A guide to the latest methane detection technologies for the oil and gas industry

CHUBB®

Methane can leak from oil and gas operations in multiple ways and at multiple points. It might leak for years, or even decades, out of a neglected or abandoned wellhead. Tiny amounts of it might leak out of pinprick-width openings along a pipeline with compromised bolting or other defects. However this greenhouse gas manages to leak, though, it impacts the climate and represents a wasted financial opportunity for operators, since fugitive emissions – if captured – can be sold on the natural gas market and become an added source of revenue.

As part of their jointly administered Methane Emissions Reduction Program, the U.S. Department of Energy and the U.S. Environmental Protection Agency have released $1.3 billion in grants and other funding to help oil and gas companies identify and reduce methane leaks at their facilities. Fortunately, an array of established and emerging technologies currently exists that can help these companies find the source of leaks, measure their volume and take immediate action to fix them.

Here's a look at some of the most promising ones.

GROUND-BASED TECHNOLOGIES

- **Optical gas imaging** (OGI) cameras use infrared technology to let us "see" methane emissions that would otherwise remain invisible to the human eye. In the presence of an OGI camera that has been specially calibrated to detect the unique infrared characteristics of methane, the gas will appear as a dark plume or cloud. Handheld and portable, these cameras can be aimed anywhere and can instantly confirm the presence (or absence) of a leak. The most high-end and sensitive OGI cameras have cryogenic coolers inside them that allow them to penetrate more deeply into the infrared spectrum; some of these cameras are capable of detecting very small leaks of methane from significant distances. Most modern OGI cameras allow the user to quantify recorded emissions in some way, and newer models employ WiFi and/or Bluetooth technology to enable real-time data transmission.

  OGI cameras do have their limitations. For a camera to properly capture an image, there generally must be at least a 2° Celsius temperature difference between the emission plume and the background surface. Since atmospheric moisture makes it more difficult to detect infrared energy, OGI cameras are much less effective under rainy or foggy conditions. The presence of strong winds may also hinder their ability to obtain an accurate reading. Other factors that can affect performance include the distance between the camera and its subject and – since OGI cameras are highly sensitive and technically complex instruments – the training level and experience of the cameraperson.

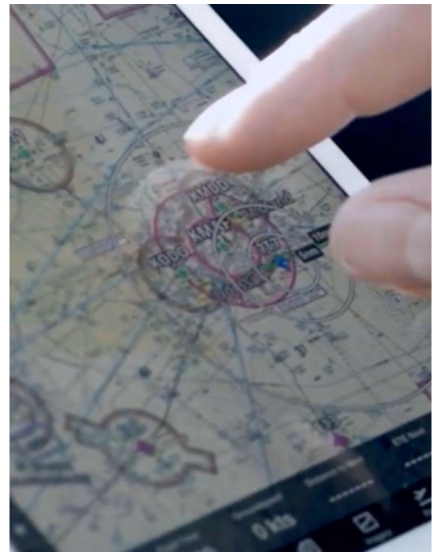
  Because they usually require a person (or a drone) to carry and operate them, OGI cameras are best suited for "scan"-type missions where the operator is looking for multiple leaks. While the simplest OGI cameras may cost only a few thousand dollars, the price tag for most models stretches well into the tens of thousands, with the most sophisticated cameras costing up to $100,000 or more.

- **Laser-based sensors** come in different shapes and sizes, but are typically portable, handheld devices that can be aimed at suspected sources of methane leakage in the same manner that one might aim a flashlight along a dark path. When pointed at a target, the sensor's laser beam bounces off of the surface and a diffused beam is reflected back to the device, which analyzes both the outgoing and incoming signals and then measures them against an internal reference cell tuned to the infrared spectroscopic properties of methane. If methane is present, the gas will have partially absorbed the laser beam's light; the device calculates the amount of light that has been absorbed and converts this information instantly into a measurement of methane density.

  Advantages of laser-based sensors include the fact that they are highly accurate and easy to use, as well as the fact that their beams can penetrate transparent barriers (such as clear glass or plastic). The newest sensors are capable of detecting methane from a distance of more than 300 feet. Prices vary according to specifications, but most hand-held laser sensors can be purchased for between $1,000 and $3,000.

- **Fixed sensors** are optimally suited for the continuous or periodic monitoring of oil and gas facilities. Once installed onsite, a fixed sensor – which might detect methane via infrared technology or controlled chemical reactions – allows for uninterrupted or scheduled sampling of air quality and instant analysis of its contents. This makes fixed sensors ideal for monitoring remote operations or operations where onsite staff members are few.

  By employing a connected network of mounted sensors, operators can achieve comprehensive or near-comprehensive coverage of a large well pad or other facility and can be immediately alerted at the first sign of methane leakage from any point within. Adding a wireless communication component allows for data transmission in real time to offsite locations. Most models that are appropriate for oil and gas facility settings can be purchased for less than $10,000, with many models coming in at less than half that price.



AERIAL TECHNOLOGIES

Their ability to cover many square miles quickly makes manned aircraft valuable at identifying so-called “super-emitter” events.

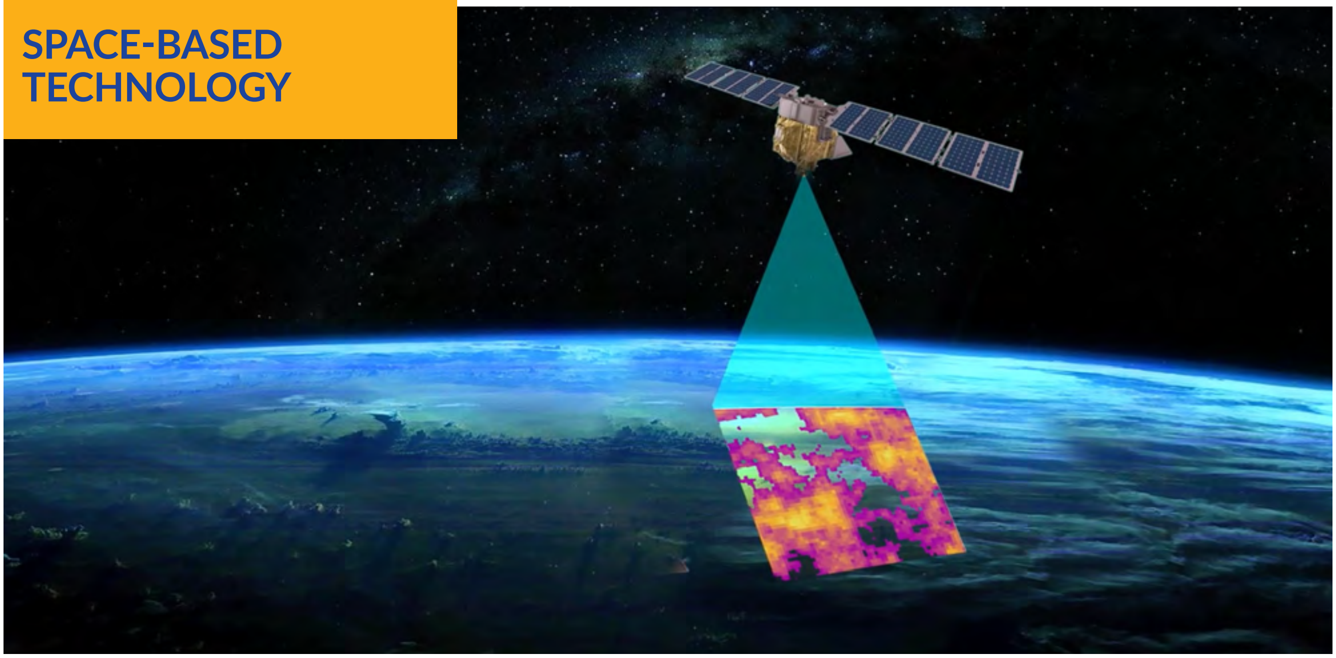
- **Drones** can be equipped with different types of methane sensors to cover large areas of land – including remote ones – and to collect data from multiple sources rapidly and efficiently. With their small size and unique ability to climb and descend vertically, they’re well suited for identifying leaks emanating from individual pieces of equipment, tight spots or hard-to-reach places. They can also be programmed to make regular and identical surveillance missions, allowing for comparative analysis of the same areas over periods of time. They can even play a role in abatement efforts, by providing response teams and technicians with real-time data to help them prioritize repairs.

  Many drones use laser-based systems that are technologically related to hand-held laser methane detectors but are able to sweep over large areas, as opposed to the handheld point-and-shoot model. These laser-equipped drones combine wide range with high sensitivity – but the combination comes, typically, at a cost of several tens of thousands of dollars.

- **Manned aircraft** can similarly be equipped with sensors to cover wide swaths of land – up to thousands of square miles per day, in fact, which makes them especially popular among large oil and gas companies with many assets that are spread out within a state, region or basin. Even a small airplane or helicopter has enough room to carry some of the most sophisticated detection equipment currently available on the market; when outfitted with a high-end laser-based detection system, a manned aircraft is capable of detecting methane leaks of all sizes, including so-called “pinhole” leaks, as well as underground leaks.

  Their ability to cover many square miles quickly makes manned aircraft valuable at identifying so-called “super-emitter” events, defined as emissions of 100 kilograms of methane per hour at or near an oil or gas facility. They’re also valued by companies whose operations are in far-flung locations, or in locations where ground access is difficult. The data obtained from a plane or a helicopter might not be as granular as that obtained from a drone, but for operators who value speed and range over granularity, manned aircraft might be the preferred option. As might be expected, the costs of manned aerial inspections are significantly higher than the costs of unmanned ones.

SPACE-BASED TECHNOLOGY



- **Satellites** have the potential to revolutionize methane detection at the global level. In March 2024, the Environmental Defense Fund, a nonprofit advocacy group, launched a satellite into orbit for the express purpose of spotting methane emissions, globally and comprehensively, from space and sharing the data with governments, industries and fellow advocates. But commercial applications are emerging as well, especially as more high-resolution satellites are coming online.

  Most satellites employ multispectral methodology, which detects methane by identifying variations in solar radiation from a small number of wavebands in the short-wave infrared spectrum. Others employ hyperspectral methodology, which looks at variations in hundreds of different wavebands; while this methodology allows for finer detection, it is also characterized by a lower revisit frequency (meaning a greater elapsed time between observations of the same point). Satellite performance can be affected by cloud cover and other weather conditions. Another limitation: At their current levels of technology, satellites are best at detecting and quantifying only large amounts of emitted methane. They're not well suited for identifying smaller sources of leakage.

Depending on an operator's specific needs, priorities and budget – as well as the size and complexity of the facility being monitored – any one of these methane-detection technologies might be appropriate. But it's far more likely that some combination of them, working in concert, will go the furthest in helping facilities identify and mitigate their methane emissions quickly and thoroughly.

Finding and detecting fugitive methane emissions saves energy companies money and keeps a powerful greenhouse gas from entering the atmosphere. New technologies are making it ever easier to do so – and energy companies should act now to determine which of these are best suited to their specific needs. By working with a trusted and experienced Chubb risk engineer these companies can spot potential sources of leakage within their operations and choose the most sensible and cost-effective solutions.