching the off-gas from the reduction reactor, the H₂S is selectively absorbed from the tail gas by means of an amine solvent. The 931/932 analyzers are used to measure H₂ and H₂S at the inlet to the absorber.

**931**

Uses AMETEK’s proprietary high-resolution UV technology in a dual-beam, dual-wavelength configuration and no-moving-parts design. Instead of using a filter/chopper wheel to alternate between measure and reference wavelengths, the 931 uses a fixed optical configuration and pulsed UV lamps.

**934**

A rugged analyzer adapted from the 931/932 UV analyzer platform for measurement of H₂ in Tail Gas Treatment Unit applications where the UV H₂S measurement is not required.
The off-gas from the top of the absorber column contains residual hydrogen (H₂), hydrogen sulfide (H₂S) and traces of carbonyl sulfide (COS)/carbon disulfide (CS₂). Quantifying these components ensures the process is operating efficiently. The 931 and 932 analyzers can make these measurements on a continuous basis.

931
Uses AMETEK’s proprietary high-resolution ultraviolet (UV) technology in a dual-beam, dual-wavelength configuration and no-moving-parts design. Instead of using a filter/chopper wheel to alternate between measure and reference wavelengths, the 931 uses a fixed optical configuration and pulsed UV lamps. This design leads to increased light throughput, reduced noise levels, and reduced maintenance. The dual-beam configuration, combined with the reference measurement, ensures low noise performance with minimal baseline and span drift.

932
Similar to the 931 mentioned previously, the 932 uses AMETEK’s proprietary high-resolution UV technology in a dual-beam design and incorporates a filter wheel that allows the measurement of COS and CS₂ in addition to the H₂S. Up to five components can be simultaneously measured with the 932, providing valuable information to users focused on safety, operational excellence and environmental responsibility.

9900RM
Rack Mount dry gas SO₂ (SO₂/NOx) analyzer. Capable of single-digit direct measurement of SO₂ and up to 200:1 dual-range capability. Wall mount option available.

919, 920, 909 & 910
Hot-wet analysis of SO₂ (SO₂/NOx) for Mass Emission measurement or high-water high-acid-dew-point-samples. The 909 (single gas) and 910 (multiple gases) are specifically configured for monitoring stack emissions on a mass rate basis. They measure stack effluent temperature and velocity in addition to pollutant concentration at stack conditions, enabling mass emission rates to be reported. With the addition of an optional zirconium oxide sensor, each analyzer is capable of monitoring oxygen. The 919 (single gas) and 920 (multiple gases) do not include flow measurement.

914
The Continuous Emission Monitor (CEM) uses dry extractive sampling techniques designed to meet government regulations for all types of compliance monitoring.
AMETEK Process Instruments delivers worldwide sales and service support through a network of direct and factory-trained global distribution channels.

AMETEK Service Assistance Program plans offer coverage up to 24 hours a day, 365 days of the year.

As worldwide experts in the manufacture of process analyzers and instrumentation, we have supplied solutions to industry since 1962, providing the widest range of analysis technology available.

Through process application consulting, we create custom-designed solutions that meet the needs of your specific application or process.