HE WAKA EKE NOA

The ancient rhythmical Maori chant, "he waka eke noa" sends a strong and timeless signal to the world that when it comes to environmental issues, such as air and water quality, "we are all in this together". The winds blow pollutant gases from the four corners of the earth and ocean currents mix chemical contamination from coast to coast with no knowledge of national borders.

The consequences of this are that looking after each other and looking after ourselves are one and the same, or to use the words of Vicky Robertson, the Chief Executive and Secretary for the Ministry for the Environment in New Zealand: "If we can crack it in New Zealand, not only will it be good for New Zealanders; it will make us a global exemplar."

Even within an ocean-bounded country such as New Zealand, no location is immune to the issues of air quality. Let's hear from a local expert in the field, Paul Baynham, Senior Scientist at the air quality company Mote Limited (formerly AirQuality Limited) in Auckland. He says that "each region brings specific challenges for air quality and this is just as true in New Zealand as in many parts of Asia. Particulate emissions from the burning of wood and coal for home heating during the winter continue to be a significant issue in many parts of New Zealand. However recent monitoring results have shown significant improvements in winter-time air quality in a number of communities due to a combination of national and local regulations. Major urban centres also closely monitor elevated NO_x/NO_2 concentrations which arise primarily from motor vehicle emissions".

Mote CVM Dust Tower

Improvement relies on measurement

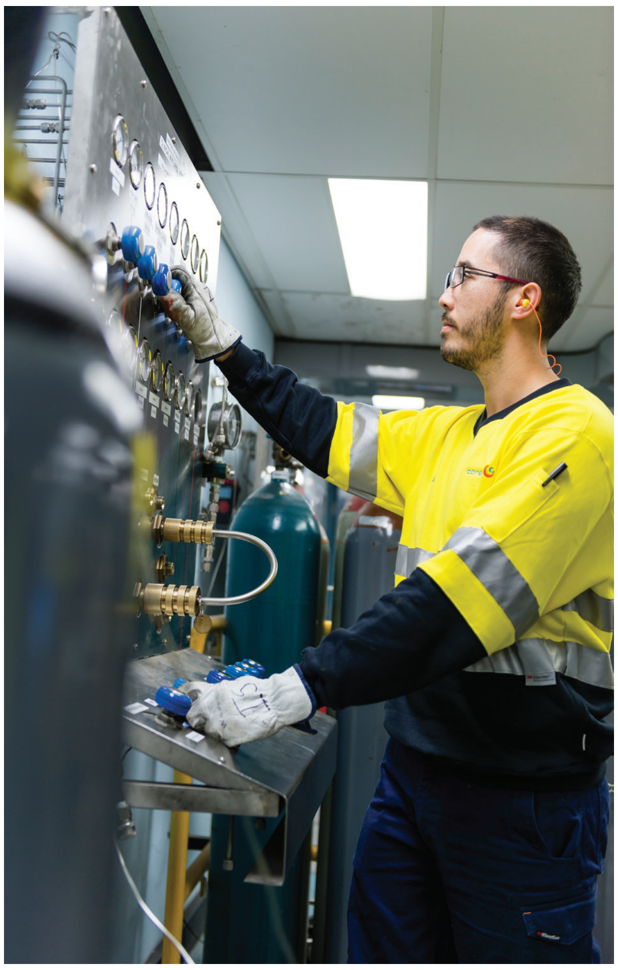
Particulate matter, ground level ozone (O_3) and NO_2 all represent undesirable health hazards and it has been estimated that 1000 New Zealanders per year die premature deaths due to poor air quality. Improvement is therefore high on the priorities at the Ministry for the Environment.

Improvements in air quality are achieved through use of cleaner, better technology and the avoidance of polluting practices. Understanding and quantifying these improvements in air quality, by definition, relies on the measurement and comparison of air quality at two points in time. This is the science of air quality monitoring and it is alive and kicking in New Zealand and Asia Pacific through world class companies such as Mote, who stretch their expertise from New Zealand throughout the Asia Pacific region. Coming back to Paul Baynham, he adds that "we are active in many countries in Asia supporting national government air quality monitoring programmes with the necessary air monitoring technology. We work with a range of legislative frameworks and whilst Australasia has a specific standard on reference atmospheres that our local clients require us to adhere to for our compliance monitoring work, different parts of Asia have different requirements in this regard. For much of Asia, compliance with the relevant US EPA protocols meets their respective requirements."

Regulated pollutants and exotics

Air quality monitoring regulated by national legislation primarily focuses on pollutants such as NO_x, SO_2, O_3 and CO in addition to PM_{10} and $PM_{2.5}$. Additionally, screening surveys or compliance monitoring of other compounds, which are not covered by national legislation, are also frequently necessary. These studies often involve the use of new or emerging technology to investigate concentrations of specific compounds that may be associated with particular industries such as relevant hydrocarbons, odours or even naturally occurring discharges such as H_2S or CH_4.

With each pollutant under investigation comes the selection of appropriate measurement technology. Baynham puts it like this: "it really comes back to the question you are trying to answer. Where legal compliance with a standard or guideline is required, there is often little discretion on instrument selection. The local legislative framework often specifies either the method or the list of instruments that may be used to assess compliance, for example the US EPA list of designated reference and equivalent



Coregas specialty gases mixture preparation

instrumentation, which requires chemiluminescence to be used for NO_x, NDIR for CO, and UV fluorescence for SO_2."

When working outside of the legislative box, he adds: "for non-regulated studies we work more closely with our clients to select the instrumentation that best fits their needs. We have implemented solutions ranging from small footprint optical devices for monitoring vehicle emissions, to the deployment of lower cost gas sensors to supplement existing networks, or even deploying multiple particle monitoring devices to determine if current monitoring stations are appropriately sited."

Kilgram and other masses

The evolution of science and digital pop culture

The past five years have seen rapid changes in sensor technology, which is reducing the cost of air quality measurement and broadening its accessibility. For example, recent developments in optical instrumentation, which has received US EPA equivalency, have begun to change the particle monitoring landscape.

The plethora of low cost sensors, both for particles and CO_2, has also initiated many citizen-science projects throughout the Asia-Pacific region. The engagement of the public in air quality issues across the Asia-Pacific region is exceptionally high, perhaps driven by the discomfort and health risks that people experience in their daily lives when they live in some of the world's busiest cities such as Seoul, Shanghai or Sydney. However, unfortunately, many of these visionary projects have been let down, in part by the poor quality of the data gathered during these studies.

As Paul Baynham puts it, "many of the instruments used in these projects are unsuitable because the detection limit is above the relevant ambient air guideline or they are prone to significant interferences such as humidity or high air temperatures." Using the appropriate instrument and ensuring that it is calibrated accurately are two critical success factors to good science in air quality monitoring.

How can we be sure 10ppm indicated by the instrument really means 10ppm?

Selection of the most appropriate analytical instrument is regulated by national environmental agencies, such as the examples previously given for NO_x, CO and SO_2. And, in addition to using the correct instrument, it is essential that it is calibrated according to the regulated practices.

Calibration of air quality monitoring gas analysers is conducted using a zero gas, such as pure nitrogen or zero grade air, and a span gas, which will be a specialty gas mixture of precisely known, certified concentration. When this span gas is presented to the analyser, the measured reading can be adjusted to correspond to the certified value of the gas mixture.

In effect, the analytical instrument is reliant on the accuracy of the calibration gas mixture. But how can we be sure that the calibration gas mixture itself is accurate? This chain of dominoes is the essence of traceable measurement and, for the measurement of chemical concentration, the roots end up at the international prototype kilogram (IPK) mass stored at the International Bureau of Weights and Measures (BIPM) in Saint-Cloud, France.

Mote Roadside Air Quality Monitoring array to measure RCS and PM10

Kilogram and other standard masses

NATA traceable calibration gas mixtures

In the Asia-Pacific region, NATA (the National Association of Testing Authorities, Australia) represents the gold standard when it comes to validation that calibration gas mixtures have been produced under a quality management scheme that will ensure traceability to SI units of measurement which forms the link to the IPK. They accredit certain laboratories that have a demonstrated capability to produce certified reference materials under ISO 17034:2016 (previously ISO Guide 34) or to test gas mixtures which the labs have produced according to ISO 17025.

Chris Bradley, General Manager for Coregas in New Zealand, explains how this works in practice: "ISO 17034:2016 is the general guideline for making a reference material. At our laboratory in Yennora, near Sydney, we make primary reference materials (PRM) under ISO 17034:2016 by following the detailed procedures laid down in ISO 6142-1. The concentration unit is traceable to mass, certified by the National Measurement Institute in Australia. And, their reference mass is at the BIPM in France."

Bradley again, "at Coregas, we also make certified reference material (CRM) by following ISO 6143 which involves concentration comparison to a primary reference material by different gas analysers, thus concentration is again ultimately traceable to our certified mass. We also certify gas mixtures we have produced using the ISO 17025 standard. For this certification, our analysers are calibrated by either a PRM or CRM and then the gas mixtures are tested on our analysers."

He goes on to say, "NATA accredit our quality systems to ensure that we really do what we say we do. It is a completely closed loop process to guarantee international harmonisation of measurement. Here in New Zealand, we can import these high-spec products from our Coregas production facility in Yennora to ensure that scientists active in air quality monitoring can also trace their measurements through to the IPK in France. That's how they can be sure that 10ppm measured here in Auckland is the same as 10ppm measured in Seoul, Shanghai and Sydney."

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