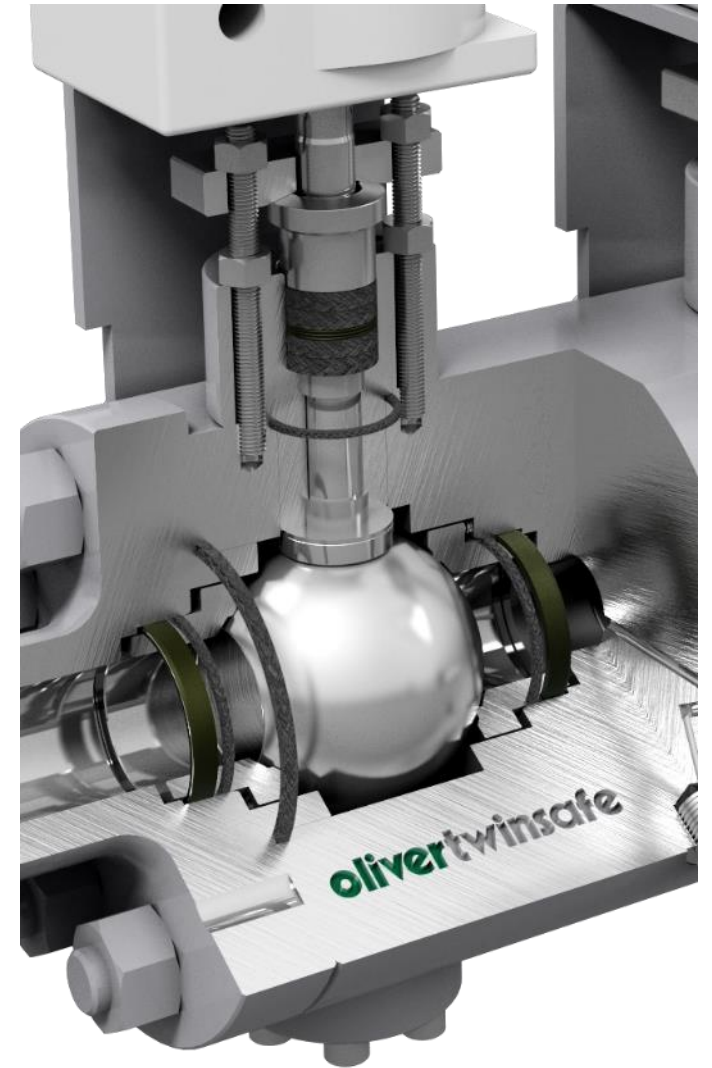


DuPont™ Vespel® Parts for Oliver Twinsafe® gas valves

A new milestone in fugitive emissions control

Electronics & Industrial Kalrez® & Vespel® parts EMEA



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DuPont™ Vespel® Parts Overview

What are Vespel® Parts and Shapes?

- Vespel® is the brand name for a range of high performance, mainly polyimide-based plastics.
- Vespel® SP polyimide has been developed in cooperation with NASA for the Apollo Space Project.
- Over the past 50 years, the Vespel® parts and shapes portfolio has expanded to include a number of different grades, each with unique performance characteristics accomplished by varying the types and levels of fillers and different manufacturing methods for parts or shapes.
- Vespel® parts and shapes are resistant to heat, creep, wear and a variety of chemicals
- Vespel® parts and shapes are used in a wide range of applications in the industry

DuPont Vespel® Parts Offering

High performance parts and shapes



Stock Shapes (ISO)

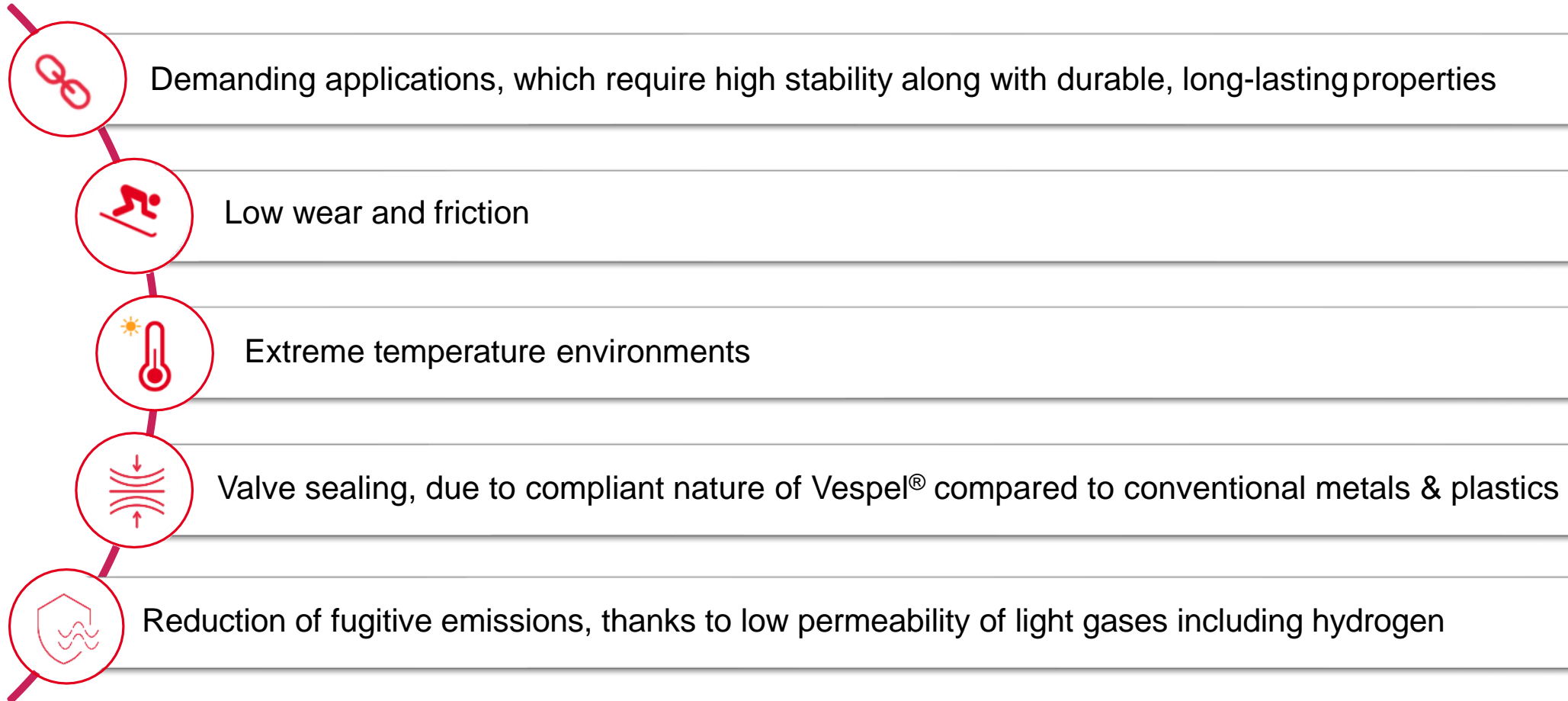
- Commercially available
- Different shapes and sizes
- Can be machined
- Excellent material properties
- Sold mainly through distributors



Custom Parts (DF/DF2)

- Proprietary design
- Engineering solution by DuPont
- Technical global support
- Minimize machining steps to lower costs per part
- Tight tolerances / quality assurance

Where do Vespel® parts and shapes fit?



Vespel® can also be machined to tight tolerances if needed



Methane – environmental effects of fugitive emissions

Methane, the second largest cause of global warming

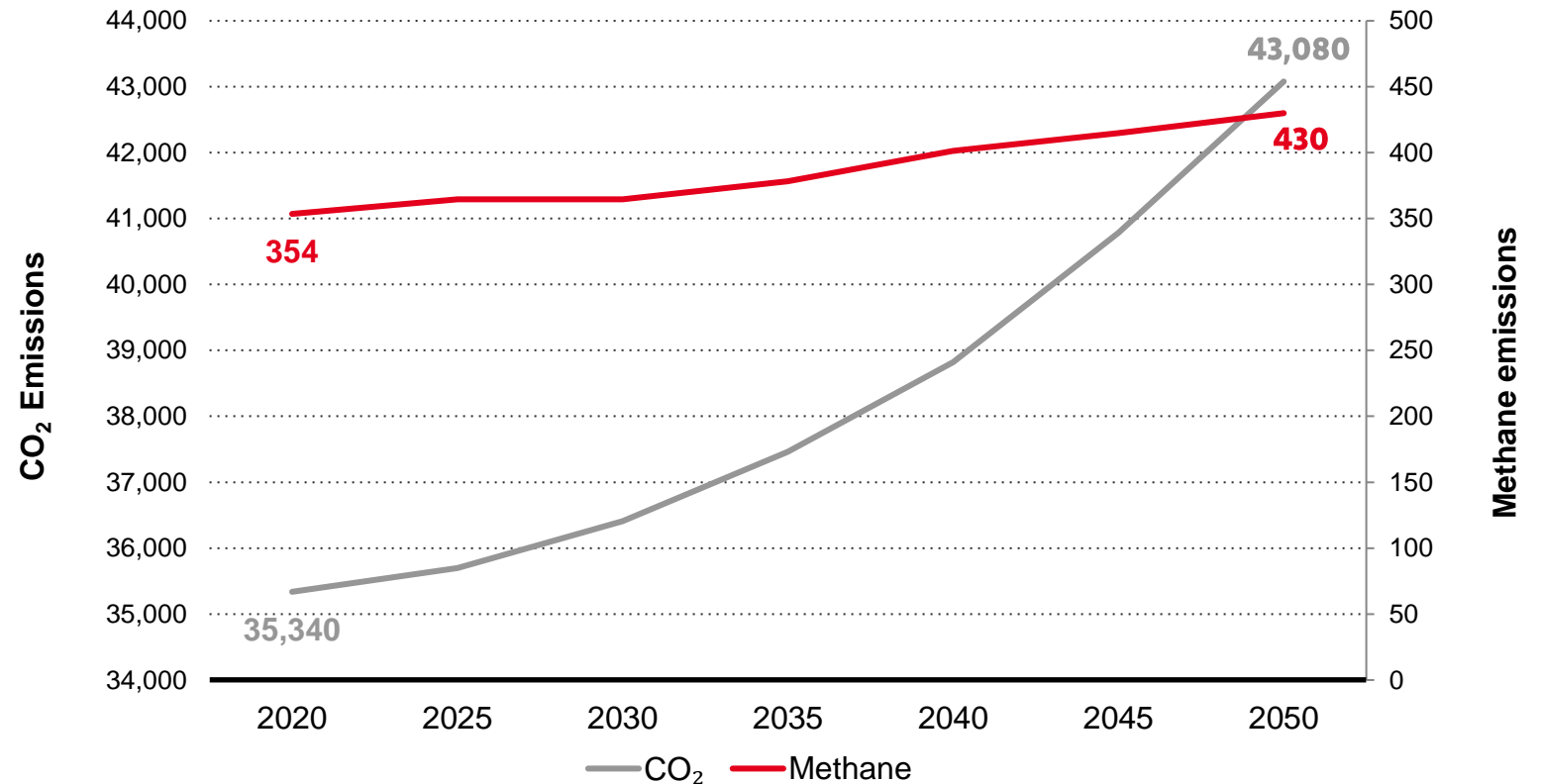
“Methane emissions are the **second-largest cause of global warming** today.”

Immediate and major reductions in methane emissions are necessary for gas to play a supporting role in the energy transition.

Methane emissions worldwide are expected to reach 430 million metric tons in 2050, growing by 22% versus 2020.

Source: International Energy Agency (IEA) [\(Link\)](#)

Forecast of emissions worldwide
from 2020 to 2050 (million metric tons)



Source: Statista.com, 2021

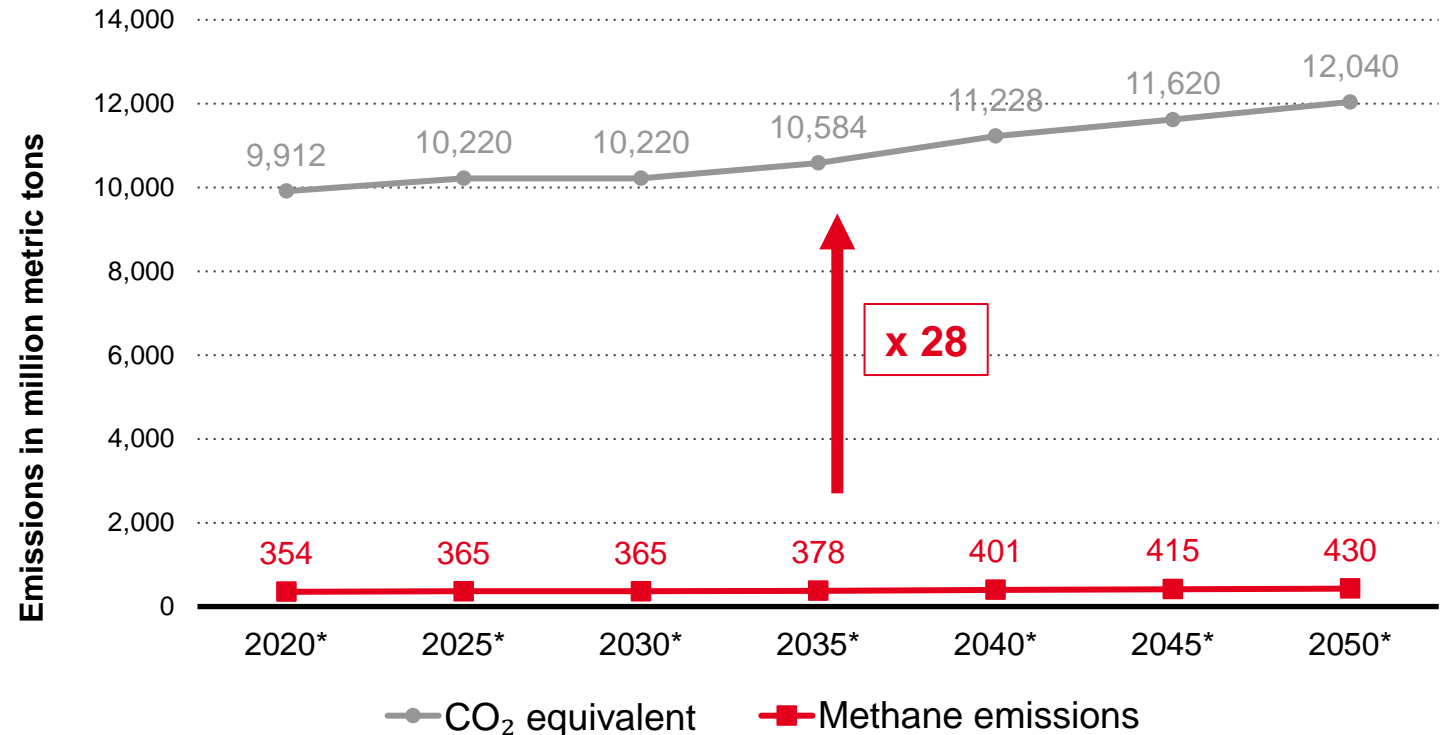
Methane: 28 times more harmful than CO₂

According to the Intergovernmental Panel on Climate change (IPCC), the 100-year Global Warming Potential of **one tonne of Methane corresponds to 28 tonnes of CO₂**.

By 2050, an estimated 430 million tonnes of **Methane emissions will become the equivalent of 12,040 million tonnes of CO₂**.

Source: Greenhouse Gas Protocol ([Link](#))

Real vs. CO₂ equivalent¹ Methane emissions worldwide from 2020 to 2050 (million metric tons)



¹ Conversion into CO₂ equivalent based on the 100-year Global Warming Potentials (GWP) as reported by the IPCC 5th Assessment Report (IPCC, 2014) : one tonne of methane is equivalent to 28 tonnes of CO₂.

Oil & Gas: dramatic decrease of methane by 2030

Oil & Gas operations

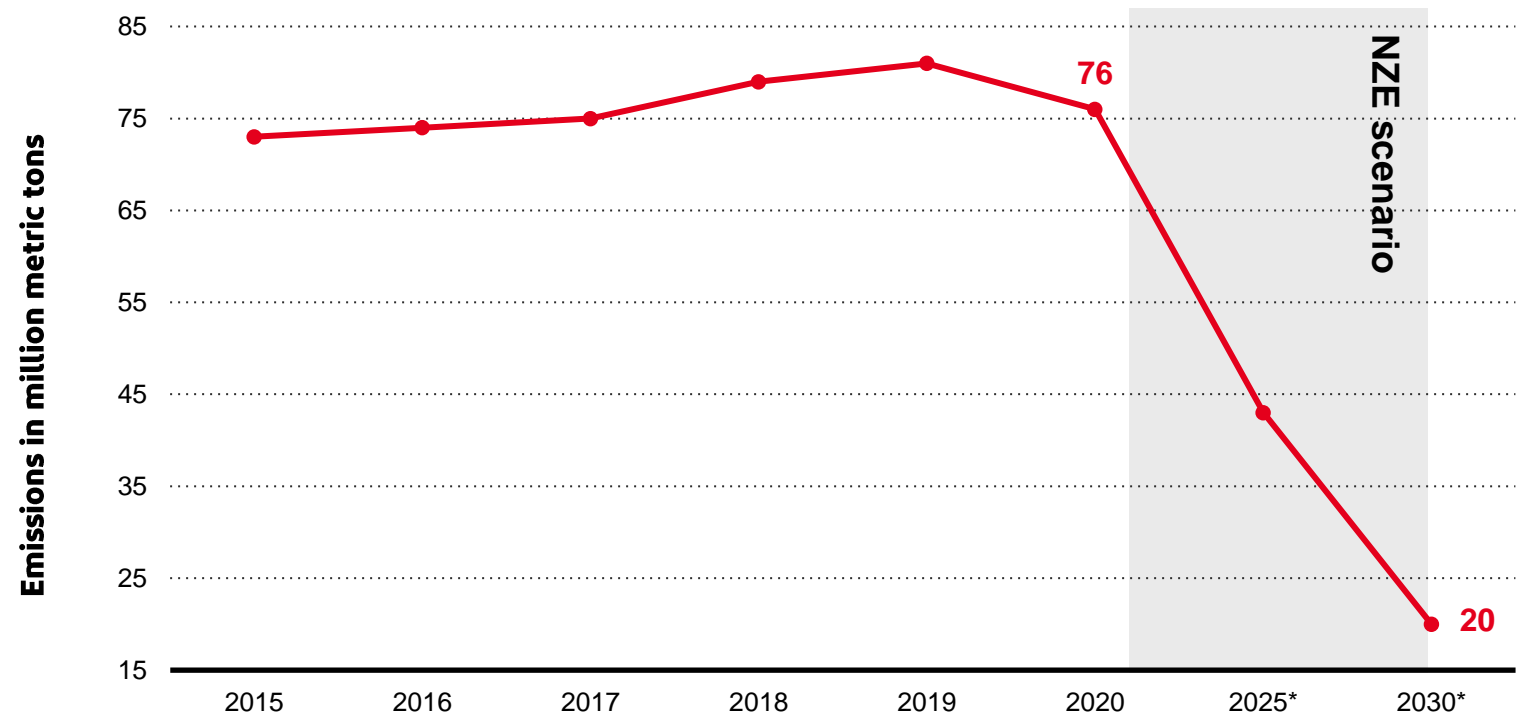
worldwide account for around **20% of global methane emissions**. This total, **equivalent to more than 1960 million tonnes of CO₂**, broadly corresponds to the entire energy-related CO₂ emissions from the European Union.

Under the Net Zero Emissions by 2050 Scenario, **total methane emissions from fossil fuel operations must fall by around 74% between 2020 and 2030**.

Source: International Energy Agency (IEA) ([Link](#))

Oil and gas sector methane emissions under the Net Zero Emissions (NZE) Scenario

worldwide from 2000 to 2030 (in million metric tons)



Source: International Energy Agency (IEA) ([Link](#))

Gas valves, the main source of fugitive emissions

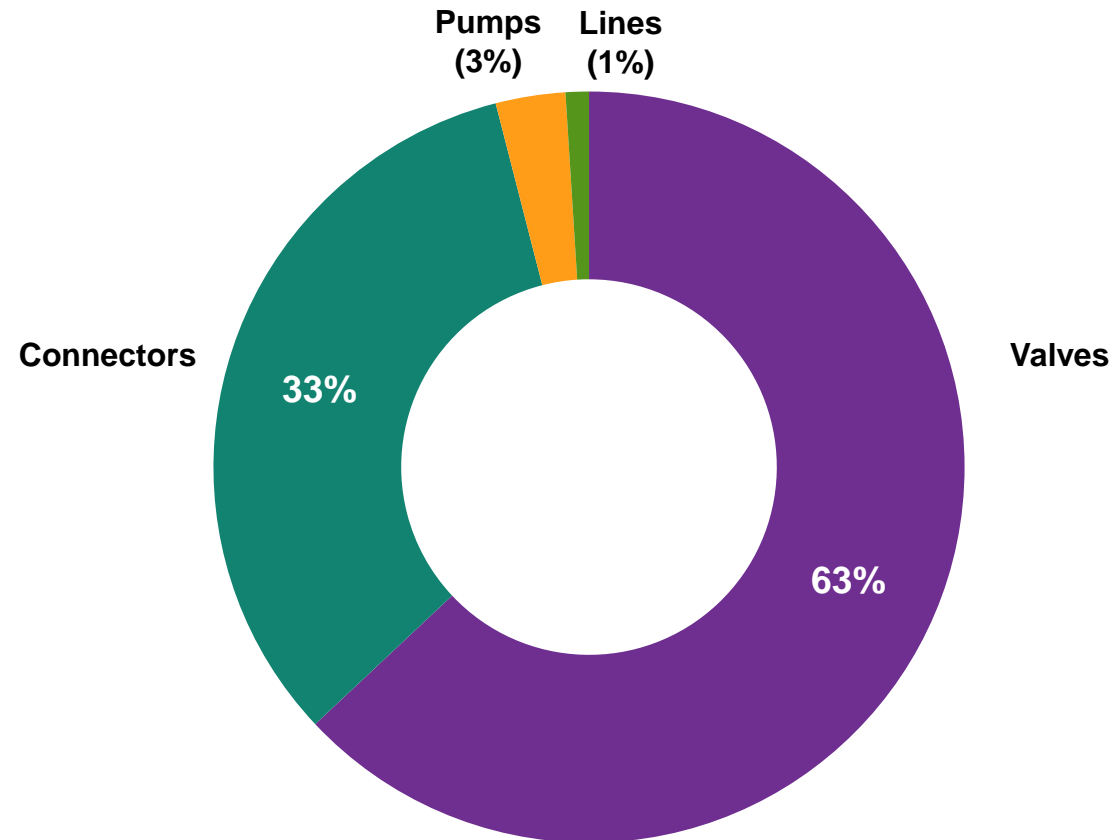
According to the IEA, **60% of total Methane emissions are originated from leaks** across the natural gas value chain.

According to the EPA, **63% of all methane fugitive emissions originate from valves.**

Therefore, if the NZE Scenario is to be achieved, addressing fugitive emissions coming from valves is a priority

Source: International Energy Agency (IEA) [\(Link\)](#)

Fugitive Emissions Sources



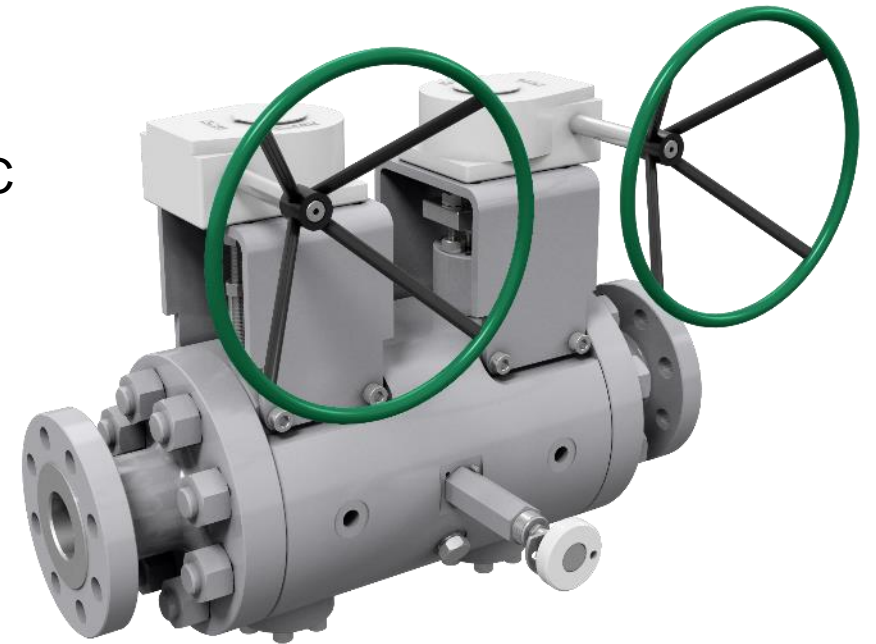
Source: valveuser (e-magazine) [Website](#)

Oliver Twinsafe[®] Valves and Vespel[®] parts value proposition for fugitive emissions reduction

Stem pack for fugitive emissions class B (-50 to +350°C)

Oliver Valves, one of the world's leading manufacturers of Instrumentation, Piping, Subsea and Hydrogen & Carbon Capture and its subsidiary Oliver Twinsafe® Valves, global experts in engineering and production of Double Block and Bleed (DBB) large bore pipeline valves, **have been commissioned to develop a valve capable of sealing to MESG 77/300 fugitive emissions class B standard at a temperature range of -50 to +350 °C**

- **Requirements:** Sealing to MESG 77/300 fugitive emissions class B standard.
Temperature range from -50 to +350 °C
Withstand repeated operation cycles
- **Critical component:** Stem pack
- **Incumbent solutions:** Graphite, PEEK & PTFE



Overview of existing stem pack technologies

- 1) Five ring braided graphite, scarf cut stem pack.
- 2) Carbon filled PEEK dynamic shaped ring sandwiched between four braided graphite rings.

To meet MESG 77/300 fugitive emissions class B standard, both solutions were tested on a 1-13/16" 10,000psi valve with nominal stem diameter of 40mm. Test pressure = 300 Class*

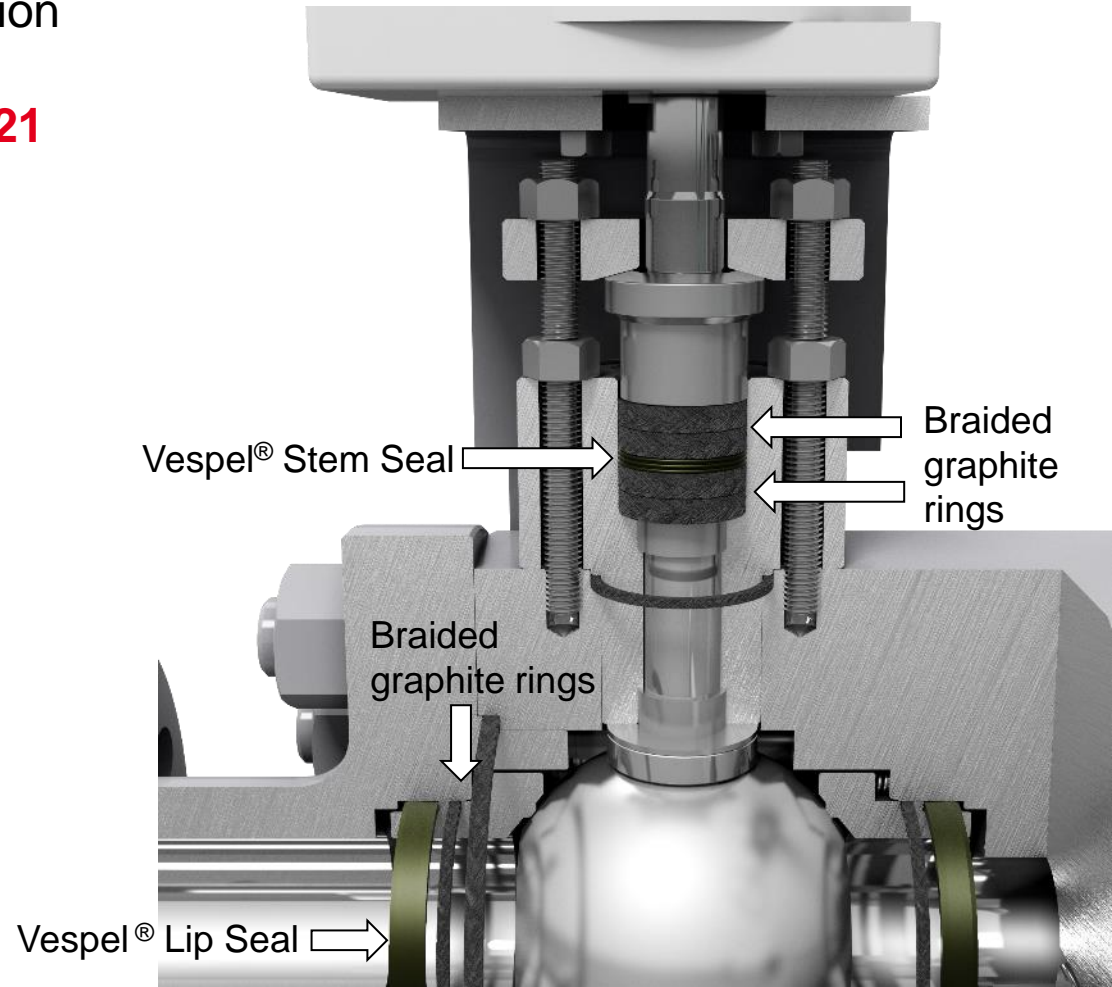
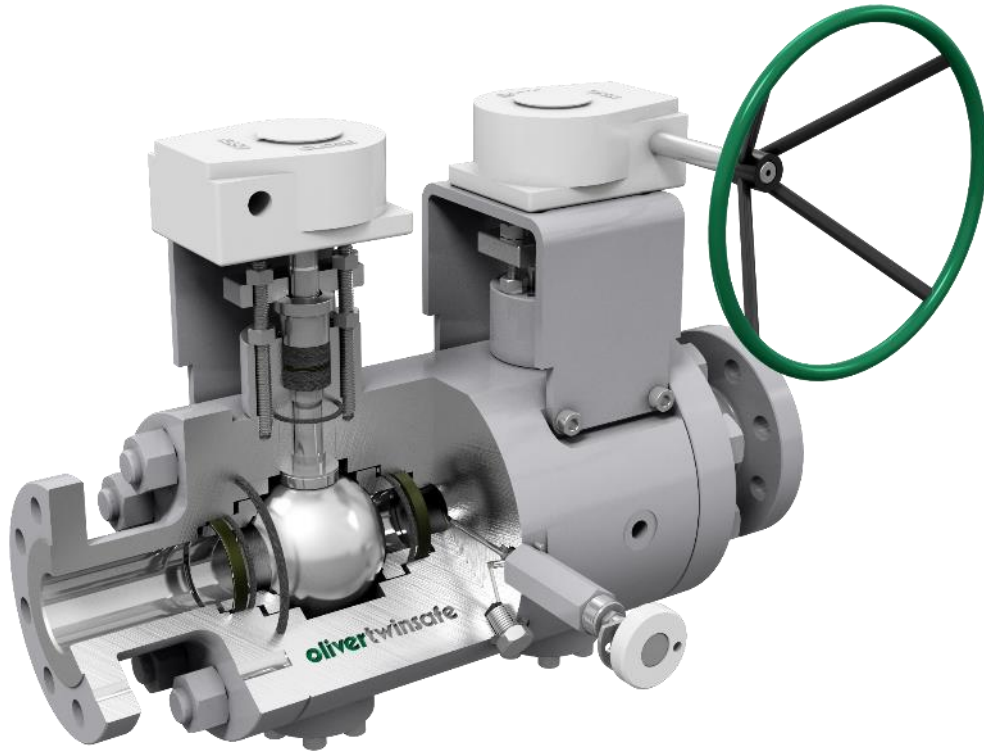
		Pros	Cons	Conclusions
Stem Ring Material	Braided Graphite	<ul style="list-style-type: none"> Wide temperature range Dimensional stability Availability 	<ul style="list-style-type: none"> Pervious to Helium. Does not meet the acceptable leakage rate even at ambient temperatures Its sealing effectiveness diminishes as the number of operations increases. 	<ul style="list-style-type: none"> Not adequate to meet MESG 77/300 fugitive emissions class B standard of 7.12×10^{-5} mbar.l/s
	Graphite + Carbon filled PEEK	<ul style="list-style-type: none"> Excellent sealing properties at ambient temperature, even after repeated operation cycles. Within the MESG 77/300 fugitive emissions class B standard at temperatures up to 300 °C 	<ul style="list-style-type: none"> Past 300 °C, unable to meet acceptable leakage requirement due to excessive extrusion. Lower dimensional stability: excessive leakage remains at ambient temperature, after +300 °C cycle. 	<ul style="list-style-type: none"> Acceptable solution for max 300 °C Opens the door to testing / finding a combination of graphite with the right polymer solution.

*Test details: 1-13/16" 10,000psi valve with nominal stem diameter of 40mm. Test pressure = 300 Class. Test media = Helium 97% minimum purity. Acceptable leakage rate - 7.12×10^{-5} mbar.l/s



DuPont™ Vespel® SP-21 stem pack

Following the promising results of the PEEK solution at low temperatures, Oliver Twinsafe® Valves developed a stem pack version with **Vespel® SP-21 Parts**.

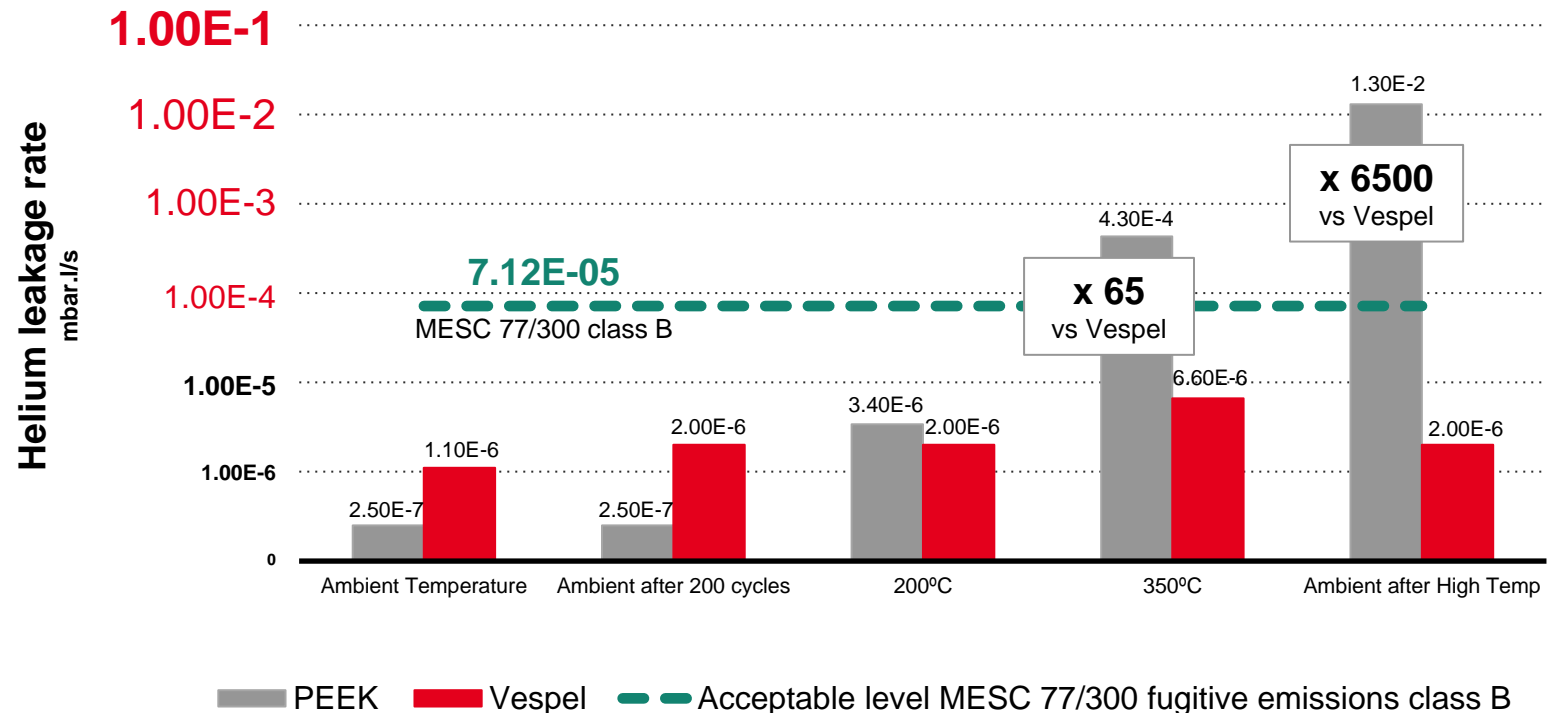


DuPont™ Vespel® SP-21: substantial performance improvement

The new stem pack version with **Vespel® SP-21 parts**, leads to:

- 40% less leakage than PEEK at 200 °C.
- 65 times less leakage than PEEK at 350 °C.
- **6500 times less leakage than PEEK at ambient temperature, after a high temperature cycle.**

Valve Performance Test*
Graphite+PEEK vs Graphite+Vespel Stem Pack



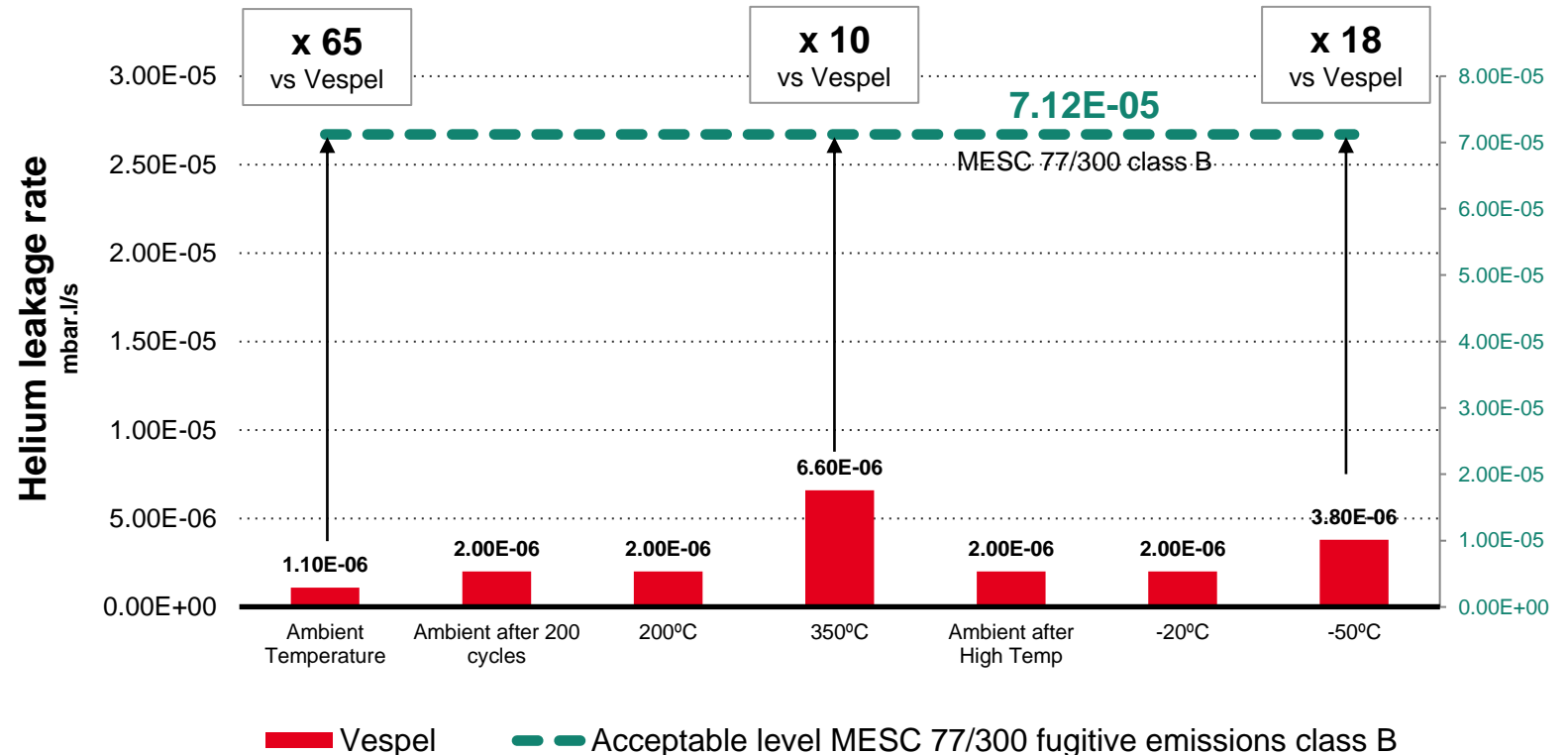
*Test details: 1-13/16" 10,000psi valve with nominal stem diameter of 40mm. Test pressure = 300 Class. Test media = Helium 97% minimum purity. Acceptable leakage rate - 7.12 x 10⁻⁵ mbar.l/s

DuPont™ Vespel® SP-21 parts: delivers beyond the requirement

Apart from representing an important improvement over PEEK, the Oliver Twinsafe® Valves stem pack version with **Vespel® SP-21 parts**:

- Allows **only 1,5% of acceptable leakage** vs MESG 77/300 class B standard at ambient temperature
- **Preserves its sealing capability at 350 °C, reducing 90% of leakage** vs. acceptable level.
- **The same is true at -50 °C**, thanks to high thermal stability of Vespel®
- In less extreme conditions, the Vespel® SP-21 pack version constantly allows **97% less leaks vs acceptable levels**

Valve Performance Test
Graphite+PEEK vs Graphite+Vespel Stem Pack



*Test details: 1-13/16" 10,000psi valve with nominal stem diameter of 40mm. Test pressure = 300 Class. Test media = Helium 97% minimum purity. Acceptable leakage rate - 7.12 x 10⁻⁵ mbar.l/s

**Conclusion: a new milestone
in fugitive emissions control**

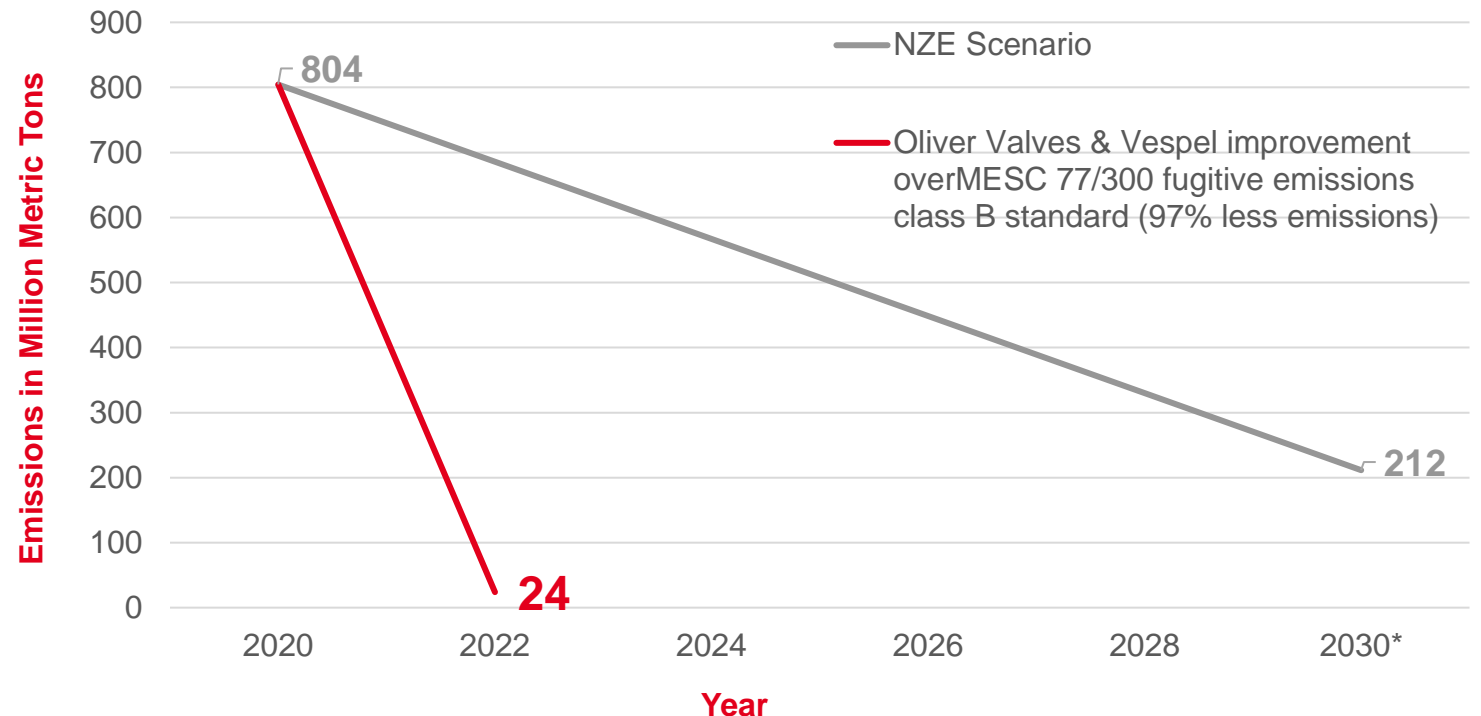
Oliver Twinsafe® Valves & Vespel® Parts: a benchmark for the industry

Oliver Twinsafe® Valves with Vespel® SP-21 parts have demonstrated that it is possible to far exceed the acceptable leakage rate of 7.12×10^{-5} mbar.l/s.

If an improvement such as this could be extrapolated to the whole natural gas industry, **the 2030 Net Zero Emissions Scenario could become a reality – even today.**

Thanks to this, **Oliver Twinsafe® Valves and Vespel® parts have achieved a new milestone and become a benchmark** in reduction of methane fugitive emissions and opening new possibilities for hydrogen applications.

CO₂ equivalent¹ Methane emissions from Liquid Gas Natural Gas Valves²



¹ Conversion into CO₂ equivalent based on the 100-year Global Warming Potentials (GWP) as reported by the IPCC 5th Assessment Report (IPCC, 2014) : one tonne of methane is equivalent to 28 tonnes of CO₂.

² Assuming 60% of total Methane emissions originated from leaks across the natural gas value chain and 63% of all methane fugitive emissions originating from valves.



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