GENERATION OF GAS STANDARDS FROM LIQUIDS HELPS ACQUISITION OF REFERENCE SPECTRA FOR ANESTHETIC GASES

Indoor air quality is an increasing concern for health. An application example described in this article is related to the monitoring of anesthetic gases in hospitals. Anesthetics can be released in air, and thus impact both indoor air quality and the environment (some anesthetics like nitrous oxide are powerful greenhouse gases).

Indoor air pollution arises from human activities (cooking, cleaning, etc), our indoor environment (chemicals contained in furniture, paints, carpets…), and the exchanges of air with the outside (particles, exhaust fumes…). While we are surrounded by more and more complex chemical products, the air we live in is more and more confined, and favours a concentration of harmful pollutants. Specifically in operating rooms, the monitoring of anesthetic gases will help determine occupational exposure to anesthetic pollutants, which has been associated with adverse health effects and thus mandating the use of efficient HVAC systems and active gas scavenging systems.

Apparatus used in this study: Blue Industry and Science laser spectrometer Blue X-FLR9 Gas Analyser uses an advanced optical source that enables the measurement of hundreds of critical molecules down to trace levels (ppb). It targets the most harmful gas pollutants of indoor air (aldehydes, BTEX, and many other compounds) in a single analyser: Blue's proprietary technology – combining the Broadly Tunable Laser source with a patented detection cell – enables to quantify simultaneously each target gas.

The Blue X-FLR9 Gas Analysers use an established spectrum library for most typical pollutants. When there is a need to monitor specific molecules that are not in the library, new spectra should be acquired and quantified.

Figure 1.Laser spectrometers X-FLR9 IAQ

The traditional way of measuring a reference spectrum is to obtain it from measurement of a reference gas cylinder. Typically the reference gas cylinder should be at concentrations in the ppm range, in Nitrogen, and without pollutants. Dynamic gas diluters can be used to get to lower concentrations down to ppb.

Such dynamic gas diluters (GasMix) are routinely used at the calibration lab of Blue. Fig 2 shows a spectrum obtained during a calibration (in black: measured spectrum, in blue: reference spectrum). We note that the GasMix has delivered a very stable concentration throughout the duration of the measure (5 minutes in the above example)

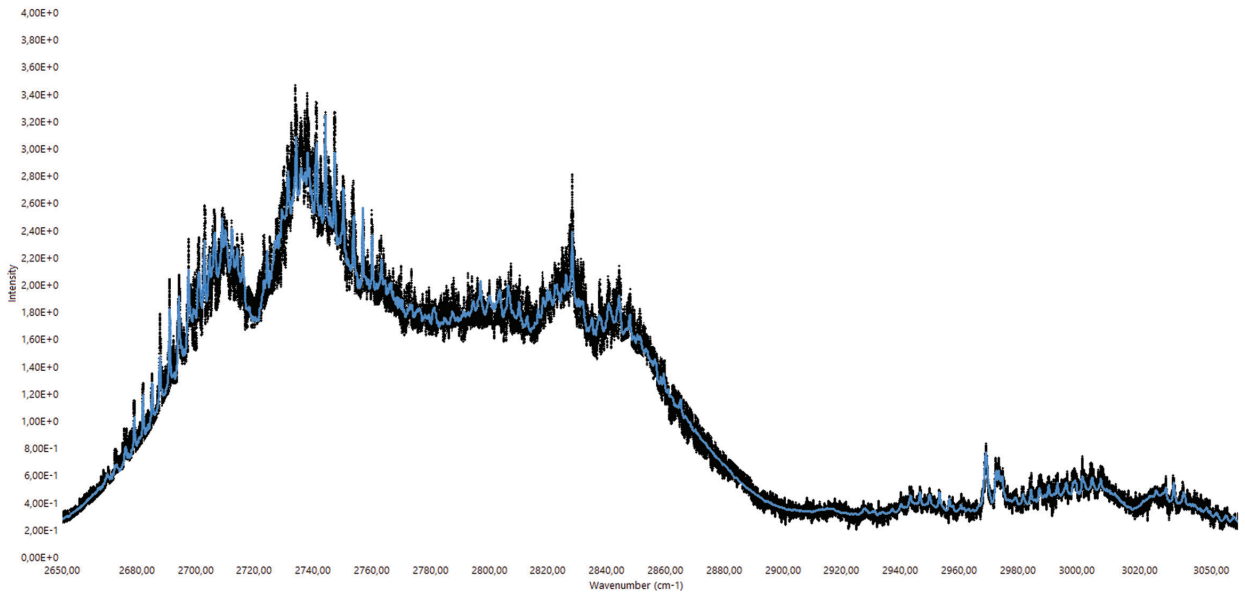

Figure 2 : As an example a spectrum of acetaldehyde acquired during the calibration.

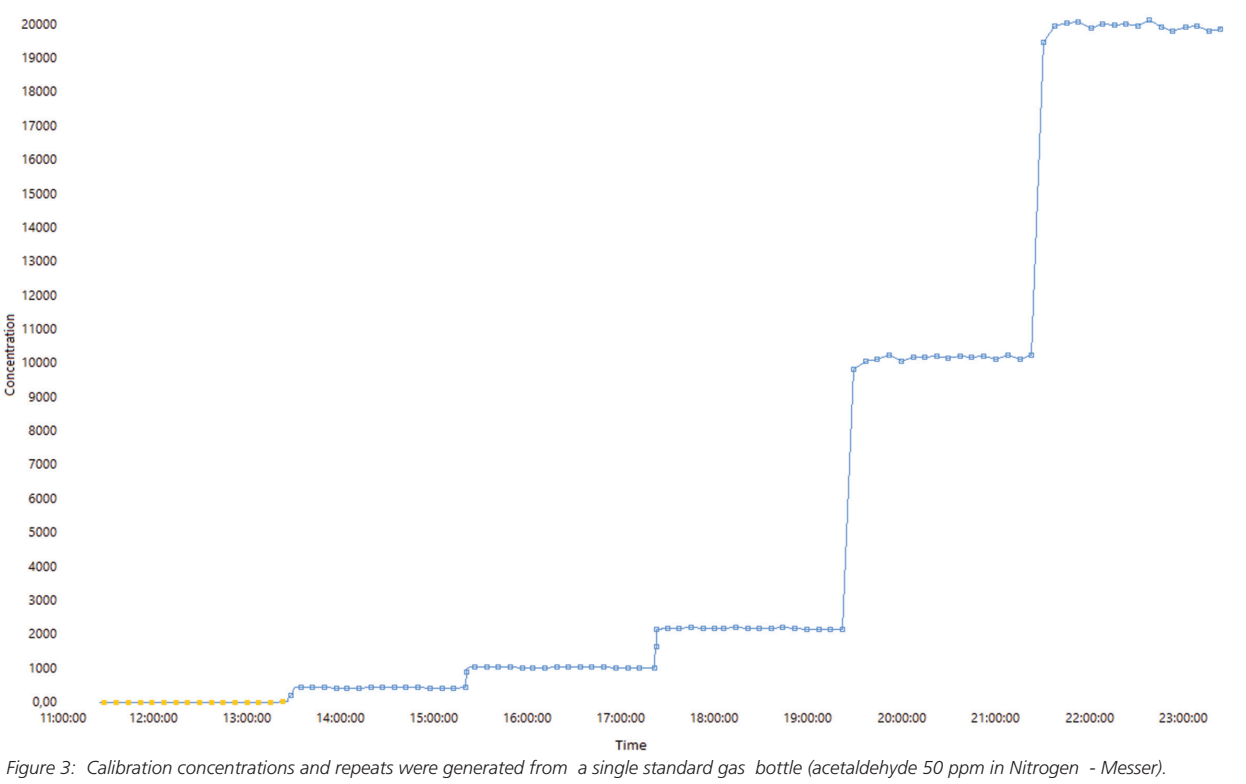

Figure 3: Calibration concentrations and repeats were generated from a single standard gas bottle (acetaldehyde 50 ppm in Nitrogen - Messer).

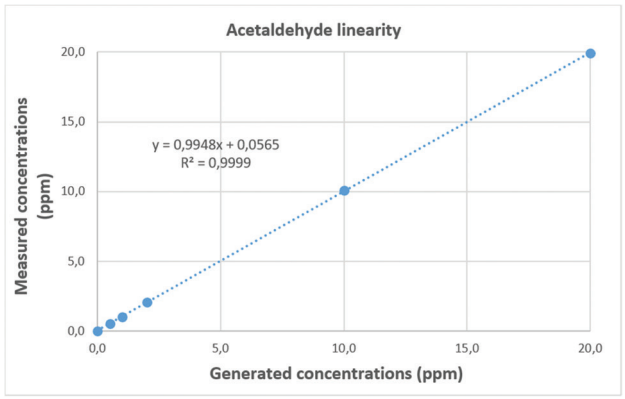

Figure 4. A linearity curve performed with the GasMix dilutor showing that the response of our analyser is perfectly linear.

However, obtaining gas cylinders can be cumbersome, it usually takes weeks (3 months is not unusual), and there are extra costs to operate with gas cylinders. Moreover, it is sometimes impossible to get a reference gas cylinder, when the target molecules are difficult to access as standard mixture in gas form because they are unstable, reactive or rare compounds.

In a recent application, it was necessary for Blue to characterise molecules of anesthetic gases: Sevoflurane, Isoflurane. These molecules need to be measured at trace levels for a pilot project for hospital indoor air quality assessment.

Mélanie Peyrind, head of the calibration lab at Blue : "We were looking for a way to measure reference spectrum of these molecules not included yet in the IR spectrum database of Blue Industry and Science. We faced a real problem, as target compounds were not commercially available in gas form, only as a liquid."

A solution was found with AlyTech LiqMix gas generator that vaporises in precisely controlled manner a liquid into a gas stream generating a gas standard at given concentration with good

Figure 5. AlyTech LiqMix Cascade

accuracy, high repeatability and full traceability. Due to its unique intelligent multi-stage cascade dilution, AlyTech LiqMix Cascade can provide a very wide range of concentrations from % down to ppb levels. Following highest metrology requirements it also automatically calculates and reports maximum relative uncertainty for every delivered concentration.

The liquid components were tared in advance using a laboratory balance, loaded in the reservoir and pressurized with helium. With its Coriolis liquid mass flow controller LiqMix Cascade can handle any type of liquid or liquid mixture without a need for a specific calibration. This technology is not dependent on ambient conditions (pressure, temperature density, conductivity and viscosity) and very accurate.

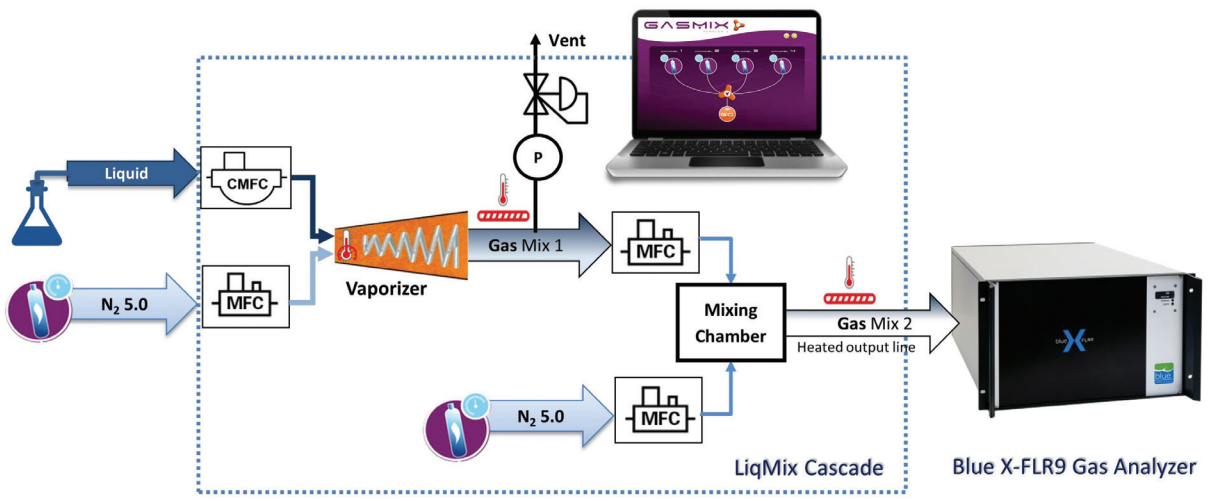

Figure 6. Operation schematics

Precisely controlled liquid flow is delivered into a vaporizer where it evaporated into a flow of a carrier gas (nitrogen 5.0). To achieve very low concentrations a portion of homogenous gas/vapour mixture is delivered to the second dilution stage, so-called Cascade, where it is further diluted by a stream of pure nitrogen and transferred to a sampling point of the Blue X-FLR9 Gas Analyser by a heated line.

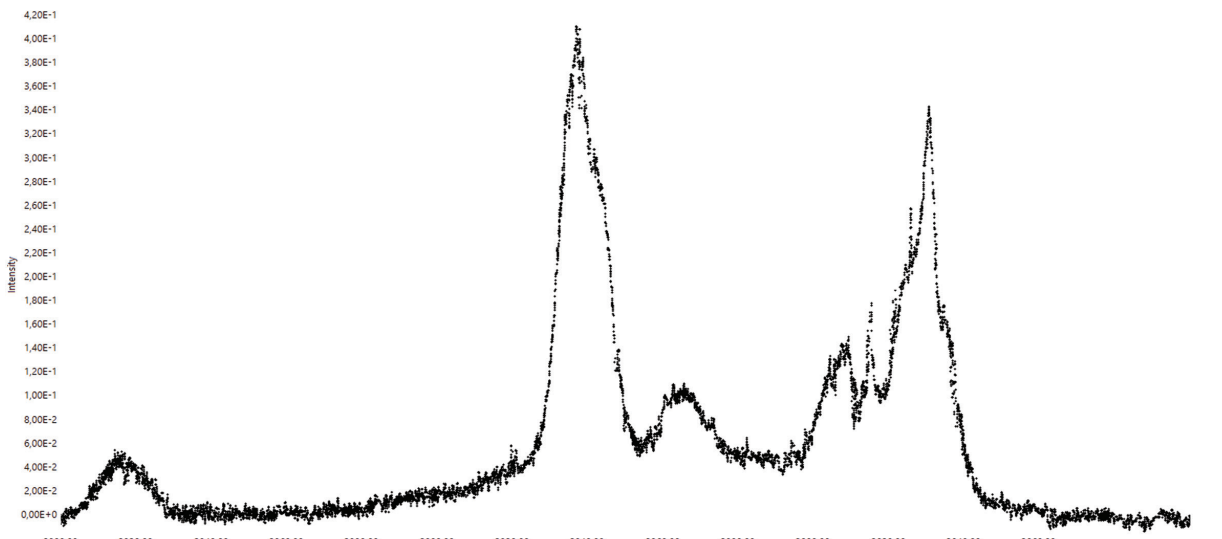

Figure 7. Spectrum of Sevoflurane (2800-3100 cm-1, sampling 0.02cm-1)

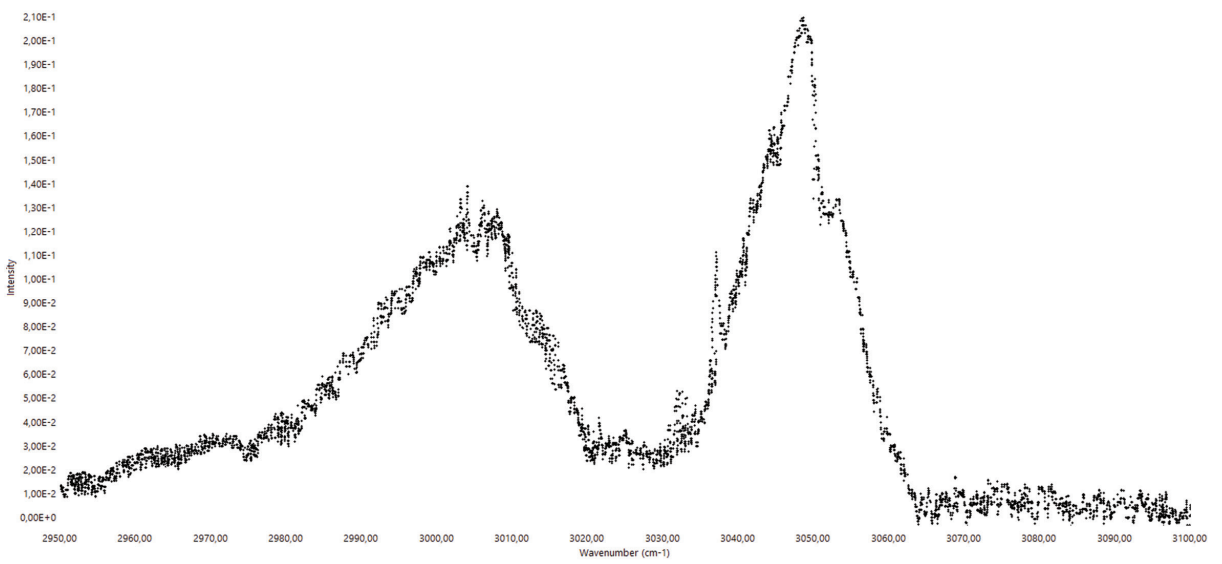

Figure 8. Spectrum of Isoflurane (2950-3100 cm-1, sampling 0.02cm-1)

Liquids used in the experiment: Methyl Salicylate (Sigma-Aldrich, concentration > 99%) was used as a reference gas to check the response from the LiqMix Cascade. Then Isoflurane (AbbVie, 100mL/100mL) and Sevoflurane (Baxter, 1mL/mL) were used for the molecules of interest.

Mélanie Peyrind: "In our study from pure liquids we have generated stable concentrations in gas phase for Sevoflurane and Isoflurane in the range 1 - 5 ppm. Multiple calibration points were created in fully automated sequence by the LiqMix software. Quality reference spectra were obtained".

The spectra on figures 7 and 8 consist of 6 repeated sequences of gas generation that show good repeatability of delivered concentration by LiqMix.

Conclusion

Alytech LiqMix Cascade was found to be a very valuable tool when it is required to generate a gas standard in wide concentration range from neat liquids. The system dramatically accelerated the research work, reduced labour time of analytical chemists and saved a considerable amount of money by producing on-site calibration gas mixtures down to ppm levels accurately and with high repeatability. Flexibility of the system and its LiqMix software fit well to different analytical techniques and serve for linearity check, multipoint calibration, LOQ and LOD determination, and other analytical needs.

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