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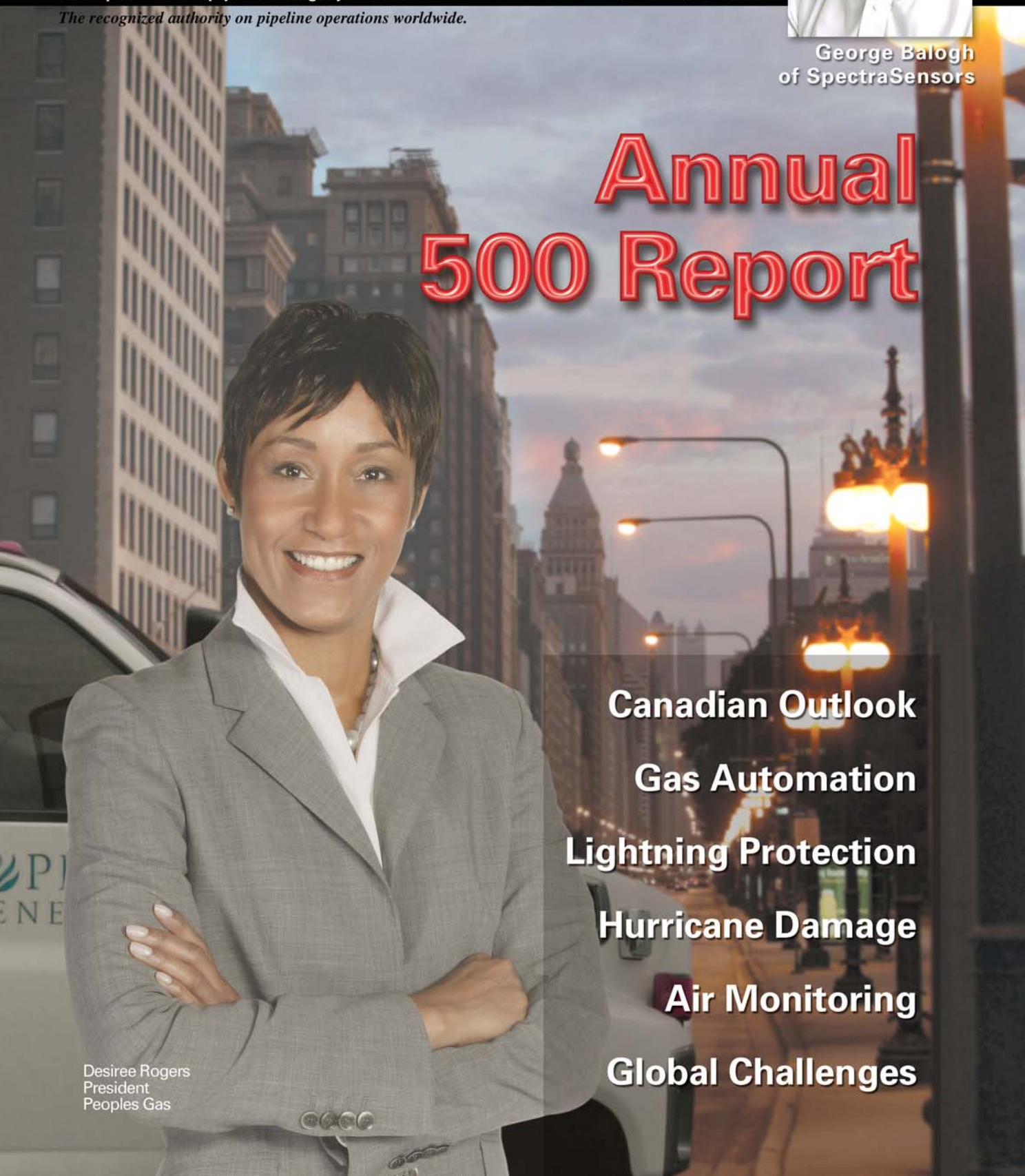
George Balogh
of SpectraSensors

Annual 500 Report



Desiree Rogers
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Canadian Outlook

Gas Automation

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Global Challenges

What Was Big As A Jeep, Became Smaller Than A Penny

Tiny Tunable Diode Laser Moisture And Carbon Dioxide Sensors For Pipeline Gas Are The Outcome Of An Exciting Story, And There Is More To Come

by **George Balogh,** CEO, **SpectraSensors, Inc.,** San Dimas, CA

It was a memorable day in January 2003. I had just joined SpectraSensors as CEO and Dr. Randy May — Vice President/Chief Technology Officer and co-founder — used a dramatic visual to put into perspective the development of the tunable diode laser (TDL).

"Imagine a gondola the size of a Jeep weighing about 2,800 pounds. We put a laser spectrometer inside that was cooled by liquid helium, suspended it from a high altitude balloon and launched it into the atmosphere to measure a number of stratospheric gases."

That is how Dr. May described the gondola containing one of the pioneering forerunners of the patented technology we use today for measuring water vapor and CO_2 in natural gas pipelines.

There is something for almost everyone in this story: Mars Lander Mission, WWII bomber, Ozone Hole discovery, Space Station death traps, U-2 spy plane, and Antarctic and North Pole expeditions. But after several meetings with Randy, I came away with a sense of awe and deep respect for American ingenuity and scientific teamwork that laid the foundation at the Caltech-managed NASA/Jet Propulsion Laboratory (JPL) for our company to spin off and commercialize what may be an historic milestone in pipeline safety. We are proud to continue that legacy in the pursuit of R&D innovation and product excellence.

This article is a distillation of main events rather than a strict historical chronology. There have been so many great people involved, from Randy's JPL colleagues to customers who recognized the opportunities and gave us our first break, that I decided to omit names rather than risk offending good friends.

The Early Years

The 1950s and 1960s had witnessed vigorous research activities in laser technologies accompanied by strident patent challenges among leading scientists. In 1964, Bell Labs introduced the first semiconductor lasers but they were very expensive, bulky, and required liquid helium cooling. However, the march toward a technological revolution in many industrial and consumer categories had begun.

In 1985 Dr. May joined JPL in Pasadena, CA and over the next 15 years co-led with Dr. Chris Webster, several major research tasks to develop diode lasers as gas sensors for atmospheric and planetary studies. He also managed a laboratory program to develop spectroscopic analysis techniques, frequency stabilization of lasers, and design of efficient algorithms for the manipulation and interpretation of molecular gas spectra. In the 1980s and '90s, Randy's 10-person group was recognized as the world leader in atmospheric research using high altitude aircraft and balloons.

Shoe Box Size

In 1986, Fujitsu miniaturized and introduced the first near-infrared diode laser that was cooled by liquid nitrogen dewar instead of liquid helium dewar, substantially reducing the overall size. In addition to more compact-sized instruments made possible by use of smaller dewars to hold the liquid cryogen, the availability of lasers operating in the 5-15 micron wavelength region in the mid infrared were ideal for measuring a wide range of atmospheric gases.

Unfortunately, because of high prices, demand was insufficient for Fujitsu to continue manufacturing and the product was dropped a year later. But Fujitsu had pointed the way. Although none of these early instruments measured water vapor, they did measure many other important gases, broadening the overall knowledge base which later benefited the evolving technology of measuring water vapor and CO_2.

During the same period, the Ozone Hole was discovered — an event that in the mid-1990s would drive ground-breaking research in diode laser spectrometers at JPL. Randy's group continued its aircraft and balloon experiments, taking them to Antarctica to conduct atmospheric research of the Ozone Hole followed by similar trips to the North Pole.

A miniaturized, self-contained diode laser system was needed that could provide both day and night-time measurements, but specific project funding was necessary to make it a reality. NASA did just that when it concluded that if the technology used in the balloon experiments was so advanced that laser spectrometers could be installed on airplanes, the Ozone Hole and other important atmospheric research could be more comprehensively studied.

50-Cent Piece Size

Then, in 1993-94, the David Sarnoff Research Center introduced substantially smaller room-temperature lasers offering different wave lengths for gas measurement. Although their lasers cost $7,000 each, Sarnoff had achieved an historic breakthrough.

Randy's group selected six Sarnoff diode lasers as an interim product development step and installed water vapor sensors on a NASA ER2 (Lockheed U-2 high altitude spy plane), a DC-8 jetliner, and a WB57 (a modified Martin bomber), all of which are still flying today and accurately measuring atmospheric water vapor.

NASA followed up with more funding in 1995-96 to develop the next generation of miniaturized diode laser sensors that could be space-qualified. But for the new technology to be effective, it would need real time software and easy-to-use operation, all contained in a small, robust package.

Another Mars mission was announced and Randy's group proposed the inclusion of two on-board diode laser gas measurement systems. Despite the high launch forces and extreme temperatures on Mars, they believed their past successes in harsh environments justified consideration of their systems. NASA agreed and both systems were included on the Mars 1998 Lander payload.

Work continued on water vapor measurement for aircraft and systems shrank in size.

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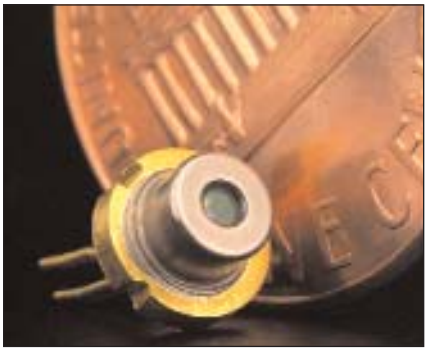
Smaller gas sensing packages became potential life savers, too, because during the same period, Randy's group developed an "advanced life sensor" intended to be worn on the chest of space station astronauts following a CO_2 poisoning event. The sensors would detect and sound an alarm in the presence of life-threatening pockets of CO_2 in crew quarters and research modules.



Typical diode laser package for sensing moisture or CO_2 in natural gas. Spectroscopy using tunable diode lasers (TDL) was developed at Caltech's Jet Propulsion Laboratory in the late 1970s. In 1999, SpectraSensors perfected and applied its proprietary TDL spectroscopy to industrial process and environmental monitoring applications.

Smaller Than A Penny

Typical SpectraSensors diode laser package for sensing water vapor or CO_2 in natural gas pipelines.

As the late '90s approached, laser-based spectrometers became even smaller and supporting software smarter. Thanks to the widespread use of diode lasers in telecommunications, CD players and bar code scanners, the cost of diode lasers plummeted, making it possible to offer affordably priced industrial process control systems. In 1998, with Caltech's and JPL's blessing, an Internet Web site announced the formation of SpectraSensors, Inc. co-founded by Randy May. Caltech became, and remains today, one of SpectraSensors' founding shareholders.

Increased Focus On Pipeline Safety

Several serious accidents in recent years prompted governmental regulatory agencies and others to seek the use of more advanced and reliable safety devices to protect the integrity of pipelines. As industry members know only too well, if natural gas is too wet, Btu content decreases as the danger of corrosion increases. Further, water vapor can combine with CO_2 to produce carbonic acid along with ice plugs in winter.

Some in the industry believed that laser-based sensors installed at critical pipeline sites could address the safety issues and possibly reduce maintenance costs because of the inherent stability of extractive, non-contact laser sensing. SpectraSensors built several prototypes and in the summer of 1999 demonstrated their accuracy and virtually calibration-free reliability. The first units were sold to El Paso Gas in the fall of 1999, followed by sales to Enron and BPM-Williams. U.S. patents were subsequently granted for tunable laser wave length and measurement method of sensing water vapor in natural gas.

In April 2003 an additional round of funding from investment bankers was achieved and the company moved its headquarters and manufacturing to its current location in San Dimas, CA.

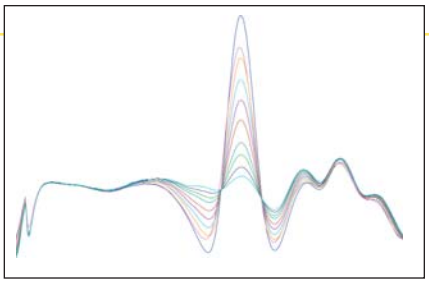
New Technologies, New Markets

As for the future, SpectraSensors will shortly introduce several new water vapor/CO_2 gas analyzers for the natural gas pipeline industry and next year will enter two exciting new fields.

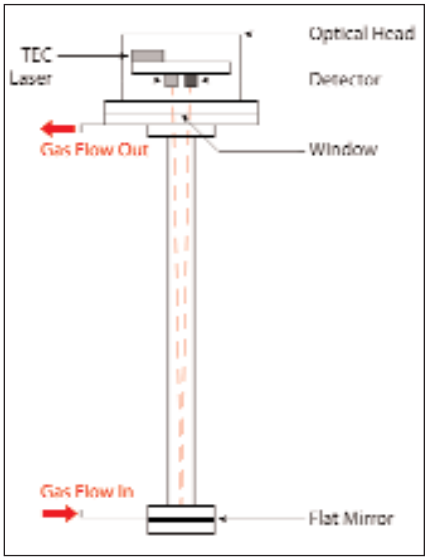
The company recently reached an exclusive worldwide agreement with a major university to develop and market an arsenic sensor based in part on its patented technology. Of special interest is helping third world nations as well as our own, to address this terrible carcinogen which pollutes many of our wells and public drinking water supplies.

Second, working with the National Weather Service, FAA, and Aircraft Communications Addressing and Reporting System, SpectraSensors will ship its new WVSS-II (Water Vapor Sensing System-II) to United Parcel Service. UPS Boeing 757 aircraft will measure water vapor at various altitudes while en route, contribute to real time weather forecasting models and help their aircraft maintain uninterrupted delivery schedules by avoiding dangerous upper level weather conditions. For more information www.spectrasensors.com. ***P&GJ***

Author: George Balogh *joined SpectraSensors in November 2002 as CEO. Balogh was Senior Vice President and founder of the Passive Telecom Group at Spectra-Physics. He has 23 years of management experience in optical components and instrumentation industries. He is a past president of the Lasers and Electro-Optics Manufacturers Association (LEOMA). Balogh holds a B.S. degree in industrial engineering from California Polytechnic State University and an MBA from Golden Gate University.*

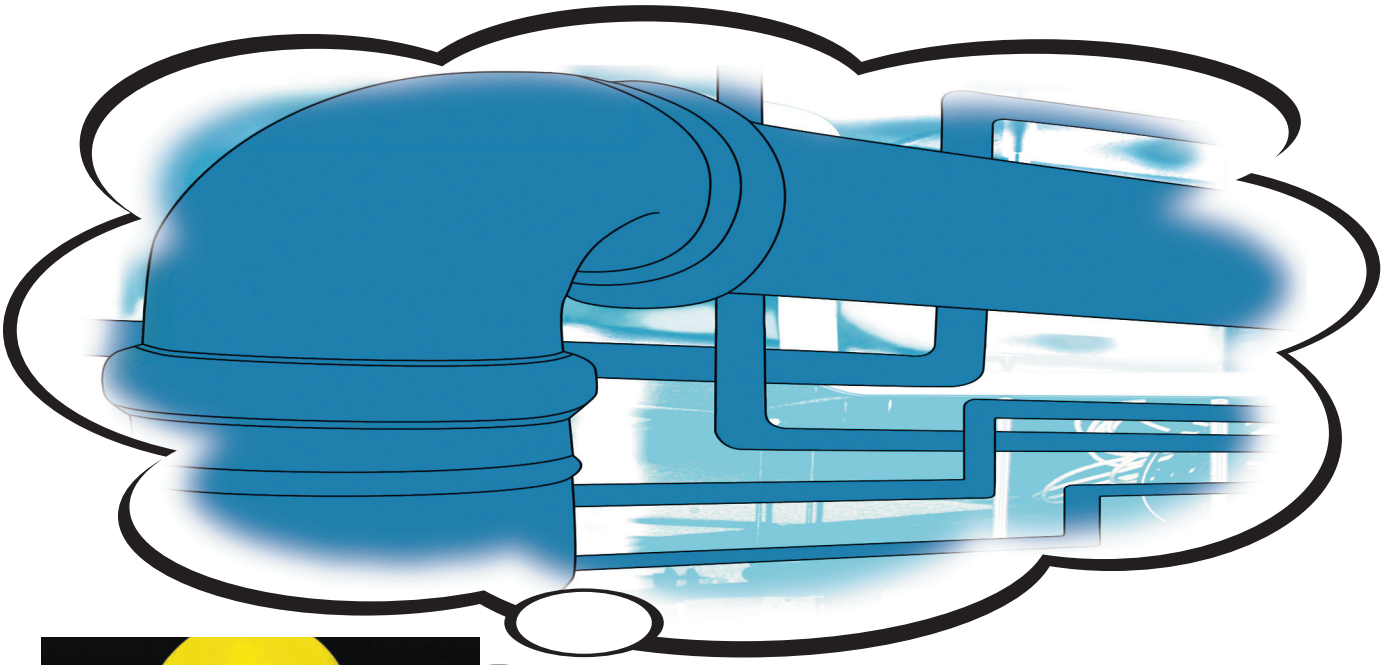


Water absorption spectra in natural gas. The graph shows several moisture spectra in natural gas. The higher the concentration of moisture or CO_2, the more absorption of light, and the stronger the corresponding absorption signal. Since the calculation is a direct, fundamental measurement, the amount of moisture or CO_2 present can be measured quickly and accurately. There are no wet-up or dry-down delays like those associated with surface-based capacitance sensors.



Schematic of laser sample cell. SS Series analyzers use robust, tunable diode lasers that emit near-infrared light at wavelengths absorbed by moisture or CO_2 in natural gas. As IR light passes through the gas sample, energy is absorbed, reducing the amount of light arriving at the solid state detector.

NO LONGER A PIPE DREAM...



...A MOISTURE SENSOR FOR EVERY TASK.

SpectraSensors has a high performance gas analyzer to handle just about any pipeline requirement. And there's more good news! Laser speed and accuracy are now more affordable than you thought. For example, choose from alternative ownership models in which we can price hardware and maintenance separately to fit your capital and maintenance budgets. It's an attractive value proposition when you consider the five-year actual cost of ownership (performance, reliability, maintenance and repairs, lack of consumables, virtually no calibrations, not to mention fewer shut-ins). Also, it's no fantasy when you add volume buying discounts and packaging flexibility to include all the attachments needed for a turnkey installation.

So dream no more! Call today and expect a pleasant awakening.

SS500

SS1000

SS2000

SS3000

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New Analyzer Makes Laser Speed And Accuracy Portable

By **Greg Hoffman,**
Director of Sales & Marketing,
SpectraSensors, San Dimas, CA

In the December 2004 issue of *Pipeline & Gas Journal* George Balogh, CEO of SpectraSensors, described the development of the NASA/JPL tunable diode laser (TDL) system for spectroscopic gas analysis and JPL's subsequent spin-off of the technology in 1999 to a new company, SpectraSensors, Inc. This high performance technology evolved over the span of 20 years and included successful operations in the harsh environments of high altitude aircraft flights in the earth's polar regions and planetary exploration missions on the surface of Mars.

Today, SpectraSensors markets its products and technology directly to end-use customers, both in branded and OEM versions. The company continues to expand its line of new laser-based process gas analyzers beyond the SS-2000 Single Channel and SS-3000 Dual Channel products.

Latest Instrument

There has been a third addition to the SpectraSensors line — a portable pipeline gas measuring instrument. Designated the SS-1000, the new analytical tool is compact and light weight, incorporating almost all of the benefits of permanent systems plus the added benefits of portability.

The SS-1000 utilizes the same patented and proven SS-2000 and SS-3000 technology. Designed for periodic and rapid sampling of water concentrations from individual wells, dehydration units or metering stations, the SS-1000 is intended to help optimize processing or flag tariff violations with laser speed and accuracy. For diagnostic purposes, the user can download captured spectra data via an RS232 into a laptop.

A single measurement takes five minutes or less-not an hour or more — and requires no wet-up or dry-down time as with other sensors. The built-in 12-volt sealed lead acid battery provides 12-hour operation on a single charge, making the new portable unit a useful resource for fast and efficient measurements.

Speed is desirable in a portable gas analyzer, especially if there are numerous locations and wells to spot check. One significant advantage is that unlike many competitive analyzers, the last reading of the day can be counted on to be as accurate as the first. In addition, glycol, methanol or amines do not affect measurement accuracy. The presence of these contaminants requires recalibration and stabilization to restore accuracy in alternative analyzers. On the other hand, SpectraSensors non-contact sensors are virtually immune to these contaminants. The result is savings in both time and money. Specifications and benefits include:

- Measuring 8-inches H x 7-inches W x 18-inches D, including handle and feet, the aluminum-enclosed unit is compact, lightweight and specifically designed for reliable laser speed and accuracy in heavy field use conditions.
- Weight: 15-lbs. (toolbox included).
- Response time: 1.0 second continuous updates (software adjustable).
- Sample flow rate: 0.21 to 21 scfh (100-10,000 scc/min).
- Glycol sensitivity: None for gas phase glycols.
- RS232 Output: Moisture concentration.
- LCD display: Moisture concentration, cell pressure and cell temperature.
- Because of its non-contact sensor, the SS-1000 was designed to maintain its accuracy for years while alternative gas-contact based sensors eventually fail or provide inaccurate measurements due to contamination, drift or corrosion.
- There is neither a need to buy multiple replacement sensors nor a requirement to return probes to the factory for recalibration.
- The instrument's durable powder-coated aluminum top cover resists inevitable scratches and scrapes from heavy field use.
- Delivered in a rugged toolbox with a weather-resistant tongue-in-groove cover, the SS-1000 nestles securely within its fitted foam interior, protected during transport in the field.
- The center balanced SS-1000 handle folds down to allow easy access to SpectraSensors' standard keypad that is used throughout the SS-Series product line.
- Operationally, the unit will run for 12 hours off its built-in battery or continuously from AC power. A battery charger is included.

SS-1000 Connections Include:

- Battery charger and A/C power connector.
- RS232 serial port for downloading spectra data to a notebook computer.
- Membrane separator filter for gas inlet mounted on the outside, making it easy to service; 1) 1/8-inch quick-connect fitting for inlet connection; 2) Bypass valve.
- Sample cell outlet has a 1/4-inch quick-connect fitting for venting gas to a safe location.

For more information on the new SS-1000 portable process gas analyzer, contact the author at 800 619-2861 X224 or ghoffman@spectrasensors.com.

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Executive Profile

Balogh Urges Engineers To Communicate Their Enthusiasm To Youngsters

By **Jeff Share/Editor**

George M Balogh, the genial chairman and CEO of SpectraSensors, Inc., San Dimas, CA, discussed his career and his company's technology for natural gas pipeline moisture content monitoring with *Pipeline & Gas Journal* recently. His enthusiasm for both his current post and his profession came through clearly during the visit. His call to engineers to get out into the schools and pass on the satisfaction and excitement of their profession is timely.

P&GJ: Was there a pivotal time in your life that influenced your career choice?

Balogh: Yes. I started working part-time jobs at 12 years of age and at 16 had my first factory job working a graveyard shift in Solon, Ohio. The factory manufactured boat trailer rollers and had a press that ran 24 hours a day. I was one of the two night-shift crew who drove a tow motor lift truck and fed the presses. Over time, I came to understand the organization of the factory floor and saw ways in which it might run more smoothly.

When I suggested new setups to management, to my surprise they accepted them. Remember, I was only an eager kid and my enthusiasm evolved into making changes on my own, then informing management as a fait accompli. They liked the initiative and encouraged me to continue. I didn't know it at the time, but I was doing industrial engineering. And even though it was not apparent, I really enjoyed problem solving on a conceptual level.

P&GJ: Who were your role models?

Balogh: First and foremost was my dad who taught by example and helped me develop a strong Midwest work ethic. One high school teacher in particular lit a fire about math and computers, but let's come back to that later.

P&GJ: How did you get started in business?

Balogh: With a BS degree in industrial engineering in hand from California Polytechnic State University, I interviewed at Crown Zellerbach and was hired to work with sales and manufacturing in the Southeast, marketing corrugated containers. It was like my teenage factory floor set ups because the issue was productivity; in other words, product cost vs. application and expediting the sales quotation process. I perfected a system in which a salesman completed a form the day before containing the customer's requirements. Using a Fortran code that I wrote, the prospect's data was keypunched on paper tape overnight. The following morning, the IBM 360 had computed the fabrication and printing costs that the salesman needed to quote and close the sale.

P&GJ: Did you continue your education and where did it take you?

Balogh: In my spare time, I earned an MBA in business and finance nights from Golden Gate University. The courses were terrific because the professors were all business leaders. The MBA opened doors to high technology companies and helped land a job in corporate finance at Varian Associates who gave me the opportunity to take on tough jobs needing solutions. My next position was in a turnaround situation at Spectra-Physics, a $100 million division of a publicly traded corporation that did a second IPO in 1997 and a merger in 2002.

During my 13 years at Spectra-Physics, I became senior vice president and founder of the Passive Telecom Group that was responsible for developing and executing the company's optical component and thin film product strategies. It was a dream job because it presented difficult challenges in bringing solutions to manufacturing, finance, and engineering issues. In addition to being able to hone my conceptual and technical skills, that broad experience planted the seed for branching out into the world of startup companies.

P&GJ: Provide us with a little history about SpectrasSensors.

Balogh: Frankly, it all started as technology in search of a business. A group from NASA/Caltech Jet Propulsion Laboratory (JPL) in Pasadena formed the company in 1999. Drawing on his extensive experience at JPL in developing advanced laser-based optical systems for atmospheric measurement, Randy May, founder and now chief technical officer, discovered that many components in the flow of natural gas interfere with accurate sensing and measuring. With the help of JPL, he developed the gas application using a tunable diode laser and software that operated on a wavelength specifically for natural gas.

P&GJ: When did you join the company?

Balogh: I started working with Randy in the summer of 2002 and joined the company in January 2003. After months of market research and sweat equity, we developed a business plan focused on energy, water quality, and atmospheric monitoring applications. The first product was purchased by El Paso Natural Gas which, with our product, pioneered optical laser-based moisture monitoring. It soon became clear that this application presented a huge opportunity because none of the existing in-line monitoring products worked as reliably as our non-contact laser system.

P&GJ: How did El Paso Natural Gas learn about SpectraSensors?

Balogh: As I said, our technology was in search of a business. Call it a stroke of luck or JPL's reputation, but this is what happened. In 1999, El Paso Natural Gas had a sampling hut in Bloomfield, N.M. where it had installed three different brands of moisture analyzers measuring discrete readings above and below tariff limits. One day in April 1999, a chem lab specialist, Charles Padilla, called Randy at JPL to ask if the TDL moisture analyzer he had heard about could monitor water vapor in natural gas.

After many trips by Randy to Bloomfield, the first SpectraSensors moisture analyzer was born and a few months later, with JPL and Caltech's blessing, the company officially started business as a technology spin-off. In fact, Caltech remains one of the company's founding shareholders. El Paso Natural Gas discovered that our unit could operate unattended 24 hours a day and reliably monitored their gas as part of a program to maintain tariff quality and resistance to corrosion within their pipeline infrastructure over a period of years, with no calibration requirements.

P&GJ: Where does SpectraSensors go from here?

Balogh: We just introduced a family of analyzers, including a portable unit, the SS1000, developed for gathering fields to identify wells that are contributing water vapor. The portable can also verify the accu-

racy of permanent installation units like the SS2000 in problem situations. Further, as imports and distribution of LNG grow, there will be an increased demand to address water vapor issues throughout the expanded infrastructure with higher performance systems. From our perspective, the easier and more turnkey our systems are to install and operate, the better. We are also adding new laser wavelengths for monitoring applications in petrochemical and industrial process plants.

P&GJ: Ultimately, how important is TDL technology to the pipeline industry?

Balogh: The National Transportation Safety Board has published a number of new rulings requiring active monitoring to help avoid gas pipeline corrosion, particularly in populated areas. We believe our SS-Series product line will grow in its contribution to overall pipeline safety. Our customers have run comparative tests between our analyzers and dew scopes and each test has proved the SS-Series to be as accurate, or more accurate than dew scopes. We strongly believe that our systems reliably comply with or exceed the standards established by the Bureau of Mines.

P&GJ:: Tell us about your family and personal interests.

Balogh: I am married and my kids are in their twenties finding their way in the world. My wife and I enjoy traveling through South America and exploring the southwestern U.S. When I am not at the San Dimas plant, I am usually at our Nevada desert home overlooking Las Vegas. I love automobiles of all kinds, admire collectors like Jay Leno, and enjoy motorcycling on the back roads of California, Nevada and Utah.

P&GJ: You mentioned earlier that you wanted to come back to the influence of a certain high school teacher?

Balogh: When I was a junior in high school, I took an advanced math class taught by an IBM professional who was granted a one-year leave to teach. He made math real and exciting and lit the fire I mentioned earlier. One day he showed up with what is now a primitive IBM 1620 computer. My classmates and I would spend hours learning how to apply mathematics to real world problems in ways that most high school teachers struggle with today. I entered undergraduate studies better prepared to pursue engineering; on my first job used Fortran to solve a productivity issue at Crown Zellerbach; and gladly tackled difficult and complex problems at Varian and Spectra-Physics applying math principles to sound financial strategies.

P&GJ: What would you advise young people who may be considering an engineering career?

Balogh: Young people should realize that engineers are a small percentage of the total work force and will always be in demand because of the few graduates entering the field annually. Demand for engineering solutions will increase, along with challenges and opportunities, as our society and economy grow. But I am troubled about the decline in undergraduate engineering enrollment.

Over the years, I have been involved in associations that promote high school career days and present engineering as a viable and exciting career. I urge your readers to get involved and emulate my high school teacher, whom I consider a hero, to create excitement in math and the sciences at their local schools. Remember, even if you reach just one kid and he or she goes on to lead a company, what can be more satisfying or more beneficial to society? ***P&GJ***

Measurement Analysis Field Test Leaves Operator In A Quandary

by **Paul Ellis**

When Sam Miller and Greg Hoffman left the SpectraSensors San Dimas (CA) factory, they had no idea that their moisture analyzer demonstration would upset the owner of the natural gas flow facility, jeopardize the business relationship between their field sales rep and the owner for other products, question the competency of two independent service techs, and involve three people from the owner's largest customer who could initiate an expensive shut-in.

The sales rep had arranged the demonstration to be part of the owner's regularly scheduled moisture measurement and report to the customer. Other than the hot Southern California sun, Miller and Hoffman expected the demo to follow an efficient routine, taking no more than five to six minutes: connect the regulator of the model SS2000 Analyzer with a pipefitting, cycle the unit, take a measurement, and summarize the benefits of a non-contact laser sensor.

Miller and Hoffman drove through a suburban neighborhood to a small walled-in concrete pad packed with regulators, membrane filters, flow meters, and odorizer. A chilled mirror scope measurement by the independent techs was nearing completion. Despite the close quarters, everyone was in good spirits, especially the owner who was pleased to hear the reading of between eight and 10 pounds, confirming an earlier measurement by his employees from the same tap.

The sales rep signaled Miller and Hoffman, who took about three minutes to connect the SS2000. Thirty seconds later, everyone leaned forward to see the LCD display, expecting a comparable 10 pounds or less moisture measurement.

The display registered 20 pounds — also representing the analyzer's top measurement limit.

Hoffman answered the look of alarm on the sales rep's face by requesting a time-out so that he could call the factory to review the situation with the vice president of engineering and ask a factory rep to pull an SS2000 out of inventory and drive it immediately to the site. Hoffman described the steps he and Miller had followed. They had downloaded the sample gas data into their laptop computer and had run a spectroscopic graph for error checking. The water peak on the graph's curve truncated at 20 pounds, indicating that the moisture content was higher than displayed. The V.P. replied that the data appeared normal and that the analyzer seemed to be operating properly.

The sales rep stepped into the conversation and suggested that the SS2000 may in fact be accurate. Miller asked that the group break for lunch because the second analyzer would arrive in about 45 minutes. The owner agreed and ordered another chilled mirror measurement with an admonition to be especially diligent. He also called for an awning to provide some welcome shade.

When the group returned, the techs had analyzed the multiple frost spots on the chilled mirror and said that it matched the morning's measurement of eight to 10 pounds.

The second SS2000 arrived, and before taking a moisture measurement, the factory tech connected a desiccant dryer in line with the analyzer and it instantly dropped to zero. Although it appeared that both machines had provided accurate moisture measurements, the group remained unconvinced that they were analyzing 20+ pound wet gas.

The owner persevered, ordering a stain tube measurement, commenting that even if the tube's known error was about 20%, he reasoned that if it agreed with one or the other measurements, it would roughly corroborate one or the other and resolve the issue. Two stain tube measurements were 60 and 80 pounds respectively, eliminating the 20% error as a deciding factor.

Hoffman suggested one additional step, recalling that the owner's gas company customer had purchased two SS2000 Analyzers factory-set to a higher upper limit. He recommended that the owner invite them to measure his gas with their instruments. The owner agreed and three gas company techs came to the site with two 90- pound top-end machines and a chilled mirror instrument.

The gas company's machines measured 50 pounds!

On the chance that even their machines may have given inaccurate measurements, they carefully installed the chilled mirror. After about 30 minutes, it revealed 48 pounds. The owner now faced the possibility of a shut-in and back flushing four miles of wet gas, plus expensive pipeline maintenance costs. He considered an additional measurement with an electrochemical sensor he had in his truck but decided that he had enough evidence.

What happened next is beyond the scope of this article. This example of a technology shootout under a hot Southern California sun is only one of many actual events as laser-based measurement technology replaces the half-century-old Bureau of Mines standard. According to SpectraSensors, even their customers find the transition difficult. Typical question: "Besides the display, how do I know the machine is working?"

Regarding the absence of consumables and rare calibration requirements, others comment with a little apprehension, "I never have to do anything to it." But once they understand the system, SpectraSensors says, most wonder why they had resisted the new technology.

It could be argued that a decision to change important measurement procedures requires trust. In the 1990s, JPL/NASA followed a rigorous decision path before choosing a predecessor of the SS2000 technology for the Mars Lander. Extensive research indicated that they could trust the laser-based system to withstand a 50-Gs rocket launch and the harsh environment of interplanetary space.

Similarly, following years of planning and product trials, the FAA recently certified, and the National Weather Service approved, another variant of the SS2000 technology that is now in service aboard United Parcel Service Boeing 757 aircraft. As the 757s crisscross the country at various altitudes, they measure atmospheric moisture and transmit real-time data every six seconds to a central weather forecasting facility. Now, UPS flights can avoid or go around dangerous weather patterns caused by volatile columns of rising moist air that until recently were a primary cause for delayed or canceled delivery service.

Given the natural gas industry's concern for pipeline safety, maintenance, and uninterrupted flow of tariff quality gas, the question is almost unavoidable. At what point does the chilled mirror standard give way to a faster, more accurate, and more reliable laser-based technology? ***P&GJ***

Note: The SpectraSensors players in this article were Sam Miller, P.E., Director of Marketing for Industrial Process Monitoring Products and Greg Hoffman, Director of Sales. Paul Ellis is a free lance writer who lives two miles from the Jet Propulsion Laboratory in La Canada, California.

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NASA-Based Technology Keeps Moisture Out Of Gas Pipelines

Special to **Pipeline & Gas Journal**

Reliable NASA-based gas analyzer technology is keeping producers aware of moisture content in their natural gas before it enters the El Paso Natural Gas Company (EPNG) pipeline, blocking formation of problematic carbolic acid and helping the producers avoid expensive shut-ins.

Tunable Diode Laser

Tunable diode laser (TDL)-based technology developed by NASA's Jet Propulsion Laboratory (JPL) now promises more accurate and dependable detection of contaminants — including moisture — in a natural gas analyzer that enables producers and pipeline operators to prevent "wet gas" from entering the pipeline system.

In the past, natural gas producers, processors and distributors have relied on direct-contact, surface-based electrochemical and crystal sensors for measurement of residual moisture or other contaminants in gas pipelines. However, that technologically old sensor technology has at times proven highly unreliable - producing false data that can result in unwarranted shut-ins or contaminated gas getting through pipelines.

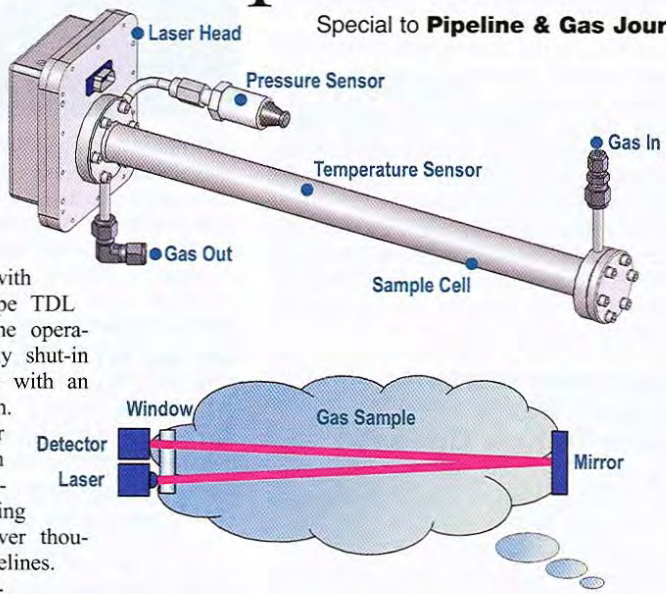
"If we were to shut-in a producer due to a false moisture reading, millions of cubic feet of gas could be delayed and possibly incur unnecessary dehydration costs," says Melvin Yancey, a field measurement technician at EPNG's San Juan District in the Four Corners area. "On the other hand, if the gas does not meet EPNG's criteria for quality, as required in our tariff, we would not take the gas and the gas may have to be vented."

To avoid those possibilities and meet quality standards of pipeline gas, EPNG has installed new TDL-based (also known as "laser-based") analyzers where each of its 16 major producers in the San Juan area joins the pipeline. Companies such as SpectraSensors, Inc. manufacture TDL-type analyzers. The California-based company is one of the leading developers and producers of optical-based sensors. It manufactures "bread box-size" sensors that provide non-contact measurement of moisture, carbon dioxide, and other corrosives and contaminants in natural gas pipelines.

Because pipeline operators have multiple producers flowing large volumes through a common point, they must immediately and accurately know the "point of concern" where unacceptable impurities such as moisture are entering the system in order to notify or shut-in only the input at fault. By providing real-time communications with producers who are unknowingly shipping over-spec (wet) gas, pipeline operators can provide significant savings and keep the pipeline full.

At the same time, with a SpectraSensors-type TDL analyzer, the pipeline operator can automatically shut-in individual producers with an over-spec gas problem. This allows the other producers to maintain their flow requirements while improving system reliability over thousands of miles of pipelines.

This advanced analyzer technology also saves on pipeline maintenance costs. By blocking the formation of carbolic acid (from water combining with the CO present in natural gas), resulting corrosion and erosion of pipeline is prevented, thereby saving substantially on associated maintenance expenditures.



Trustworthy and highly reliable, the high spectral purity of a laser-based analyzer enables the detection of specific gases - such as water, ammonia, and carbon dioxide in natural gas pipelines.

The ever-increasing use of TDL analyzers by the natural gas industry has consistently shown that they are fast, highly accurate and much more flexible than their electrochemical predecessors. They are also proving to be cost-effective as well. While initial purchase price is somewhat higher than surface-based sensors, even the most conservative evaluation of this advanced technology indicates that maintenance saving alone (e.g., calibration, replacement sensor heads, service labor) will also provide a return on investment in a relatively short period of time.

El Paso feels that pipeline operators and producers alike are in need of ongoing and accurate gas analysis. "If there were faulty or bad readings," says Yancey, "then the customer is going to dispute why I shut them in. Let's say a producer is piping 400 million cubic feet of gas. So, if I shut in that producer, the cost could be immense."

Readings Are Shared

So that each producer can monitor El Paso's gas analyzer readings, they are capturing the electronic signal from El Paso's unit via a SCADA system and viewing the readings at the producer's control room.

Considering the downside risk from moisture in the gas, and that TDL analyzers are monitoring the quality of gas worth tens of millions of dollars per day within this area of EPNG's transmission operations alone, it is reasonable to conclude that this laser-based sensor system could pay for itself in a brief period of time.

For example, transmission pipeline operators have frequently relied on electrochemical sensors as gas analyzers to monitor moisture. These sensors incorporate a coated surface and a higher electrical capacitance across the surface indicates higher water content. However, these capacitance sensors are susceptible to contamination by glycols or amines in the gas, which can cause exaggerated readings or a failure to detect. An erroneously high reading could force the operator to temporarily shut down the pipeline, costing the company tens or hundreds of thousands of dollars.

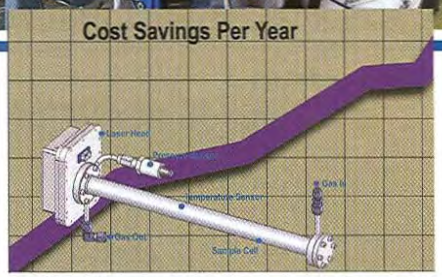
The gas producer may choose to over-process the gas to ensure that it is within the tariffs imposed by the pipeline operator. The TDL analyzer responds quickly and provides a reliable measurement that will not drift. It can be used in a closed loop to control the blending of dry and wet gas, allowing the producer or the pipeline to optimize costs by staying just within the tariff.

The high spectral purity of the TDL enables the detection of specific gases — such as water, ammonia, and carbon dioxide. Measurement intervals are as frequent as every two seconds, giving far more timely responses than the

several-minute (sometimes hours) readings of contaminant-vulnerable quartz crystal and electrochemical sensors. And those must be frequently cleaned and replaced.

Because a laser system never comes into contact with the contaminants present in natural gas — as do electrochemical and crystal gas sensors — the laser-based gas analyzer practically eliminates maintenance and operational costs. Studies have shown that the cost of operating and maintaining "conventional" electrochemical sensors continues to escalate annually, including labor, recalibration and rebuilding, back-up sensor heads as well as unnecessary gas dehydration and tariffs — all of which are obviated by the laser-based gas sensor.

It is not unusual for electrochemical sensors to carry with them cumulative annual expenses exceeding $50,000 per unit, most of which can be avoided through the use of a more dependable laser-based technology that provides more timely information and eliminates maintenance headaches. *P&GJ*



SpectraSensors natural gas sensors provide significant savings to companies who use them. Their NASA-based laser technology is fast, accurate, and reliable with extremely low maintenance cost.

Software Provides 3D CAD From Ordinary Photos

By **G. Walter Hill, Strategic Reach PR,** Denver, CO

When Shan Pehlman consults with oil refineries on replacing aging piping systems, he might get as-built drawings of the old infrastructure. Then again, he might not. Even if he does, he generally considers them poor counterfeits for the real-world fittings.

"Everyone knows as-built drawings are just an imperfect world," says the CDI Corporation design engineer. "With equipment that is 30 or 40 years old and the modifications thrown in, the drawings are not going to match what's there. Everyone involved realizes this is a major difficulty, so they hire an outside firm to take care of it."

To deal with the refitting of a stretch of 20-inch diameter piping system in a Corpus Christi refinery that rambled through the facility, up a four-story tower, through walls and between plant equipment, Pehlman first measures what's there. He says the real pipe differs from the original as-built plans because when it was installed it was likely altered to in-the-field contingencies to create a seamless fit of segments and obstacles.

Among the many possible methods of measurement, Pehlman chooses the quickest way to collect the data in the field and the most direct way to generate new 3D CAD models. His technique is to take ordinary photographs. From these, he is able to derive highly accurate measurements through a desktop software called PhotoModeler.

"There are other options," Pehlman said, "but PhotoModeler offers the most accurate way of conducting a survey. We can do it by hand with a measuring tape, but it is more difficult with large bore pipe inside a multi-story facility. We can use a laser survey machine, but that's not as accurate when there are a lot obstructions."

PhotoModeler, developed by Eos Systems, requires only a minimum of two photographs of an object from multiple angles in order to recreate the 3D dimensions in CAD. The method automates the old techniques of photogrammetry — measurement from photographs.

The technology has attracted many organizations specializing in industrial measurement and reverse engineering. The non-contact method has numerous advantages: It is not limited by the size or shape of the photographic subject and can measure sub-centimeter flows in manufacturing inspection and generate CAD for cathedral spires. The application also comports with most common CAD system formats, so the models integrate with other design work. Perhaps most importantly, the PhotoModeler solution does not require a substantial investment in measuring instruments — most people have a camera lying around.

Pehlman says PhotoModeler is also ideal for the industrial environment since large, sometimes hazardous, equipment can be documented at a safe distance. "I've used PhotoModeler in the past for industrial units as hot as 700 degrees, in congested areas and up a 200-foot tower, as in this case. A lot of companies will go straight to laser measurement and think it's an all-end solution to their needs. In essence, it's not. Photogrammetry often is much more economical and faster."

Precision CAD From Photos

After a camera captured every bolt, flange, miter cut, and curve on a 60-foot stretch of oil pipeline in the Corpus Christi refinery, Pehlman was ready to process the digital photos into 3D CAD.

He began by matching corresponding points on the images after uploading the photographs into PhotoModeler. Once enough matching control points had been established, the program adjusts the photographic scene into a 3D axis, accurately drawing the real-world parts into a CAD model.

The photogrammetric analysis uses the camera parameters to solve measurement units in the photographic scene. A special cylindrical shape feature in PhotoModeler allows Pehlman to outline the exterior lines of the bore and the program automatically extrapolates the 3D surface. A 3D voluble model of the configuration then exports to engineering CAD systems, ready for fabrication.

Ultimately, Pehlman's photo model proved accurate within one centimeter. PhotoModeler can provide tighter accuracy by increasing the number of photos and points matched in the project.

Because the new pipe is set in place with the help of a crane and a crew of workers, the lack of modifications and readjustments saves a great deal of costly downtime. *P&GJ*

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Drilling Fluids

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Jon Callen
President KIOGA
"The markets seem to be completely disconnected. There is a lot of anticipation built into the futures price that does not make sense in the physical markets."
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Industry Benefits From NASA's Ideas

By Brian Schaible
Special Correspondent

DENVER–Perhaps the most famous technology spin-off originally developed for the National Aeronautics and Space Administration is the no-stick material Teflon™ developed by DuPont, which is used in everything from frying pans to clothing. But space-age technology also is finding its way into the oil and gas industry to improve safety, efficiency, and environmental protection in very challenging environments.

It's hard to imagine a more forbidding and hazardous environment than the low-gravity vacuum of space. The difficulties encountered by astronauts performing structure assembly and repair operations prompted NASA to design Robonaut, a humanoid robot, to work side-by-side with the astronauts, or alone in conditions too hazardous for humans. NASA engineers equipped Robonaut with human-looking, dexterous hands, complete with five fingers to accomplish its tasks.

During the Robonaut development process, NASA soon discovered the need for an advanced sensor system to measure the movement and forces exerted by its forearms and hands. The agency awarded a research grant to Astro Technology Inc. (ATI) of Houston, which developed a sensor system based on fiber-optic technology that can measure the bending of the fingers, tactile forces at the fingertips, and tendon forces in the forearm. Astro Technology engineers miniaturized and strengthened the sensor system so it could be used not only for Robonaut, but for solid rocket motor testing and to evaluate fatigue on subsea pipelines and risers.

Strain Sensors

The industry is completing many undersea oil and gas wells in waters deeper than 7,500 feet. Production risers frequently are more than a mile long and are unsupported from the wellhead to the water surface. Water currents flowing past the pipeline create a vortex-induced vibration that ultimately can cause fatigue damage and possible pipeline failure. ATI is using fiber-optic sensors to provide real-time measurements and monitoring of strain, vibration, and fatigue of pipelines and in some cases drilling equipment. In one offshore project in the Gulf of Mexico, hundreds of sensors were placed along a 7,500-foot riser at 500-foot intervals. Connecting the sensors is a single cable that contains only 20 fiber-optic strands.

ATI President David Brower says the deepwater production risers form a big part of the demand for his company's sensors. Critical points for monitoring are near the sea surface and at the ocean floor.

"In the top zone, the riser is subject to vortex-induced vibration," he explains. "Then, in the touchdown zone, where the riser bends and meets the sea floor, you find extremely high stresses. These two areas are of most concern to the industry, so that is where we focus most of our attention."

With rising U.S. demand for natural gas has come an increased interest in, and demand for, liquefied natural gas. Most LNG is imported to the United States by ship and offloaded to pipelines that connect to onshore facilities. Brower says larger LNG transportation ships are being built that will require transportation pipelines to be extended into deeper water. ATI has developed fiber-optic sensor systems to help monitor critical pipeline operations.

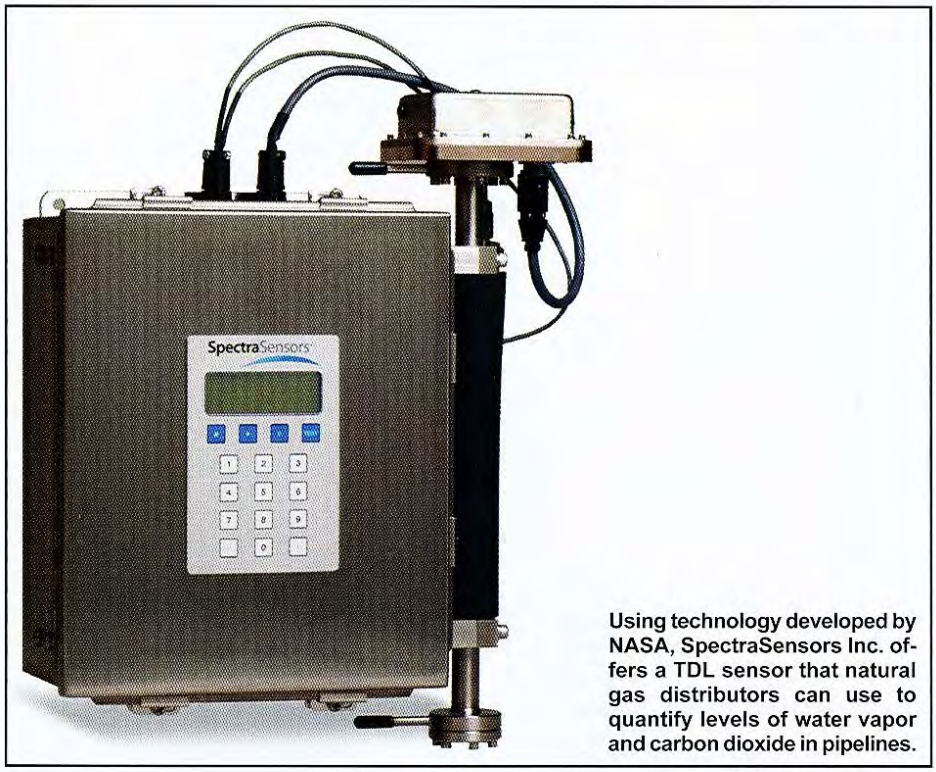
"We are working with the industry to monitor the pipeline temperature to ensure the insulation is working properly or to detect a leak, either of which could cause regasification in the pipeline," Brower says. "Parameters measured include strain, temperature, pressure, and heat flux along the entire length of the riser, which could be 10-15 kilometers long."

The entire length of the fiber-optic cable serves as the sensor in these applications, Brower observes.

"Using our system, we can identify the location of any leak within a few meters," he indicates. "We also will be using this technology on extremely long LNG pipelines in the North Sea and Barents Sea as they become available."

Brower says a third oil and gas application for ATI's fiber-optic sensors is to detect the buildup of hydrates in a pipeline. The company first identifies pipeline points that are particularly susceptible to hydrate buildup. Sensors would be deployed to measure temperature and pressure at these locations. Once a buildup has been detected, the sensors can trigger corrective action.

"If hydrate formation is detected, you could start corrective action right away–either activating a heating element or trig-



Using technology developed by NASA, SpectraSensors Inc. offers a TDL sensor that natural gas distributors can use to quantify levels of water vapor and carbon dioxide in pipelines.

gering the injection of inhibitors," Brower explains.

Laser Sensors

Another NASA sensor, the tunable diode laser (TDL), originally was built to measure the composition of the atmospheres of Earth and Mars. The technology was so promising that NASA's Jet Propulsion Laboratory spun off a separate company to commercialize use of the sensors for everything from aircraft safety and wafer fabrication in the semiconductor industry to pipeline monitoring.

In the oil and gas arena, SpectraSensors Inc. has developed a TDL sensor that is being used by natural gas distributors to quantify levels of water vapor and carbon dioxide in their pipelines. Sam Miller, SpectraSensors' director of marketing for energy products, says the measurement process is a form of spectroscopy.

"The sensor receives gas from a pipeline through a stainless steel tube," Miller explains. "A laser shoots through the gas stream, bounces off a mirror on the other side, and is reflected back to a detector. The electronics of the sensor then determine the amount of target gas or moisture by measuring the amount of light that is absorbed at a specific wavelength."

Miller says a small laser diode produces light at the narrow and specific wavelength of the target gas molecule. The light energy being absorbed at the target gas frequency then is compared to light energy at surrounding frequencies. The sensor continuously monitors parts per million of moisture and contaminant levels in the gas stream, making it possible for the pipeline or its suppliers to instantly change the gas composition or shut in the flow if problems arise.

"Companies route the sensor output to a computer that can sound an alarm when moisture content is too high, or can actually control the process by changing the gas blend or closing a valve," he says.

The constant monitoring is important because gas transporters usually have a moisture limit in the contract with a producer. If moisture levels exceed the limit, the flow is shut in. Companies also can change the mix of gas through dehydration processors to increase the amount of dry gas and ensure moisture levels stay below contract levels, Miller says. Monitoring moisture levels also is important from a safety standpoint, since water can combine with other chemicals in the pipes to cause corrosion.

Refineries and petrochemical companies also are using the TDL sensors to measure and control various elements in their process streams, according to Miller.

"Refineries can use sensors to measure moisture levels and contaminants in gas streams, feedstocks, and fuel gases," he relates. "The measurement also is important in determining gas composition of emissions to ensure they meet Environmental Protection Agency standards. Here they would be measuring levels of ammonia, hydrogen sulfide, or other contaminants."

Microbe Treatment

Encapsulation technology developed and used by NASA's Marshall Space Flight Center and the Jet Propulsion Laboratory is being put to use by Universal Remediation Inc. in a completely natural process designed to help naturally occurring microbes in soil or water degrade petroleum and other hydrocarbon products.

UniRem Vice President of Operations Gary Dalrymple says his company manufactures tiny hollow spheres of treated beeswax (PRP) that serve as nutrients. The spheres can be sprinkled on oil or other hydrocarbons by hand or mechanical spreader. When the beeswax spheres come in contact with a spilled hydrocarbon, they bind with the substance and stimulate microorganisms from the immediate environment to biodegrade the spilled hydrocarbon. He says over time the PRP will absorb and remediate more than 20 times its weight.

"The spheres range from five to 50 microns in diameter and are manufactured in layers like paper maché," he explains. "They are hollow and very absorbent. When you apply the PRP powder to oil, diesel fuel, benzene, or any other hydrocarbon, there is immediate absorption. The beeswax is basically a nutrient for the microbes. Put the two together, and the microbes create an enzyme which biodegrades hydrocarbons."

Originally, UniRem encapsulated hydrocarbon-munching microbes within the beeswax spheres. But the company soon found that each spill location had its own unique set of microbes that were well adapted to local conditions. Instead of trying to match local microbes, UniRem decided to leave the beeswax spheres hollow and use them to feed and encourage whatever microbes might be in a spill area.

Dalrymple says PRP powder also is used in absorbent pads, socks, rings, bio and well booms to biodegrade petroleum products as well. The combination is being used very effectively at refineries, gasoline stations, gas and electric vaults, and other locations where there is concern about

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Shell's Mars TLP platform is back in operation after sustaining heavy damage from Hurricane Katrina last August -- Page 7.

Shenzi gets $4.4B nod

Facility can handle 100,000 b/d oil, 50 mcf/d gas

Owners have approved the proposed $4.4 billion development of the Shenzi oil and gas field, located in the Gulf of Mexico's prolific Green Canyon area.

The Shenzi facility will have a design capacity to produce up to 100,000 barrels of oil and 50 million cubic feet of gas per day, Shenzi operator BHP Billiton said June 7, adding that first production is expected by mid-year 2009.

Australia's BHP holds a 44% stake in the field, with partners BP and Hess each holding a 28% interest in the project.

BHP said recoverable reserves in the portion of the field covered by current expenditures will be assessed further during development drilling, but are currently estimated to be 350-to 400 million barrels of oil equivalent. Additional potential reserves will be targeted for follow-up development, the company said.

Shenzi, located in roughly 4,300 feet of water, is about 120 miles from the Louisiana coast. The field consists of Green Canyon blocks 609, 610, 653 and 654.

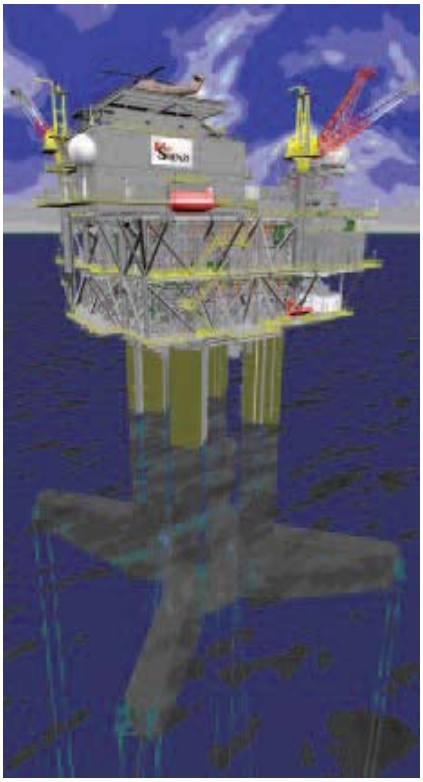
Initial field development will consist of seven producing wells, and the full field development is expected to have up to 15 producing wells and possible water injection, BHP said.

Total costs for the full field development through 2015 are estimated at $4.4 billion, with BHP's share amounting to $1.94 billion.

"This project further demonstrates our transition to becoming a significant operator and producer in the deepwater Gulf of Mexico," said J. Michael Yeager, BHP's group president of energy.

Shenzi joins the development of the Neptune field as a BHP-operated project, and together with BHP's interests in the Atlantis and Mad Dog fields, significantly expands the company's production base in the region.

A standalone, tension leg platform (TLP) was selected for the production facility. The proposed facilities, wells and completions are proven designs that have been successfully used in other deepwater Gulf of Mexico projects, BHP said, noting that all major contracts are in place to launch the project.



The seven initial pre-drilled sub-sea production wells will be tied back to the TLP. Shenzi oil will be exported via a new-build pipeline to Ship Shoal Block 332, with the gas going via a new-build lateral into a connection in the Cleopatra trunk lines, and then on to Ship Shoal 332, BHP said.

Rig orders climb as supply fizzles

Construction orders for new offshore drilling rigs are pouring into shipyards around the world as exploration and production companies scramble for what's left of a rapidly dwindling supply of rigs.

Industry analysts believe there could be 65 to 70 orders in for new jack-ups and around 25 to 30 orders for deepwater rigs, but the actual newbuild total is difficult to pin down and therefore largely a matter of speculation.

"Someone told me today that another deepwater floater was ordered. If that continues then at some point we're going to overbuild this cycle," Robert Long, chief executive officer of big offshore drilling contractor Transocean, warned in a May 24 presentation to the UBS Oil & Gas Conference in Austin, Texas.

In addition to known orders for newbuilds, 35 to 40 refurbished drilling rigs are expected to re-enter the market over the next few years. But right now the issue is rig availability.

"The main thing is finding a rig," Carl Thorne, chief executive officer of another large drilling company, Ensco International, said at the UBS conference.

He added: "We can talk all we want about operator preference. But when you have a shortage of equipment like we have today, the overriding concern is to find a rig that can drill within the timeframe of some of these people who need work done."

There's no question the world needs more offshore drilling rigs, especially in places like the Gulf of Mexico, where thousands of federal oil and gas leases are expected to expire over the next few years without ever seeing a drillbit.

However, there is a fine balance between supply and demand when it comes to rig markets. For sure, the drilling industry does not want to see a repeat of the 1980s when soaring oil prices collapsed, leaving drillers holding the bag with too many rigs and too few customers. It took industry years to recover from that miscalculation.

Once again, orders for new rigs are rapidly escalating with no

See **RIGS** page 8

COMPANY SPOTLIGHT

SpectraSensors, Inc.

NASA-based technology keeps moisture out of gas pipelines

Reliable NASA-based gas analyzer technology keeps producers aware of moisture content before entering El Paso Natural Gas Company pipeline, blocking formation of problematic carbolic acid and helping producers avoid expensive shut-ins.

The U.S. space program has produced an amazing number of advanced technologies, many of which are benefiting consumers, science and industry every day. Among those, NASA-sponsored research has developed sensors for environmental control that are now applicable to the natural gas industry. Tunable diode laser (TDL)-based technology developed by NASA's Jet Propulsion Laboratory (JPL) now promises highly accurate and dependable detection of contaminants – including moisture—in a natural gas analyzer that enables producers and pipeline operators to prevent "wet gas" from entering the pipeline system.

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For information contact: SpectraSensors, Inc., 972 N. Amelia Avenue, San Dimas, CA 91773; Phone (800) 619-2861 or visit the web site at www.spectrasensors.com

New, Laser-Based Natural Gas Moisture Analyzer Provides 'Maintenance-Free' Accuracy at Williston Basin Interstate Pipeline

Although somewhat more expensive than traditional sensors, new laser-based natural gas analyzer technology saves on operational costs to maintain and replace erratically performing probes.

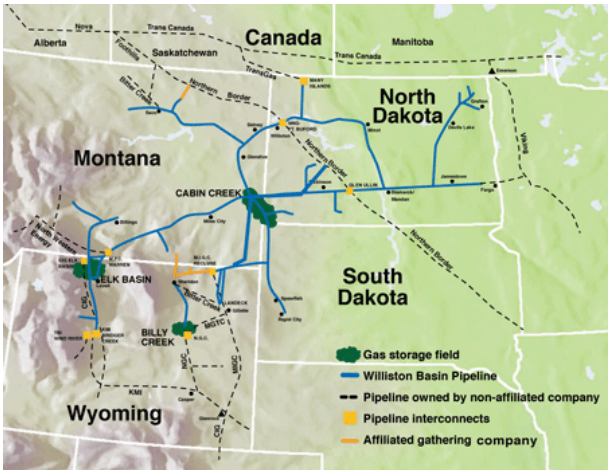
Looking at the new moisture analyzer technology, the gas measurement engineers at Williston Basin Interstate Pipeline (WBIP) could se e the potential savings in replacing their aluminum oxide probes with a new, laser-based type of moisture analyzer. "So, we ran the numbers, and it appeared that we could save on the costs of refurbishing or replacing probes, as well as the considerable labor on the part of field technicians," says measurement engineer Nate Hagerott.

For the first few months we compared the laser-based natural gas analyzer with the Bureau of Mines chilled mirror hygrometer WBIP provides natural gas transportation and underground storage to customers throughout the upper Midwest. As a subsidiary of MDU Resources Group, Inc., the company provides services to utilities, natural gas production companies, energy marketing firms and large industrial consumers.

Hagerott, who works at WBIP's Montana operations, says they purchased a SpectraSensors gas analyzer in 2005 to find out if the new technology could provide the consistent accuracy that would make it trustworthy in the field.

"For the first few months we compared the laser-based natural gas analyzer with the Bureau of Mines chilled mirror hygrometer," he says. "The readings were consistently within 1/10 pound. We have since found it unnecessary to compare it as often as we did at first, because we know that we can trust the readings."

Accurate and trustworthy performance is essential to a business whose flow of pipeline-quality gas depends on it. For this reason, engineers often wait for years to be sure that



Williston Basin Interstate Pipeline in North and South Dakota, Montana and Wyoming.

new natural gas sensor technologies have been debugged before even evaluating them.

But Hagerott saw a real need for the SpectraSensors technology, enough to easily justify the cost and evaluation effort.

"We install moisture analyzers downstream of processing, including dehydration," he explains. "When glycol carryover coats our natural gas sensor probes in addition to other contaminates, which happens over time, they tend to start giving erratic readings. Our field technicians know when that happens, so they have to replace the probe. The technician then sends the probe to the shop to be refurbished, or replaced if necessary. And if we don't have a replacement probe available, then a technician has to go out and take readings with a portable analyzer. All of that can get pretty expensive."

Using a "tunable-diode" laser-based technology, the SpectraSensors natural gas analyzer accurately measures and monitors

moisture content by precisely measuring the absorbance of light by moisture molecules, thereby measuring the exact amount of water (or carbon dioxide). There are no chemical conversions involved, and no natural gas sensor contact with the sample gas. This eliminates "coating" problems, erratic measurements, and exceeded tariffs.

Hagerott says the new moisture analyzer has proved the technology so well that his WBIP operation installed a second unit earlier this year.

Other pipeline operators are using the new moisture analyzer technology, too. Their goals vary from saving on maintenance and labor costs to ensuring that moisture does not cause customer complaints or dangerous pipeline corrosion. The new laser-based technology precludes such problems through parts-per billion accuracy and through measurement intervals as frequent as every second, as opposed to the 10-12 minutes between readings typical of contaminant-vulnerable quartz crystal and electrochemical sensors.

Factors to Consider When Choosing a Natural Gas Moisture Analyzer

Savvy Engineers know the most economical natural gas analyzer balances price with performance with maintenance and accuracy.

Although an economic analysis will usually show field repair and consumables have a far greater impact on the total cost of ownership, initial investment is often seen as the most important consideration when choosing a natural gas moisture analyzer. In fact, there are many considerations when specifying a moisture analyzer.

Accuracy
Electrochemical sensors, quartz crystal sensors, and electrolytic sensors have an important commonality; they all interact with the gas, where as the moisture is absorbed into a treated surface and some physical property change takes place that can be precisely measured. Due to the gradual decline in effectiveness of the sensor's surface, it drifts over time.

Recent developments in Spectroscopy have made it possible to send a beam of light through a natural gas sensor that is then analyzed to determine the absorbance of certain wavelengths of light. This technique is not susceptible to contamination and insensitive to flow, because the sensor is not touching the gas stream.

Speed
Some processes occur very slowly and the amount of moisture in the natural gas does not change rapidly. In other cases, moisture spikes or "slugs" as they are called can occur with highly detrimental effects. For example, if something goes wrong at a dehydration plant, or if a wet source of gas is introduced upstream, moisture levels can instantly spike. With a laser-based natural gas analyzer no time is needed for absorption. The readings are provided every second, with the only delay being the time required to get the sample to the analyzer. This eliminates any delays in reading time.

Interference
Interferences occur when a sensor can be fooled by a gas other than the target gas. Surface based sensors work by allowing moisture molecules into the surface where it can react with the sensitive layers inside. But what if another molecule can get into the surface and react?

The laser-based moisture analyzer measures the absorption of light. Since no other component in natural gas absorbs light of that same wavelength, there are no interferences. A laser-based analyzer is completely immune to any amount of methanol, amines, glycols, sulfurs, or any other gases present; it only detects water molecules!

	Tunable Laser	Quartz Crystal	Electrolytic/ Electrochemical
Sensor Response	1 second	5-10 minutes	5-10 minutes
Accuracy	2%	5%	5%
Methanol Vapor	a	d,e	b,d,e
Glycol Vapor	a	d,e	b,d,e
Amine Vapor	a	d,e	b,d,e
H_2S Vapor	a	c	c
Chlorine Vapor	a	c	c
Ammonia Vapor	a	c	c

a = Analyzer unaffected
b = Increased frequency of calibration/cleaning required
c = Can severely effect or permanently disable the sensor
d = Slows responses of sensor
e = Can cause innacurate readings

Moisture Analyzer Comparison Chart: The chart above shows several moisture sensing technologies and their respective attributes.

Maintenance
Electromechanical and electrolytic sensors require periodic refurbishment or replacement of the sensor heads. Several sensor heads should be kept on hand to prevent long downtimes. Quartz crystal analyzers require sensor head replacements as well as expensive desiccant and permeation tube replacements that require downtime and specialized training.

The laser-based natural gas analyzer is made up of electronic (solid state) parts that do not come into contact with natural gas and does not have any moving parts it is an extremely robust and simple device that requires virtually no maintenance.

The Bottom Line

For the total cost of ownership, the initial investment plus the cost to maintain the analyzer over some period of time must be added together.

The first year of ownership shows the electrochemical or electrolytic sensors cost the least, but by the end of year two the expense will equal the amount of a laser-based system. After 5 years the cumulative cost could be twice as high or more.

For users the bottom line is always going to be measured in costs as well as quality. The advantage they now have is the option to choose a natural gas moisture analyzer that offers high reliability and justify it with lower overall costs.

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Laser Technology Cuts Through Haze with Moisture Analyzer

A new natural gas pipeline technology services firm gains a competitive advantage by adopting a quantum leap in natural gas analyzer technology.

Often it's the "young turks," the new enterprise, that hits the ground running by quickly assessing and adopting a better technology -- to grab a competitive advantage. In the field of natural gas measurement, specifically a moisture analyzer, such an opportunity has been a long time coming. Wet gas, high maintenance costs and frequent replacement of conventional natural gas sensors has been a thorn in the side of producers and pipeline operators.

Wet gas can lead to expensive producer shut-ins and high legal costs if it breaks an end-user contract

That's why Premier Services (Watonga, OK) began to look for a better moisture analysis technology soon after the firm opened its business in instrumentation, automation and measurement of natural gas and associated fluids three years ago.

Looking for a more efficient and accurate technology than conventional quartz crystal and electrochemical sensors, last year Premier Services discovered the new standard in reliable, trustworthy and trouble-free measurement -- the laser-based natural gas analyzer.

"This was like comparing a new Cadillac to a 1960s hatchback," says Premier Services president David Liebensohn. "The laser-based technology is a quantum leap over conventional natural gas sensors. It is the best one out there in terms of ongoing accuracy, and it pretty much takes care of itself in the field."

Operating mainly in the mid-continent areas of Texas, Louisiana, Arkansas and Oklahoma, Premier Services strives to be a lean and highly competent organization. Because the firm consults with producers and pipeline services on selecting instrumentation as well as measurement and maintenance, dependable moisture analysis is a high priority.

"Wet gas can lead to expensive producer shut-ins and high legal costs if it breaks an end-user contract," Liebensohn says, "and that can easily amount to tens of thousands of dollars per incident. We have found that the new laser-based technology, while more expensive than conventional sensors, will pay for itself in the long run -- through improved accuracy and lower maintenance requirements."

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Liebensohn views the problems with conventional gas sensors as twofold: lack of consistent accuracy, and high maintenance costs. When a conventional sensor probe becomes coated with contaminants present in the natural gas stream, such as glycol carryover from the dehydrators, the moisture readings can become erratic or even frozen.

"If the conventional analyzer becomes flooded with any type of liquid, you have to take it apart and clean it out and reinstalled, all of that takes time and maintenance efforts. With the newer, laser-based moisture analyzer, even if it is flooded, it will come right back on line with dependable accuracy."

Liebensohn adds that even routine checking and calibration of conventional sensors is maintenance intensive, requiring that moisture tubes are manually pulled as well as recalibrated and, often, refurbished or replaced. He says that the laser-based analyzers, which he buys from SpectraSensors (San Dimas, CA), are shipped pre-calibrated from the factory and require virtually no maintenance.

Using a "tunable-diode" laser-based technology, the SpectraSensors natural gas analyzer accurately monitors moisture content by precisely measuring the absorbance of light by moisture molecules, thereby measuring the exact amount of water (or carbon dioxide). There are no chemical conversions involved, and no natural gas sensor contact with the sample gas. This eliminates "coating" problems, erratic measurements, and exceeded tariffs.

Liebensohn as well as many producers, services and pipeline operators have determined the cost difference is overcome very quickly, especially with the prevention of a single incident by utilizing a laser-based moisture analyzer.

Laser-Based Moisture Analyzer Zeros in on Wet Gas with Unfailing Speed and Accuracy

Crosstex, a midstream natural gas services company, enhances its quality assurance with a new moisture analyzer technology that outperforms traditional gas sensors.

The costly dilemma of getting consistently accurate readings on wet gas through conventional sensors has become a thing of the past with many pipeline operators, producers and treatment facilities who have seen the light on a new technology -- the laser-based moisture analyzer.

There is no maintenance to speak of, plus there is not wet-up or dry-down time. And the readings are instantaneous.

Unaffected by the contaminants in natural gas streams, especially wet ones, the laser-based natural gas analyzer offers producers and service companies a precision alternative to the problems of inaccurate and slow measurements that results in problematic and expensive sensor maintenance and too often leads to excessive treatment costs or disastrous shut-ins.
"We were unhappy with the traditional sensors because they gave us problems with rich gas," says Del Tibbetts, Measurement Specialist with the Lafayette, La. operation of Crosstex Energy Services, a midstream energy services company.

> "The probe-type analyzer cells are all based on the same technology. They may perform well in lean streams, but with wet gas, they can be troublesome. We've had to change our cells once a month."

The replacement of sensor probes, amounting to hundreds of dollars a month in hardware and maintenance costs, is almost incidental when compared to the

costs and other consequences of shut-ins or having to provide unexpected treatments due to inaccurate readings. If a producer with faulty dehydration equipment inadvertently sends millions of cubic feet of wet gas into a pipeline system, the costs and logistical problems of handling the gas are considerable, but that is often not the end of the problem. In the meantime there may be delays in supplying customers.

Worse yet, there could be the delivery of wet gas to the utility or industrial end user, resulting in expensive litigation based on broken contracts.

In May 2006 Tibbetts' measurement group bought the newest in moisture analyzer technology from SpectraSensors (San Dimas, Calif.), the company who developed the laser-based technology. "I am very impressed by the laser absorption principle," he says. "There is no maintenance to speak of, plus there is not wet-up or dry-down time. And the readings are instantaneous."

Using a "tunable-diode" laser-based technology, the SpectraSensors natural gas analyzer accurately monitors moisture content by precisely measuring the absorbance of light by moisture molecules, thereby measuring the exact amount of water (or carbon dioxide). There are no chemical conversions involved, and no natural gas sensor contact with the sample gas. This eliminates "coating" problems, erratic measurements, and exceeded tariffs.

Although the laser-based moisture analyzer technology is somewhat more expensive than the conventional gas sensors, Tibbetts as well as many other measurement specialists, feel that the cost may be overcome very quickly, possibly with the prevention of a single incident.

Crosstex Energy, L.P., a midstream natural gas company headquartered in Dallas, operates over 5,000 miles of pipeline, 12 processing plants, four fractionators, and approximately 150 natural gas amine treating plants and 22 dew point control plants.

Crosstex Energy, Inc. (NASDAQ: XTXI) owns the two percent general partner interest, a 42 percent limited partner interest, and the incentive distribution rights of Crosstex Energy, L.P. Additional information about the Crosstex companies can be found at http://www.crosstexenergy.com.

Laser-Based Moisture Analyzers -- Dependable As Chilled Mirror Tests

An expert in natural gas analyzer technologies and instructor in the chilled mirror reading technique say the laser-based moisture sensor is the only device that maintains accuracy without all of the maintenance headaches.

The inability of most sensors to accurately measure the moisture in natural gas remains a major problem for producers and pipeline operators everywhere today. Wet gas can cost millions of dollars every day in shut-ins, end-user problems, law suites and even pipeline damage -- all for want of a reliable and trouble-free moisture analyzer.

"It's just a matter of time before conventional sensors start giving erroneous readings, and the problem will worsen until it is repaired or replaced," says Mark Smyth, a moisture analyzer specialist whose firm, Smyth Analytical Services (Okemah, OK) performs on-site hydrocarbon and moisture dew point analysis of 'natural gas' utilizing the U.S. Bureau of Mines chilled mirror hygrometer method.

> "but whenever I do that the laser-based analyzer is so close to dead-on that it could be the chilled mirror that is a couple of tenths off."

A veteran of the natural gas industry for almost 40 years, Smyth troubleshoots gas contamination problems and teaches the chilled mirror technique all over the world. He travels to producer and pipeline locations to verify the analyzers of various clients, usually on three-month cycle.

"In all of the time I have been doing this, there is only one natural gas analyzer besides the chilled mirror that I can say with confidence is consistently accurate: The SpectraSensors laser-based moisture analyzer," Smyth says.

He explains that while most natural gas sensors are affected by the contaminants in the gas, making them sometimes grossly inaccurate sometimes within just weeks, the SpectraSensors laser-based moisture analyzer is not affected by contaminants, and is accurate within a few tenths of a pound for long periods of time.

"Of course, the only way to prove the accuracy of the laser-based analyzer is using the chilled mirror comparison," Smyth says, "but whenever I do that the laser-based analyzer is so close to dead-on that it could be the chilled mirror that is a couple of tenths off."

The first time Smyth ran across the laser-based analyzer was on an offshore site where the contaminants were unusually extensive. "That's the nastiest gas in the world, full of alcohol and extremely rich gas. There is not a single analyzer on the market that can successfully measure offshore natural gas - other than the SpectraSensors analyzer. Nothing else works for any length of time. It's really amazing."

Perhaps equally amazing is the fact that many producers and even pipeline operators still rely on various conventional natural gas sensors. "The smart ones are converting to the laser-based technology," he says. "The initial purchase price is higher, so the market will always be there for the cheaper analyzers. Ironically, the cost of maintaining them is extremely high. That may be okay with some people, but in a critical application they would save in the long run by using the SpectraSensors analyzer. Who knows, they just might save more than the cost difference in a day or less, especially if there is a shut-in because

of wet gas. But, of course, some producers don't seem to realize that."

Using a "tunable-diode" laser-based moisture analyzer, the SpectraSensors unit accurately monitors moisture content by precisely measuring the absorbance of light by moisture molecules, thereby measuring the exact amount of water (or carbon dioxide). There are no chemical conversions involved, and no natural gas sensor contact with the sample gas. This eliminates "coating" problems, erratic measurements, and exceeded tariffs.

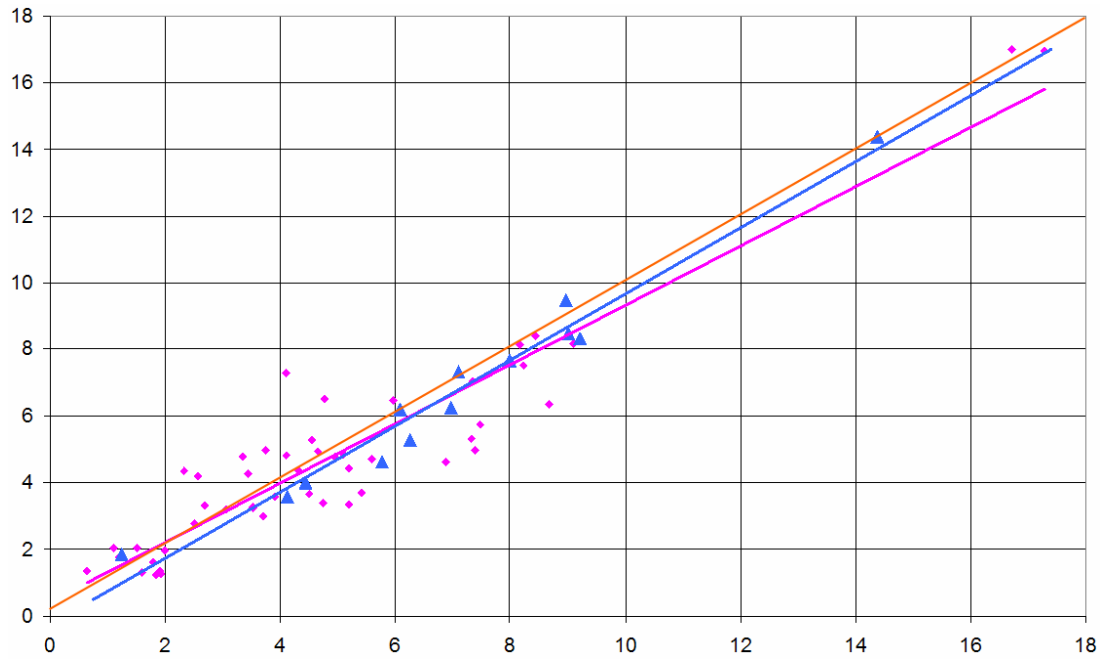

Chart 1: Scatter Plots of Chilled Mirror Results versus Laser. As the graph shows, a high degree of scatter can be observed, but the overall average results are highly correlated.

SpectraSensors™

For information: www.spectrasensors.com