# PACKED CONFERENCE REFLECTS CONCERN ABOUT GLOBAL METHANE

**A hugely popular industrial methane measurement conference took place during PEFTEC 2017 in Antwerp on 29th and 30th November. Reflecting current concern with rising global methane levels, the conference was packed throughout both days of the event, and has been hailed a major success.**

Methane is an important Greenhouse Gas (GHG), absorbing significantly more energy than carbon dioxide for example, so it performs a major role in global warming. Atmospheric methane concentrations rose during the decade from 2006 to 2016 following a previous decade of near-constant concentrations, so there is major concern about the sources of this increase and also with the monitoring methods. The methane measurement conference was therefore created to provide an opportunity for experts from around the world to share their experiences in the detection, monitoring and mitigation/prevention of methane emissions.

## Conference: Day 1

The keynote presentation of the first day of the Industrial Methane Measurement Conference was given by Baroness Worthington from the Environmental Defense Fund. She set the scene for the conference themes, outlining the challenges ahead and providing a global perspective on the needs and drivers.

*Baroness Worthington, Environmental Defense Fund, setting the scene for the conference themes*

Providing a case study from Canada, Ian Kuwahara from the Alberta Energy Regulator explained that his organisation has been tasked with reducing methane emissions from the upstream oil and gas sector by 45 per cent by 2025. He then outlined the challenges and regulatory development approach, and described the learnings for industry and other regulators.

Prof Neil Harris from Canfield University in the UK described a study in which atmospheric methane concentrations were recorded at four locations within East Anglia. In parallel, a study of hot-spot emissions from a landfill near Cambridge was conducted - using the Gaussian plume analysis of 3 years of measurements, the workers found strong evidence for a seasonal cycle in methane emissions from the landfill with more being emitted in winter than in summer.

Unfortunately, due to a lightning strike on his plane, Prof Nick Cowern from NC Tech Insight Ltd was unable to deliver his presentation on the role of shale production in the recent rise in atmospheric methane.

Dr Konstantin Romanov from PAO Gazprom in the Russian Federation described the lifecycle of greenhouse gases in natural gas and compared the technical, regulatory and methodological differences between the European (including Russian) and North American gas systems.

Dr Hugo Denier van der Gon from TNO in the Netherlands described the use of state-of-the-art mobile methane measurements, including tracer release and inverse modelling, on several landfills in the Netherlands and France to address the optimisation and uncertainty issue of extrapolating measurements from 1-3 hours to annual estimates. His results show that there may be a substantial discrepancy between 'guidebook' calculated emissions and real world emissions. Whilst this study focused on landfills, he said that the extrapolation from short term flux measurements to validate annual reported emissions is relevant for many source sectors. This is a key issue for setting realistic targets, connecting country GHG reduction plans, climate finance, private investors and GHG emitting companies.

Dr Paul Balcombe from Imperial College in London described a study of the distribution of total methane and CO2 emissions from different natural gas supply chain routes, identifying the contribution from each stage and quantifying the effect of key parameters on emissions. The study uses recent high-resolution emissions measurements with estimates of parameter distributions to build a probabilistic emissions model and Monte Carlo simulation for a variety of technological supply chain scenarios. He said that emissions-minimising technology is only part of the solution; reducing the impact of super emitters requires more effective detection and rectification, as well as pre-emptive maintenance.

Jesus Manuel Gil Jimenez from Enagas in Spain described the technical innovations developed by his organisation to reduce the carbon footprint related to the development and operation of gas infrastructures. In particular, Enagas start-up VIRA GAS IMAGING has developed a portable uncooled infra-red camera (OGI JULIETA) that represents a quick and cost-efficient system for natural gas, hydrocarbons and VOC leak detection and monitoring.

Dr John Korsman from DCMR, a regional environmental protection agency in the Netherlands, described work to determine the detection limit for an infrared camera as a function of multiple operating conditions, including wind speed, viewing distance, and temperature difference between the background and a gas cloud. Operational boundaries were derived from laboratory data for six different process components to ensure that the IR camera's detection limit is lower than the repair thresholds in leak detection and repair (LDAR). An emission model was developed and validated with field data to determine whether a leak is inaccessible or the remote process component exceeds its repair threshold.

Providing the keynote presentation for the afternoon session, Gerard Moutet from OGCI in France described the needs and challenges from an industrial perspective. Prof. Susan Waldron from the University of Glasgow then presented the results of work where catchment scale sampling found methane present at concentrations above background in river water and allowed the

*Prof Neil Harris-Cranfield University*

*Rod Robinson-NPL-Chairman of Methane Conference*

identification of nearby sources of fugitive emissions.

Dr Jacob Mønster from FORCE Technology in Denmark described the application and validation of a tracer dispersion method for quantifying fugitive methane emissions from landfills, wastewater treatment plants and biogas production. Accreditation and validation studies were also described.

Dr Fabrizio Innocenti from NPL in the UK explained range-resolved infrared Differential Absorption Lidar (DIAL) measurements for the mapping and quantification of a wide range of different methane sources. He said for the last decade the NPL DIAL system has carried out landfill emission surveys at over thirty sites in the UK, France and the USA. The DIAL data can be used by site operators to validate emissions estimates and by regulators to revise and update emission inventories.

Dr Jan Liebetrau from DBFZ in Germany described the different emission sources occurring at biogas plants and explained the methodologies used for their quantification. An overview of the possible mitigation measures to reduce methane emissions at biogas plants was also presented.

Charlotte Große from DBI Gas- und Umwelttechnik GmbH discussed concerns about methane emissions from natural gas. She said different countries have different methods for estimating methane emissions from the national grid, but to-date there has been no consensus on which is the best method. She described a project titled Methane Emissions Estimation Method (MEEM) which has recommended a combination of the best elements of the different methods.

Rebecca Fisher from Royal Holloway, University of London gave a presentation on the isotopic characterisation of methane emissions to help identify their sources. She referred to trials at Bacton Gas Terminal in Norfolk, and jokingly said that the paper was nearly called "What a lot of methane is coming out of the gas plant," however, subsequent isotopic analysis showed that the bulk of the methane was from mainland biogenic emissions.

In a joint presentation by 2 presenters from GRTgaz in France, the main sources of leaks from their network were outlined, including for example seals on compressors and micro-leaks. Infra-red cameras were used for detection and the EN15446 method was used for fugitive leak quantification. They said that they are currently looking at an IoT detection system, and in 2016 GRTgaz achieved ISO 15001 which includes methane emissions reduction.

## Conference: Day 2

Adam Brandt from Stanford University provided the opening keynote presentation in which he highlighted increases in biogenic

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*A busy exhibitor presentation*

methane emissions. In his estimation some of the increase is derived from the oil and gas sector. He described bottom up and top down studies. He outlined a project with the Environmental Defense Fund in which helicopter based work found that 90% of leaks were from tanks and hatches. He highlighted sources of error in calculations that assume for example the number of tanks per well. Also work by one of his students showed that leaks can be intermittent. In summary, he said that there are challenges and data gaps to be addressed in the bottom up top down approach.

Rod Robinson of NPL said that the detection and quantification of fugitive and diffuse methane emissions has become an increasing priority in recent years. As the requirements for routine measurement to support industry initiatives increase there is a growing requirement to assess and validate the performance of fugitive emission measurement technologies for reported emissions traceability and comparability of measurements.

Rod described the DIAL technique - a laser based remote sensing technology, able to map the concentration of gases in the atmosphere and determine emission fluxes for fugitive emissions. In addition, to support the validation of technologies, NPL has developed a portable controlled release facility able to simulate the emissions from area sources. He also described recent studies using DIAL and the controlled release facility to validate fugitive emission measurement techniques, and he mentioned that a European Standard is under development for the measurement of fugitive emissions of VOCs and the use of validation data in the standardisation process. The Standard will include methane measurement.

Dr Grant Allen from the University of Manchester presented a case study characterising the precision and uncertainty constraints of a newly developed mass balancing flux calculation method, using in situ measurements of methane concentration sampled by an unmanned aerial vehicle (UAV) platform. Of the two types Grant said that he prefers rotary drones because of their ability to 'stop and stare'. He said that high precision instruments cannot yet that be flown on a drone, but you can measure $CO_2$ and therefore methane by proxy. He warned not to use drones when the wind is more than 10 m/s.

Grant described a project funded by the UK Environment Agency and conducted by the University of Manchester and NPL with assistance from the UK Met Office at its Cardington research facility. The results of the validation demonstrate that the method offers a new technology (and technique) through which industrial facility-level methane fugitive flux can be accurately and traceably quantified in case study (snapshot) approaches. Moreover, routine UAV sampling can help to monitor emissions and detect hazardous leaks quickly over a wide area, taking advantage of the portability of UAVs and their ability to safely access hazardous environments.

Prof Daniel Zimmerle from Colorado State University provided an overview of a US Department of Energy program (MONITOR), a 45M US$ investment in methane detection technologies. The eleven technologies funded under the program are reaching the end of their second development year and beginning field testing. Initial testing has been performed at the Methane Emissions Test and Evaluation Center (METEC) at Colorado State University, which reproduces emissions behaviour at oil & gas wells, small compressor stations, and underground gas gathering lines. In addition to MONITOR, many other sensor advanced technologies are under development. Daniel provided an overview of the sensor technologies, deployment methodologies and testing methods employed in the project.

Matthew Williams from the UK's National Grid and David Butterfield from NPL explained that the National Grid Plc is incentivised by the Office of Gas and Electricity Markets (Ofgem) to conduct research into new techniques to enable National Grid Gas (NGG) to improve understanding and transparency, and allow for cost-effective mitigation, of GHGs venting on the National Transmission System (NTS).

The aim of this project was to develop a cost effective methodology to enable NGG to monitor and control fugitive emissions from above ground installations on the NTS, and to understand both planned and unplanned venting events. The project involved trialling a method to assess the practicality, performance and cost effectiveness of the approach. The project is ongoing but it is hoped it will provide a more accurate picture and understanding of total site fugitive emissions on a continuous basis. The improved understanding and quantification of the emissions should enable a better cost/benefit analysis for investment plans for areas such as asset health and defect remediation.

Dr Renato Winkler from Picarro Inc in Switzerland said that the main source of atmospheric ethane is fossil energy production and distribution, making it a meaningful tracer for fugitive methane emissions from industrial activities. Microbial methane is virtually ethane free. He described a portable Cavity Ring-Down Spectrometer (CRDS) that measures methane, water and ethane concentrations without an upfront separation requirement or multiple analyses to derive the origin of the methane gas.

Dr Damien Weidmann from MIRICO Ltd in the UK outlined the development of Laser Dispersion Spectroscopy (LDS) - a new gas sensing technique that applies a novel approach to tuneable diode laser spectroscopy. Established laser absorption techniques depend on measuring detected intensity to derive concentration. This significantly impacts measurements in 'dirty' environments where detected intensity of the transmitted light is bound to fluctuate. MIRICO's LDS-based instrument derives concentration using the phase of light. This makes it highly immune to intensity fluctuations received at the photodetector, and offers a wide dynamic range.

In a long open-path, multi-direction configuration, coupled with a retroreflector array, and anemometer, the LDS analyser is capable of measuring methane concentrations associated with large area sources, and locating and quantifying point source emissions. Trial work with multiple beams was also explained in a project with Shell at the Chilbolton Observatory.

*Exhibitor presentation at PEFTEC*

CI Systems in Israel have developed a dedicated Methane Imaging Camera to serve the petrochemical industry. Their Amir Gil said that the MetCam is a multi-functional camera that connects to site infrastructure and automatically performs detection of gas clouds exceeding safety thresholds, monitors small leaks for preventive maintenance and supplies situational awareness capability. It is designed as a fixed imager, with large volume coverage, to monitor sensitive areas such as compressors stations, PRMS, rigs process areas and more.

Dr Jane Hodgkinson from Cranfield University in the UK talked about work to develop two methane detectors. Much of the engineering requirement and achievable field performance of TDLS is attributable to the gas cell in which the light interacts with the target gas. Jane described a technology that has been developed for in-flight measurement of methane on board light aircraft, with the potential for further development for UAVs. A second instrument uses a novel, low volume gas cell with a long interaction length (5-10m). Through a combination of optomechanical engineering and use of the fast intra-pulse modulation technique, issues of vibration and drift for these cells are removed, making them robust, and a limit of detection of 0.3ppm has been achieved. Performance results for both technologies were presented, and common themes of sensor systems design, certification and typical applications were discussed.

Dr Craig Richmond from VTT in Finland talked about biofraction determination of mixed biogenic and fossil methane samples through stable isotope analysis. VTT has developed a TDLS for simultaneous measurement of 13CH4 and CH3D in methane samples. Using less than 2 ml of sample gas, the spectrometer is capable of determining the biogenic content to within 1.5%, provided the isotopic composition of the source materials was known. The performance of the developed methane isotope analyser for on-line and real-time measurement was tested, with the instrument demonstrating suitability for precise, long-term monitoring and optimisation of biogas production processes.

Dylan Jervis from GHGSat in Canada gave a presentation on the monitoring of methane from space. In June 2016, GHGSat launched the world's first and only satellite capable of measuring GHG emissions ($CO_2$ and methane) from targeted industrial facilities around the world, with a 50m spatial resolution. The technology on the satellite was designed to be capable of detecting medium to large methane leaks around installations in near real-time. The system's capacity to monitor hundreds of sites around the world has been demonstrated by achieving 1,700 measurements with a single satellite.

The technology is not capable of detecting the smallest of leaks, so the effectiveness is greatly enhanced when combined with ground based monitoring methods. The lessons learned from the first satellite have shaped the design of the next two satellites (scheduled for launch in Q4 2018/ Q1 2019). Dylan concluded that this technology can play a key role in increasing and accelerating the detection of methane leaks while considerably lowering the cost of LDAR activities. A lively discussion with the audience ensued.

Prof Andreas Zinssmeister from FLIR in Germany said that Optical Gas Imaging (OGI) is gaining traction as an important LDAR technology. In addition, the emerging field of Quantitative Optical Gas imaging (QOGI) has opened up new applications and new possibilities for OGI. A recently developed QOGI method allows operators to determine emission rates using a handheld optical gas imager. The technology has been tested and validated in various field studies and independent testing, and Andreas reported on these, emphasising the need for a temperature difference (delta t) between an emission and the background.

Dr Bill Hirst from Shell Global Solutions International in the Netherlands provided a detailed description and experimental results for a new gas emission survey method that remotely detects and maps the locations of multiple gas emission sources distributed across an extensive area. The method, which is called LightSource, not only localises but also estimates the mass emission rates of each of the detected sources. The approach is generally applicable to any airborne contaminant that is passively transported and conserved during transport within the area of interest. An experimental evaluation of performance was conducted using 17 calibrated releases and a novel optical beam gas sensor.

Effective dispersion prediction is fundamentally dependent on good measurements of: wind direction, wind speed and turbulence as well as high precision concentration data. Sufficient data is required to adequately reflect the steady state plume and hence be compatible with the steady-state ensemble average for concentration predicted by the dispersion model.

The advantages of this approach over tomographic approaches proposed by others, are that the required instrumentation is simpler, the volumes of data lower, and sources outside the beam array are not excluded. Experimental results demonstrate that it is possible to distinguish and usefully estimate the individual mass emission rates of single and multiple sources both within and outside the beam array based on surprisingly limited changes in wind speed and direction.

Sébastien Ars from LSCE in France described a new method that he developed during his PHD, which combines the tracer release technique, local scale transport modeling and a statistical inversion framework. The presentation of the results focused on both the estimates of total emissions from the sites and on the analysis of the ability to quantify individual sources within the sites when using a statistical inversion approach.


*Methane Conference - Networking at PEFTEC*

Rod Robinson concluded the conference by providing a summary, in which he expressed his pleasure with the number of delegates that had participated in the conference across all of the presentations. He said that he had been very impressed with the talks and had learned a great deal. He was also particularly encouraged by the interaction between the different communities that had been well represented – industry, academia, regulators and instrument/measurement providers. On behalf of the scientific committee, Rod said that the success of the event was very pleasing, and that they would look to find ways to build on the conference and to take forward the discussions that had begun over the previous two days. He added that another conference on this topic would definitely take place. Wishing everyone a safe journey home, he thanked all the speakers, the session chairs and attendees, and acknowledged the help of his colleague Matt Whitney for all his hard work in helping to organise the event.

The full Conference programme and links to abstracts for all of the presentations is available at www.PEFTEC.com.