Embracing change

Peter Maas, Grandperspective GmbH, explains why a sea-change in emissions monitoring is needed if green ammonia is to become the future of farming.

Last December, policymakers representing 200 nations struck an historic deal to transition away from fossil fuels at COP28.

Some of these policymakers may have been influenced by the potential of the green ammonia sector. According to Persistence Market Research (PMR), a firm based in New York, it is a sector which is expected to 'witness explosive growth' in the coming years.[1]

The research, which was published in December 2023, forecasts that the market for green ammonia could increase from US$97.8 million to US$4517.6 million by 2030.

One of the largest areas of growth, says PMR, will be the fertilizer production market, which is expected to increase by over 75% between now and 2032.

The Royal Society, the world's oldest, independent scientific academy, says that between 70 – 80% of ammonia is currently used to make fertilizer.[2] However, figures from the Greenpeace Research Laboratories show that ammonia-based fertilizers are responsible for over 2% of the world's carbon footprint, while agriculture accounts for nearly a quarter of the world's emissions. Recent research by McKinsey & Company states that if farms switched to green ammonia, greenhouse gas emissions from agricultural end products could be reduced by about 5%.[3]

Figure 1. Sensor units can monitor huge areas with up to 1 km of distance 24/7, 365 days a year, autonomously and fully automated.

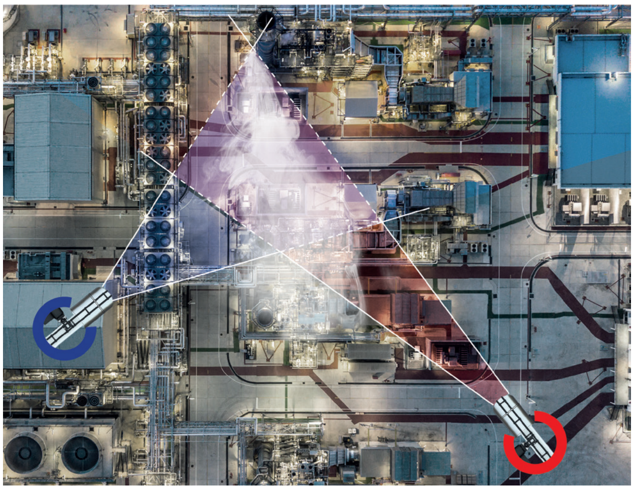

Figure 2. With the help of two or more sensor units, gas cloud positions can be located in 3D, and triangulation and concentration distributions can be determined by tomographic reconstruction.

Figure 3. Mounted in an elevated position, the sensor unit continuously monitors large areas for dangerous emissions. One significant advantage of the system is that it operates completely independently of weather conditions.

A step-change in ammonia emissions visibility is required

There are concerns that without more precise emissions monitoring, a significant scaling up of green ammonia production in farming might end prematurely.

Dr Reyes Tirado, a Research Scientist for Greenpeace Research Laboratories, says that if large scale industrial emissions occur, they might have potential impacts on air quality for human health (depending on the range of exposure) and more widely can increase N_2O emissions as greenhouse gas in the atmosphere.[4]

This has not stopped governments ploughing large amounts of resources into developing a green ammonia production capability. With green ammonia now being widely regarded by scientists as a fuel that can help to drastically lower our carbon footprint, nations around the world are setting up specialist research institutes to unlock its rich potential.

In the UK, the Science and Technology Facilities Council is building a small-scale plant to generate ammonia using only renewable energy sources.[5] Dr Tristan Davenne, Principal Engineer at the STFC Energy Research Unit, says that if the prototype is successful, it could prove to be a watershed moment, as it will enable the UK to scale up production, and begin to "build the foundation of a green ammonia economy to decarbonise large swathes of society."

Scaling-up green ammonia production

Several nations are one step ahead, however. Saudi Arabia will soon be home to what will be the world's biggest green ammonia plant. According to the Ammonia Energy Association, by 2026, the facility at Al Muwaileh is expected to produce 1.2 million t of renewable ammonia.[6]

If the world is to follow Saudi Arabia's lead, innovative green policy in the form of carbon taxes and subsidies will be required. Energy plants will also need to invest in ammonia cracking technologies as well as hydrogen separation and purification systems. But, if green ammonia is to replace ammonia in farming, entire ammonia distribution networks equipped with leak detection technology will be needed.

Ammonia, whether it is green, blue or turquoise, presents significant safety challenges. It is toxic, highly poisonous, and extremely difficult to detect with conventional sensor point technology. If it is not identified instantly, it can cause immediate burning of the eyes, nose, throat and respiratory tract. Without the right monitoring systems in place, it can leak uncontrollably in confined spaces, such as a green ammonia plant, and in the worst case scenario, it can result in blindness, lung damage or even death. Needless to say, it is also harmful to the environment and therefore emission-limited.

If plant managers are to protect their staff, and the large population centres who live beyond the perimeter fence, then they need to ensure that the right detection technology is in place.

Many plants have built a world-class safety culture within their operations. Not only do they comply with safety standards, they exceed them. But what about those who do not?

Before surveillance technology, AI and open source data became widely available, local communities had no choice but to blindly place their trust in process plants. Now, thanks to sophisticated cameras and drones which are providing greater visibility and have given them a much more powerful voice, they do not have to.

Driven by economies of scale, almost anybody, anywhere can now deploy a drone-mounted camera equipped with sensor technology along the perimeter fence of a green ammonia facility, or sight a fixed camera on a nearby building, to detect, track and monitor emissions. Moreover, open-source data has levelled the playing field. Those with greater resources – such as a government agency, an insurance company or an environmental pressure group, can go even further. They can access satellite imagery to detect leaks, or mount state-of-the-art sensors onto helicopters or fixed-wing aircrafts.

This points to the fact that energy plants have lost control of the emissions narrative. Now, they are wondering who might be watching them and their facilities. However, if green ammonia facilities have rigorous and robust detection systems in place to detect, identify and monitor leaks, then what does it matter if others are also tracking their emissions?

Within the confines of a green ammonia plant, a leak is often impossible to detect using conventional sensor technology. This is because conventional point sensors, which are traditionally used by plants to identify ammonia leaks, have two major weaknesses.

The greatest technological limitation is that conventional points sensors are only capable of providing a local reading. Therefore, to suitably cover a three dimensional production site would require an inordinate number of sensors. One way of doing so, would be to install hundreds of point sensors across the facility, but the installation and maintenance costs would be crippling.

Secondly, for a point sensor to detect ammonia, the chemical needs to be in direct contact with the sensor point in order to trigger an alert. But, even if this were possible, gases rarely behave in the way that we expect. They are unpredictable and can change direction and trajectory very quickly, which means that plants simply cannot always rely on them.

Remote sensing technology

Grandperspective GmbH has developed Fourier-Transform infrared spectroscopy (FTIR) remote sensing technology. With each scanfeld® remote sensor unit covering over 1 km in radius, one, or a few sensors can deliver 3D area coverage to an entire green energy facility.

The technology provides autonomous detection rates of typically 0.05 kg/hr and less. The instrumentation is sensitive, meaning it can identify ammonia and hundreds of other chemicals, whilst at the same time, offering quantification and monitoring capability.

The risk of employing such sensitive detection technology is that it is unable to distinguish technical emissions from an actual incident. This would of course render the technology unusable. Therefore, it is important to ask how can such precise instrumentation make this critical differentiation? The system recognises normal behaviour of a technical emission which enables remote sensors to spot unconventional behaviour automatically and in real time. It is only then that the system will send an alert to the operator.

The remote sensing technology analyses radiation in the same way finger print detection technology identifies an individual. It allows for forensic detection of ammonia, while accurately pinpointing the source of a leak and the quantity of ammonia in the air.

FTIR technology is not new. It was first developed in the 1940s and the first FTIR spectrum was recorded in 1949. It is an incredibly established method for identifying chemicals in the laboratory, or in space science. What is a development is that the spectrometer is used to analyse omnipresent infrared radiation autonomously 24/7.
The technology is highly automated. The light from a kilometre's distance to find the gas composition in the air is analysed. This is how the precise information is collected, which reveals the exact type and quantity of chemicals in the air. Then, the entire gas cloud is made visible. In doing so, the analytical precision of the laboratory analyser with the overview of camera technology 24/7 is combined.

Additionally, the installations, once set-up, continuously learn more about the normal emission cycles of the plant. Throughout the production cycles, including loading procedures, start-ups, cleaning and maintenance, the system learns to differentiate between technical emissions and potentially dangerous gas leaks.

Furthermore, the system enables plant safety teams to map a gas cloud in real time. This is absolutely key, as in providing facilities with the exact location of a hazardous area, they can take immediate action to stop the leak.

Conclusion

While producers may no longer be in control of the emissions narrative, due to the ubiquitousness of surveillance technology, AI-enhanced remote sensing technologies, which provide low detection rates that conventional sensor technology cannot match, can help them to wrestle it back.

This is why plants who are producing and distributing ammonia are likely to opt for an FTIR spectroscopy-based remote monitoring solution in the near future. It is also the reason why green ammonia facilities will follow in their footsteps. The stakes for them – and the future of green ammonia – are simply too high for them not to. WF

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