

# "Mars Mix" and Other Molecules That Matter

## Developing Specialty Calibration Gas Mixtures for Niche Applications

By Bob Jefferys, Air Liquide America Specialty Gases, LLC

Made possible by ever-changing and emerging technologies, our industry is constantly looking for ways to create innovative products based on new materials and fresh ways of thinking. Sometimes the challenge comes in deciding when to invent and when to rethink, especially in the realm of specialty gases. No doubt about it, greater accuracy, stability, and homogeneity between cylinders of HBr (hydrogen bromide) can indeed lower production costs and improve time-to-market in the semiconductor industry. Similarly, calibrating a Continuous Emissions Monitor with an EPA protocol that exhibits  $\pm 1\%$  accuracy (instead of the required  $\pm 2\%$ ) can help a customer improve efficiencies and meet critical environmental goals.

Air Liquide ([www.airliquide.com](http://www.airliquide.com)), having combined forces with the former Scott Specialty Gases, has been at the forefront of developing the technology to engineer the types of products that meet the increasingly more stringent needs of many different types of industries. Few would argue that technology is not important. However, without thorough knowledge of the chemistry behind blending gases, along with broad application experience in how to effectively use them, spec gas is simply a colorless mystery mixture contained in a high-pressure cylinder.

This is why, as part of its 100+ year commitment to innovation, Air Liquide maintains scientific and technical teams who answer

technical questions and recommend products that will cost-effectively meet or exceed a customer's application requirements, creating added value and greater productivity. Beyond merely producing specialty and industrial gases, Air Liquide considers its approach as a specialization in "molecules that matter." For example, when the laws of chemistry and physics wouldn't cooperate, Air Liquide found a way to simulate an extraterrestrial atmosphere when a customer needed a mixture to calibrate a mass spectrometer that was to be rocketed to the planet Mars. The out-of-this-world Mars Mix, as specified on a mole basis, was to include:

0.9545: CO<sub>2</sub>; 0.027: N<sub>2</sub>; 0.016: Ar; 0.0016: O<sub>2</sub>; 8E-4: CO; 1E-4: NO; 2.5E-6: Ne; 3E-7: Kr; 8E-8: Xe; 1E-8: CH<sub>4</sub>.

Air Liquide knew that preparing a mixture to these specifications would be nearly as challenging as navigating the spaceship on its way to Mars. Air Liquide identified three critical areas of concern (here on Earth). First, with O<sub>2</sub> and NO in the same mix, the O<sub>2</sub> would convert the NO to NO<sub>2</sub>, which would be unacceptable. The O<sub>2</sub> therefore would have to be provided separately. Second, using CO<sub>2</sub> as the balance gas would result in vapor pressure issues, meaning a cylinder pressure of only around 500 psi. Third, there is no such thing as 100 percent pure raw materials on Earth. Furthermore, not all compounds are available in a high-purity level of 99.9999%. Since most of the minor components of this Mars mixture are impurities of each other, cross-contamination and precise evaluation would be a serious issue.

Air Liquide determined a feasible work-around might be to provide the CO<sub>2</sub> in a separate cylinder. Not only would this approach eliminate the vapor pressure issue, but it would also allow larger quantities of the minor components on a proportional basis. This in turn would help alleviate the component purity issue. Problem solved.

The Mars project is just one example of

how Air Liquide's specialty gas experts create unique and highly sophisticated customer solutions. Air Liquide's Solutions Center received a call from a start-up company who manufactures buckyballs and also nanotubes. A buckyball is the only known molecule of a single atom to form a hollow spheroid. Nanotubes are carbon molecules in which the carbon atoms are bonded in cylindrical form. Through a new process using a continuous high flow of hydrocarbon burned at low pressure in a 3-dimensional chamber, this company can produce up to 95 percent pure fullerenes at one-tenth the cost of previous methods. Because its process involves combustion, the company inquired about a calibration gas to monitor combustion emissions, looking for the following custom mixture with  $\pm 2\%$  accuracy in a balance gas of argon or nitrogen. Mixture components were to include: 45% CO, 20% H<sub>2</sub>, 4% CO<sub>2</sub>, 4% acetylene, 2% methane, 0.5% O<sub>2</sub>.

Air Liquide quickly determined that it could safely blend this mixture while observing precautions concerning explosive ranges for some of the components. However, one of its Application Solutions Engineers was able to help determine that while this customer's application may be unique, the calibration gas doesn't need to be. A single cylinder containing a custom mixture might be more convenient to use, but in a start-up operation when costs can be critical, multiple cylinders containing standard, and less expensive, catalog gases would suffice.

As a leading world supplier of specialty and industrial gases, Air Liquide is all about molecules that matter. The company's technologies are carefully engineered to provide customers with meticulously analyzed measures of certain molecules in the form of pure or mixed gases and liquids. These molecules are in turn used as raw materials or end products in themselves, as is often the case in healthcare or food and beverage processing. Other times the molecules it provides are used to measure or test for the presence of other molecules, as in applications such as



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environmental monitoring, homeland security, or process control.


Air Liquide's focus, however, goes well beyond the refining and selling of molecules. It includes providing definable value that can be measured at the bottom line. About one third of Air Liquide's product sales can be linked directly to applications that are helping to preserve our environment or ensure human safety. Other Air Liquide products and services involve helping our many customers keep

pace with a challenging global economy — by empowering them to improve efficiencies without sacrificing end product quality or analytical accuracy.

Steadfast commitment to safety, technology, and innovation has kept Air Liquide at the forefront of the high-tech business of specialty and industrial gases for more than 100 years. Our presence of nearly 43,000 employees across more than 75 countries enables us to leverage the resources of a truly global enter-


prise with powerful, personalized service from localized, customer-focused teams. Combined with innovative products and services, it is a winning formula that transforms molecules that matter into greater customer satisfaction, efficiency, growth, and success — plus a safer and cleaner environment for us all.

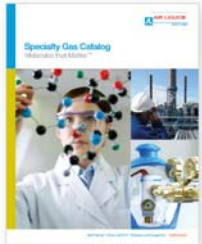
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