

# The complexities of oxygen and clean gas valve applications

This article explores how valve manufacturers are tackling the challenges of oxygen and clean gas applications, where even the smallest oversight can have serious consequences.

By Melonie Dodaro



Clean room within a Velan manufacturing plant.

In this interview, Valve World spoke with Vahe Najarian and Doug Lay from Velan about the critical developments in oxygen and clean gas valve applications. With recent industry standards changes and increasing demand across multiple sectors, understanding these specialised valves is more important than ever for engineers and procurement specialists. Vahe, with an extensive background in R&D and fugitive emissions, brings decades of experience to the table. Doug, as the product line manager for gate, globe and check valves, offers valuable insights into the practical aspects of valve design and implementation. Together, they discussed the challenges and recent developments in this specialised field.

The valve industry has undergone significant changes in standards and practices for oxygen and clean gas applications. In 2017, the Compressed Gas Association (CGA) and European Industrial Gases Association (EIGA) started introducing new international standards that have reshaped manufacturing processes. These standards, including CGA G-4.14 / EIGA Doc 200 and CGA G-4.4 / EIGA Doc 13, were driven by a series of incidents in the industry, highlighting the need for more stringent safety measures. In response, Velan has focused on three critical areas to meet these new standards: design validation, cleanliness and training. Vahe Najarian explains the significance of oxygen concentration: “When the oxygen percentage

reaches 23.5%, it’s classified as industrial oxygen. At this level, the risks start to increase and strict industrial oxygen safety protocols must be applied.” This is only a few percentage points higher than the oxygen concentration in the air we breathe.

This clear divide highlights how important it is to design and handle valves correctly in environments with high oxygen levels. Mistakes can lead to serious accidents that may cause deaths.

## The three pillars of oxygen valve safety

Doug Lay stresses the importance of design validation in these applications. “Proper design validation is crucial in many of these cases. It’s not just about preventing small leaks. The consequences of improper design can be much more serious. That is why Velan is aligned with the new standards which place direct responsibility on valve manufacturers and material suppliers.”

This validation process involves risk analysis which includes careful review of material compatibility, component thicknesses and flow velocities. The goal is to mitigate ignition risks, a critical concern in oxygen-rich environments where the valve itself can react as a fuel source. Velan has partnered with WHA International Inc., an independent third-party company specialising in risk analysis in oxygen and hydrogen combustion, to ensure conformance

### About Velan

Velan is a global manufacturer of valves for a wide range of industrial applications founded in 1950 by A.K. Velan. Headquartered in Montreal, Canada, the company currently operates 12 specialised manufacturing plants located in North America, Europe and Asia. Velan holds all major industry certificates and approvals including: ASME N/NPT; API 6A, API 6D; API 624, API 641, ISO-15848-1, TA-LUFT; PED; and SIL. Velan is also certified for operational quality including ISO 9001; ISO 14001; ISO 45001; IEC; and ATEX.

## OXYGEN VALVES

with the latest industry standards. This collaboration covers three crucial areas: design safety review, cleaning process protocol validation and comprehensive training.

Cleanliness, the second pillar of safety, often requires clean room manufacturing and third-party validation. Velan's cleaning processes have been validated to conform to CGA G-4.1 and EIGA Doc 33 standards, ensuring valves are free from contaminants that could potentially ignite in an oxygen-rich environment.

The third element, training, represents a significant cultural shift within organisations. Velan has implemented a comprehensive training program developed in partnership with WHA International Inc. This program ensures that all personnel involved with processing oxygen cleaned valves are trained in the hazards of oxygen service, current design standards and proper cleaning techniques.

### Material selection

Material selection is a cornerstone of safe valve design for oxygen service. Contrary to common assumptions, stainless steels often fall short in a vast range of these applications due to their potential for ignition in oxygen-rich environments. Instead, manufacturers must use specialised materials such as Monel®, Inconel® or specific bronze alloys. These materials offer superior ignition resistance and maintain their integrity under the extreme conditions found in oxygen applications. For example, Monel K-500 has an exemption pressure of 3000 psi, compared to 375 psi for 316 stainless steel.



Oxygen cleaned gate valve. Photo credit: Velan

Vahe explains, "Material selection is crucial. We're not just looking at corrosion resistance, but also at a material's propensity to ignite in an oxygen-rich environment. This often rules out common stainless steels in favour of more specialised alloys keeping in mind, of course, the unique material limitations that need to be additionally addressed for each valve type (i.e. gate, globe, check, ball and TOV.)"

### Meeting industry standards

Velan's valves for oxygen and clean gas applications comply with the latest harmonised standards set by international industry associations. These include:

1. CGA G-4.1 / EIGA Doc 33 (2018): Cleaning of Equipment for Oxygen Service

2. CGA G-4.4 / EIGA Doc 13 (2020): Oxygen Pipeline and Piping Systems for gaseous oxygen with a temperature range between -30°C and 200°C (-22°F and 400°F)

3. CGA G-4.14 / EIGA Doc 200 (2017): Design, Manufacture, Installation, Operation, and Maintenance of Valves Used in Liquid Oxygen and Cold Gaseous Oxygen Systems for temperatures less than -30°C (-22°F)

### The semiconductor surge

The semiconductor industry has emerged as a significant driver of innovation in specialised valve technology. Modern chip manufacturing processes require ultra-high purity oxygen, often at 99.9999% (6N) purity or higher. This demand has pushed valve manufacturers to provide more highly clean valves for both safety and clean gas applications.



Oxygen cleaned valves ready to be shipped. Photo credit: Velan



Triple-offset valves special cleaning. Photo credit: Velan

Additionally, the need for precise flow control in semiconductor manufacturing has led to advancements in valve actuation and control systems, benefiting other industries that use oxygen and clean gas systems.

### High temperature applications

While current industry standards cover applications from cryogenic temperatures up to 200°C, there's a growing need for solutions beyond this range.

Vahe adds, "We're seeing demand for valves that can operate safely at temperatures above 200°C in oxygen service. It's a challenging area, but one where we're actively developing solutions."

Velan offers specialised high temperature oxygen applications above 200°C (400°F), extending beyond the typical range covered by standard industry guidelines.

### The growing importance of hydrogen

As more industries look to use hydrogen, valve makers face new challenges. "Hydrogen introduces risks such as material embrittlement," Doug explains. He adds, "The industry is developing specialised sealing solutions and adapting cleanliness standards for these applications to minimise risk."

Hydrogen valves must meet varying requirements. Fuel cell vehicles need ultra-pure hydrogen, while industrial uses often require valves that withstand higher pressures and temperatures.

Vahe adds, "Preventing leaks is crucial. Hydrogen can escape through tiny gaps that would contain other gases, therefore creating better seals and more precise components is necessary."

### A key to safety in oxygen applications

Doug concludes with a cautionary note about the risks of treating oxygen service valves as standard components: "It's not advisable to simply request an oxygen-clean valve from a local distributor who might claim, 'We cleaned it in-house.' This approach can lead to significant problems and safety risks."

As the industry adapts to new challenges, including higher operating temperatures and the increasing use of hydrogen, valve manufacturers must continually refine their processes. This includes staying current with the latest safety standards, investing in advanced cleaning facilities and providing comprehensive training for all staff involved in valve production. For those specifying or using valves in oxygen and clean gas applications, it's crucial to work with manufacturers who can demonstrate a thorough understanding of these specialised requirements. By doing so, users can ensure they're getting components that not only meet current standards but are also prepared for future developments in this critical field. ■