Turning waste into green energy

Panametrics
a Baker Hughes business

This renewable natural gas e-book contains a series of application notes based on optimizing and upgrading biogas to biomethane.

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1. Multi-stream analysis in biomethane

Benefits:

The advantages of using the Panametrics thermoparamagnetic and thermal conductivity sensors are:

- Continuous measurement of all streams
- Can be calibrated in minutes
- The rugged design means many years of service
- Global hazardous-area certifications for all devices

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Summary

Biogas is increasingly seen as a more renewable source of natural gas for injection into gas networks for home heating, cooking and fuel.

Application

The gas entering the network must have a high calorific value, and therefore be scrubbed of contaminants such as CO_2, O_2 and H_2S.

Challenge

Oxygen concentration is measured in the gas generated by the decomposition of waste. Methane is a flammable gas, and its flammable limits in air are 5% to 15%. In order to transport biogas safely through pipelines, it is necessary to ensure that the oxygen content is less than 2%. The hydrogen sulfide must be scrubbed by carbon filters from the gas before entering the networks and needs to be <10 ppm.

Carbon dioxide is measured as it is separated from biomethane and the methane purity of the cleaned biogas needs to be measured before entry into the gas grid.

All of the measurements need to take place in hazardous-area environments.

Solution

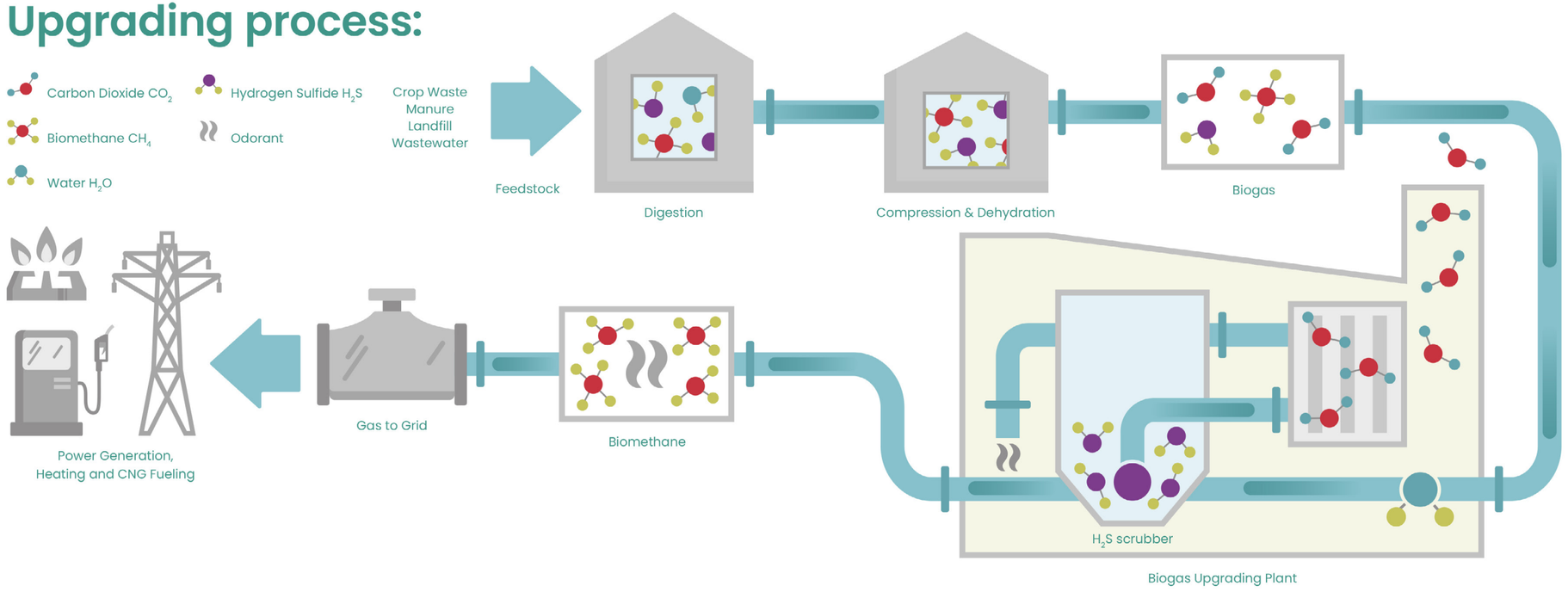
The Panametrics XMO2 transmitter utilizes thermoparamagnetic technology to measure the oxygen level and the Panametrics XMTC transmitter uses thermal conductivity technology to measure the carbon dioxide and methane. The H_2S is measured using fuel cell technology. These are all incorporated into a single sample-system solution that regulates the pressure and flowrates of the gas streams ensuring accurate measurement of;

- Oxygen and hydrogen sulfide in the cleaned biogas stream
- Methane content in the CO_2 off-gas
- CO_2 impurities in the methane stream
- Methane purity

Specifications

- Oxygen content range: 0 – 2%
- Carbon dioxide content range: 90 – 100% against methane background
- Methane content range: 90 – 100% against CO_2 background
- Hydrogen sulfide: 0 – 10 ppm
- Operating temperature: -5 °C (23 °F) to 50 °C (122 °F)
- Operating pressure: Regulated to 14.7 psia (101.3 kPa)

Upgrading process:



2. Biogas flow measurement

Benefits:

- Actual flow rate
- Real-time calculations of normal gas flow rate
- Help to accurate reporting

Summary

A small city in Scandinavia was using flowmeters to report to the environmental authorities how much gas they were using and venting.

The city was using mechanical meters with a local totalizer and no output. Every morning they had to send an employee to look at the totalizer from the two meters and calculate the actual difference from inlet gas and the burned gas to assess their plant performance and amount of gas flared.

Application

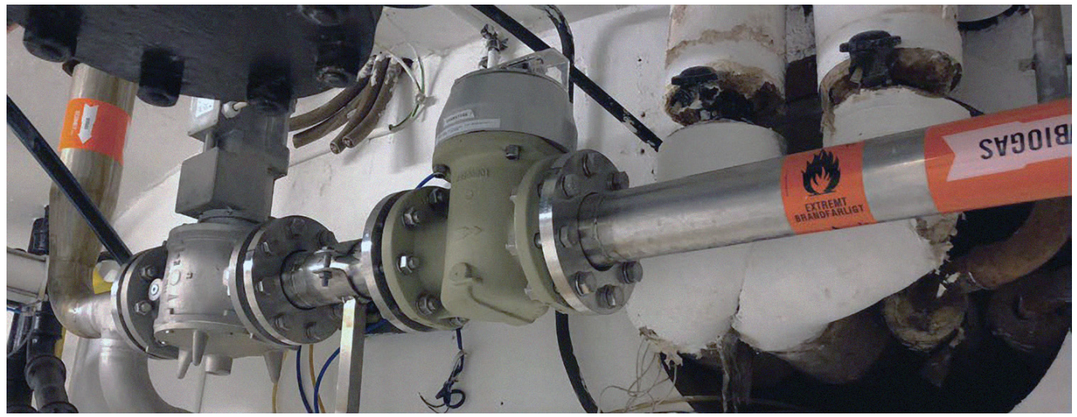
- Medium: Biogas
  - Pipe: 2" (DN50)
  - Temperature: ambient
  - Accuracy requirement: ±2% of reading

Challenge

This biogas was somewhat "dirty" and "wet" and the municipality was questioning the meters' totalizers. They were looking for a more reliable solution, with outputs showing actual flow as well. When the company erected another biogas plant, they were keen to find the most suitable solution.

Solution

Across both plants, the customer opted for the Panametrics PanaFlow Z1G DN50 ultrasonic flow meter. The package we supplied included pressure and temperature sensors to read normalized flow. After several months of operation, the customer confirmed the meters were working to their satisfaction.



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3. Oxygen content in wastewater digester

Specifications:

Range	0-100% O_2 in N_2/CO_2
Temperature	Ambient
Pressure	Atmospheric
Enclosure	Weatherproof (Stainless steel optional)

Benefits:

- Years of reliable service
- No moving parts
- Non-depleting sensor
- Turnkey analyzer + sampling system

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Summary

In wastewater treatment, aerobic digestion enables plants to increase their capacity by injecting oxygen into the wastewater head space. This results in up to a five time-increase in the treatment capacity.

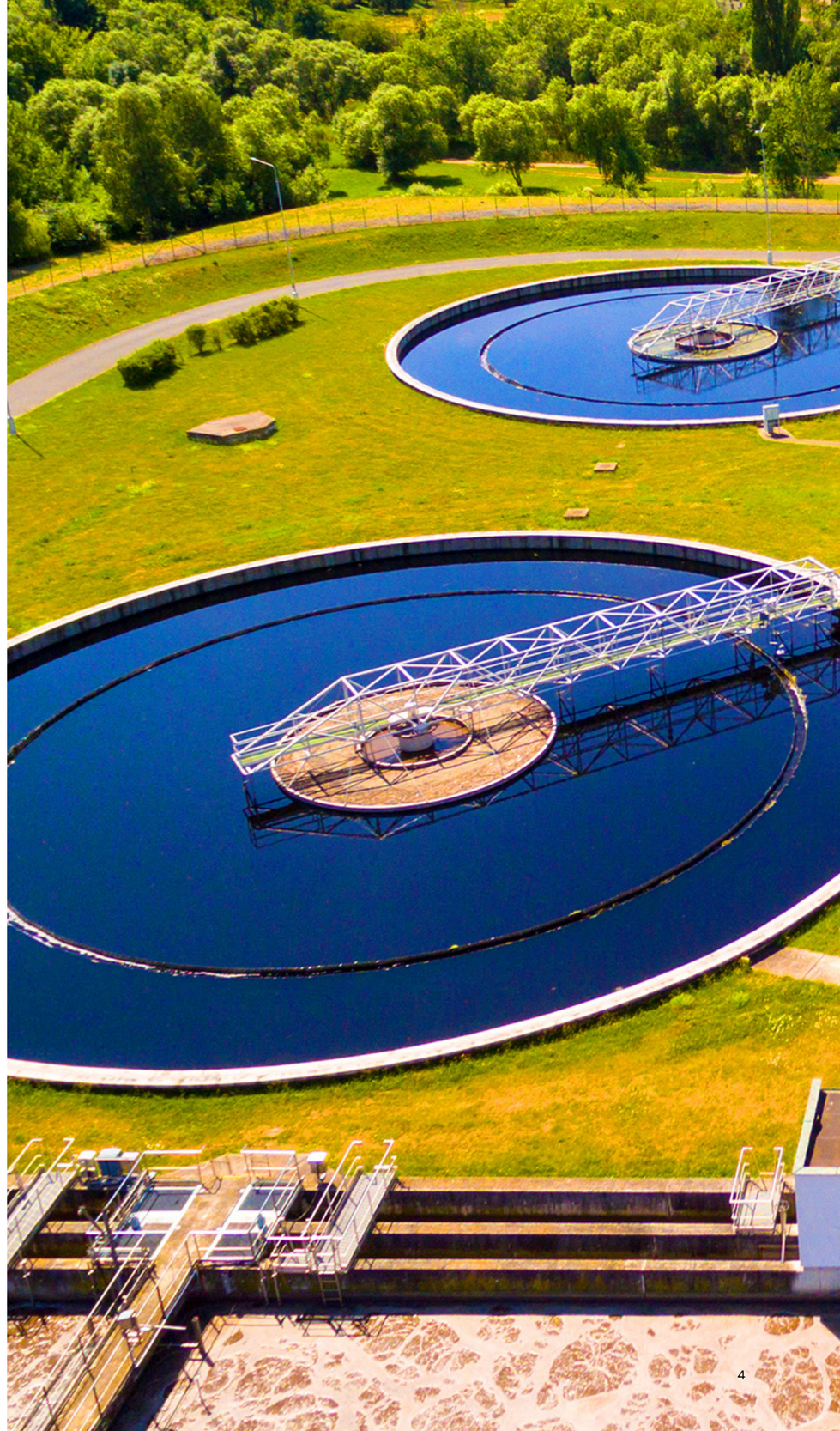
Application

Oxygen concentration is critical to the treatment process. If the oxygen concentration is too high, it is an indication that the active population of microorganisms has died off and needs to be replenished. If the oxygen concentration is too low, the oxygen flow rate must be increased.

The process involves a four-stage reaction chamber. Pure oxygen is injected in the head above the liquid wastewater. Microorganisms in the water digest the waste, while consuming oxygen and producing CO_2 (carbon dioxide). The oxygen level in the fourth stage is measured by the Panametrics XMO2 thermoparamagnetic oxygen transmitter. The transmitter is used control the flow of oxygen and wastewater on demand to enable optimal digestion.

Solution

The process requires monitoring of the oxygen content, to ensure proper wastewater treatment and the survival of microorganisms that decompose the waste. Oxygen concentration indicates process efficiency. The Panametrics XMO2 is ideal for this application. It is installed in a turnkey sample-conditioning system and provides an output to the plant's data acquisition and control system. The XMO2 is reliable and time proven. It has no moving parts, and its cost effectiveness makes it the oxygen transmitter of choice.



4. Biogas flow measurement from wastewater

Benefits:

- Accurate and reliable measurement
- Ability to measure at very low pressure
- Absence of pressure drop

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Summary

Stockholm Vatten (Stockholm Water Company) produces biogas from their wastewater facility, which feeds Scandinavian Biogas for energy production. Because they need to accurately meter what they sell to the energy facility, they used a project contractor firm to engineer and define the best solution for the project.

Application

Biogas comes from the digester. It is a mixture of methane and carbon dioxide and is handled at very low pressure and ambient temperature.

Biogas: CH4 58% to 70% + CO2: 42% to 30%, traces of N2 and H2S < 500ppm

Flowrate: 400 to 5,000 Nm3/h

Pressure: from 15 mbarg to 30 mbarg (0.22 psig to 0.44 psig)

Temperature: 0°C to 37°C (32°F to 99°F)

Pipe: DN300 (12") PN10 EN 1.4404 (SS316).

Challenge

Due to the technical challenges, ultrasonic technology was selected. To get accurate readings, they needed to find a compromise between meter velocity and pressure drop. Our partner's technical advice was taken into consideration, and they went with a DN300 line (12").

Solution

Panametrics supplied our gas flow meter with our T5 transducers mounted on a flowcell with air calibration. That's a set up that has good records for low pressure application like what we see on flare lines.

With this in place, **Stockholm Vatten** (Stockholm Water Company) can now accurately bill Scandinavian Biogas and maximize the energy transfer, thanks to the absence of pressure drop.

5. Carbon dioxide and methane ratio in biomethane separation

Application specifications:

- Application: 0% – 21% O_2 in N_2 (typically less than 2% O_2)
- Temperature: 800°C – 900°C
- Pressure; Atmospheric

Benefits:

- Robust measurement with no moving parts in the XMO2 analyzer
- Single-solution offering, including sample handling system
- Easy calibration of the XMO2 unit
- Reduced maintenance costs compared to other dumbbell-type paramagnetic sensors susceptible to liquid/ particulate carry over

Summary

Active carbon has many uses including decolorizing sugar, solvent recovery, waste treatment, SO_2 removal in stack gases or clean rooms and in water or air purification systems.

It is characterized by high absorptivity for many gases, vapors, and colloidal solids. Activated carbon is charcoal that has been treated with oxygen to open up the pores in the material and heated to 800°C - 900°C with steam or carbon dioxide. The resultant material has a highly porous structure with 1 pound (450g) of activated carbon containing approximately 100 acres of surface area. It is within this porous material that contaminants are captured.

Application

Oxygen is measured in the hot gas before and after the carbon reactivation reactor. This measurement is vital for both safety and product-yield considerations.

Activated carbon is an extremely dusty and flammable material. When exposed to high heat and in the presence of oxygen it is likely to explode. To mitigate the explosion risk, oxygen levels are maintained below 2% and the content is continuously monitored.

The presence of excess oxygen reacts with the carbon to form carbon monoxide and carbon dioxide, which can lead to a reduction in yield. This can have a significant impact on the lifespan of the carbon as it is depleted in the chemical process.

Challenge

The application is especially challenging given the considerable amounts of water vapor, HCl, H_2S and SO_2 impurities. The extremely dusty and flammable material can pose a risk to an accurate measurement and the analyzer itself if an appropriate sampling system solution is not used.

Solution

The robust Panametrics XMO2 thermoparamagnetic oxygen analyzer, along with a suitably designed sample handling system, provides the complete package solution. This offers the customer an oxygen measurement at a competitive price point.

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6. Moisture measurement in biomethane dehydration

Application specifications:

- Multiple moisture measurement technologies
- Systems designed to meet your technical requirements
- Complete turnkey systems: just connect power, gas sample, and output signal
- Laser-based analyzers eliminate need for regular maintenance and calibration

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Summary

Natural gas is distributed through a network of pipelines and stored in tanks, underground caverns and spent oil wells. The presence of excess moisture in natural gas results in liquid water condensing or ice forming in cold climates or when gas is decompressed due to the Joule-Thomson cooling effect. Excess moisture combined with high pressure leads to the formation of solid hydrates. Ice and/or hydrate formation can restrict or even block the flow of natural gas in the pipeline. In addition, the moisture content of the gas can adversely affect the heating value (BTU), thus lowering the quality and value of the product. Water also combines with acid gases such as carbon dioxide and hydrogen sulfide and accelerates corrosion. In order to meet gas-quality requirements and protect the pipeline and storage infrastructure, the moisture content must be continuously monitored.

Application

The distribution of natural gas must comply to specifications for the maximum moisture concentration referred to as the tariff. In the United Sates the tariff is 7 lbs H2O/MMSCF natural gas (pounds water per million standard cubic feet natural gas) and in Europe the maximum recommended level is -8°C dew point at 70 Bar(a). Other countries and localities have similar specifications for the maximum amount of water in natural gas. Suppliers that exceed the maximum levels may be shut in for non-compliance. A shut-in results in a loss of revenue for gas suppliers.

Challenge

Early detection of an increase in the moisture content allows the operator to quickly respond to prevent catastrophic blockages in the pipeline, leaks due to corrosion, or loss of revenue due to a shut-in at a custody transfer point. Most gas distribution and compression facilities have fewer operation and maintenance personnel and face higher reliance on automated data acquisition and control systems. This means that the instruments must be low maintenance and have the reliability to operate unattended 24 hours a day. Today, Big Data collection is showing benefits by using intelligent processing to implement control, corrective action, and to predict maintenance.

Solution

Installing Panametrics' time-proven aluminum oxide trace moisture sensor offers great value. HygroPro transmitters offer a local display and a 4-20mA signal for lbs/MMSCF, dew point temperature, or ppmv (parts per million by volume). For natural gas applications, the HygroPro is installed in a sample system designed to filter contaminants, regulate pressure, and indicate flow while giving the added option to control temperature.

The moisture.IQ is a multifunction, multichannel analyzer that connects to six AlOx trace moisture probes, six oxygen sensors, and 12 analog inputs. The analyzer, which is programmed via a color touch screen or remotely via ethernet (TCP/IP), provides digital and analog outputs and is equipped with an internal data logger. The moisture.IQ has a built-in intrinsic safety scheme enabling connection to sensors in hazardous areas. These instruments are ideal for facilities with multiple measurement points or where redundant measurement is required. The wall-mounted 19" rack is weatherproof and in an explosion-proof enclosure.

The PM880 is an intrinsically safe analyzer that is ideal for spot checking and data logging. The portable battery-operated analyzer can be used to verify the moisture content at various locations in pipeline infrastructure.

The Aurora TDLAS (Tunable Diode Laser Absorption Spectrometer) moisture analyzer provides definitive moisture measurement by using a fully non-contact measurement-sensing technology. Because there is no need for field calibration or sending sensors out for recalibration, the Aurora provides significant long-term savings. The analyzer uses the fastest-responding trace moisture measurement technology and therefore quickly alerts personnel to process upsets and confirmation of dry gas. The Aurora provides a local display, 4-20mA signals, RS232/485, and Ethernet with MODBUS. The Aurora TransPort is a battery-operated portable analyzer in a high-impact case which is perfect for spot checking and anywhere portable and fast-responding measurements are a priority.

Application specifications

- USA: 0 - 25 lbs H2O/MMSCF natural gas (0 - 525 ppmv) with alarm at 7 lbs
- Europe: -40 to 0 °C frost point at 70 Bar(a) with alarm at -8 °C frost point
- Options for display of moisture in lbs H2O/MMSCF, dew point temperature or ppmv
- Analog outputs
- Local display
- Optional weather-proof and heated enclosures
- Optional sample conditioning systems
- Certification for hazardous-area operation: Explosion proof and intrinsically safe

7. Measuring oxygen in landfill gas

Benefits:

- Rugged weather proof design
- Explosion proof
- No moving parts
- Recovers from entrained liquids

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Summary

The oxygen concentration in landfill gases is critical for safety. As landfill gases are vented and/or extracted for processing and use, air can be pulled in from the ambient. By monitoring the oxygen content, you can ensure that the gas remains below the lower explosive limit.

Application

Organic waste in landfills decomposes to generate methane and carbon dioxide. It is necessary to ensure that the oxygen concentration is less than 2%. Landfills are divided into several zones, and a series of vent holes are fitted with perforated pipe that are bored into the ground. Each zone can be monitored independently. When a large volume of gas is collected underground, the gas is forced to the surface by displacing the gas with water. The gas collected from the vents is compressed and used as a fuel source. When the gas from a certain zone is temporarily depleted, the extraction is rotated to the next zone. If a leak develops in the vents or in the control piping, or due to ingress of oxygen into the compressor itself, and oxygen exceeds the flammable limit, a dangerous situation exists. Oxygen analyzers applied to this measurement are typically explosion proof or intrinsically safe.

Application specifications

- Oxygen concentration: <2%
- Explosion proof
- Outdoor installation

Challenge

Safety is the paramount requirement. The maintenance and calibration of process instruments comes at a premium. Panametrics XMO2 does not use a depleting sensor and is easily field-calibrated and can be installed with autocalibration using the XDP display. This results in a rugged and reliable solution. The XMO2 has all necessary explosion-proof certifications for continuous oxygen measurement at the landfill facility.

The solution

To assure safe operation, two XMO2 thermoparamagnetic oxygen transmitters are used: one upstream of the compressor and one downstream. The analog output from each transmitter is sent to the customer's SCADA system. The SCADA is configured with interlocking relays to provide an alarm and a shut down of the compressor if the oxygen concentration exceeds the safety limit.

The XMO2 is ideal for this application:

- Non-depleting sensor
- Does not fail low, as with other technologies
- Rugged sensor with no moving parts, as with dumbbell-type paramagnetic oxygen sensor
- Explosion-proof certification and weather proof enclosure

Contact us

A Panametrics expert is ready to listen to your case, or visit panametrics.com.

Panametrics, a Baker Hughes business, provides solutions in the toughest applications and environments for moisture, oxygen, liquid and gas flow measurement.

Experts in flare management, Panametrics technology also reduces flare emissions and optimizes performance.

With a reach that extends across the globe, Panametrics' critical measurement solutions and flare emissions management are enabling customers to drive efficiency and achieve carbon reduction targets across critical industries including: Oil & Gas; Energy; Healthcare; Water and Wastewater; Chemical Processing; Food & Beverage and many others.

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