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

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Where do Vespel® parts and shapes fit?

- Demanding applications, which require high stability along with durable, long-lasting properties
- Low wear and friction
- Extreme temperature environments
- Valve sealing, due to compliant nature of Vespel® compared to conventional metals & plastics
- Reduction of fugitive emissions, thanks to low permeability of light gases including hydrogen

Vespel® can also be machined to tight tolerances if needed

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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."

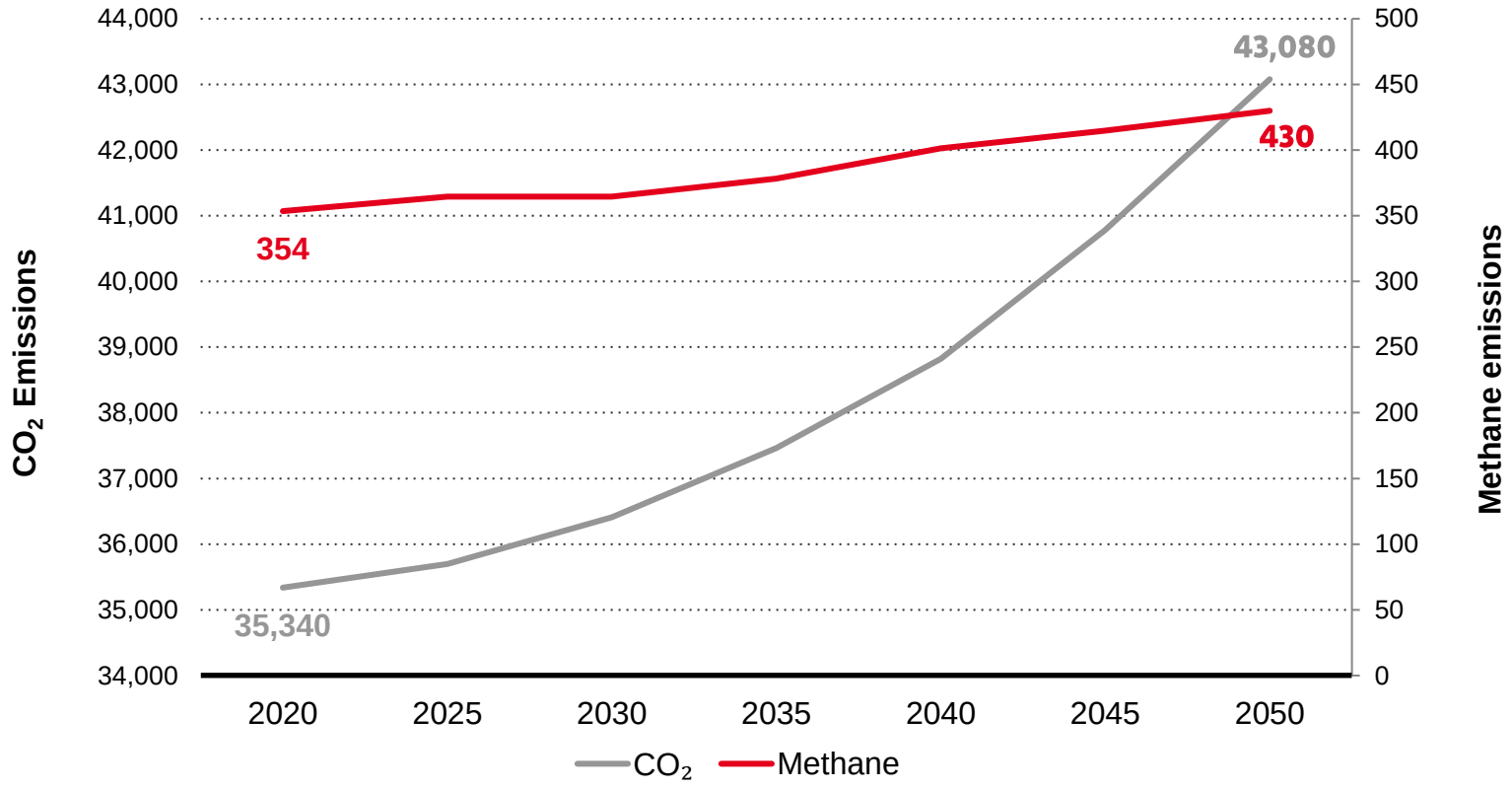
Immediate and major reductions in methane emissions are necessary for gas to play a supporting role in the energy transition.

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

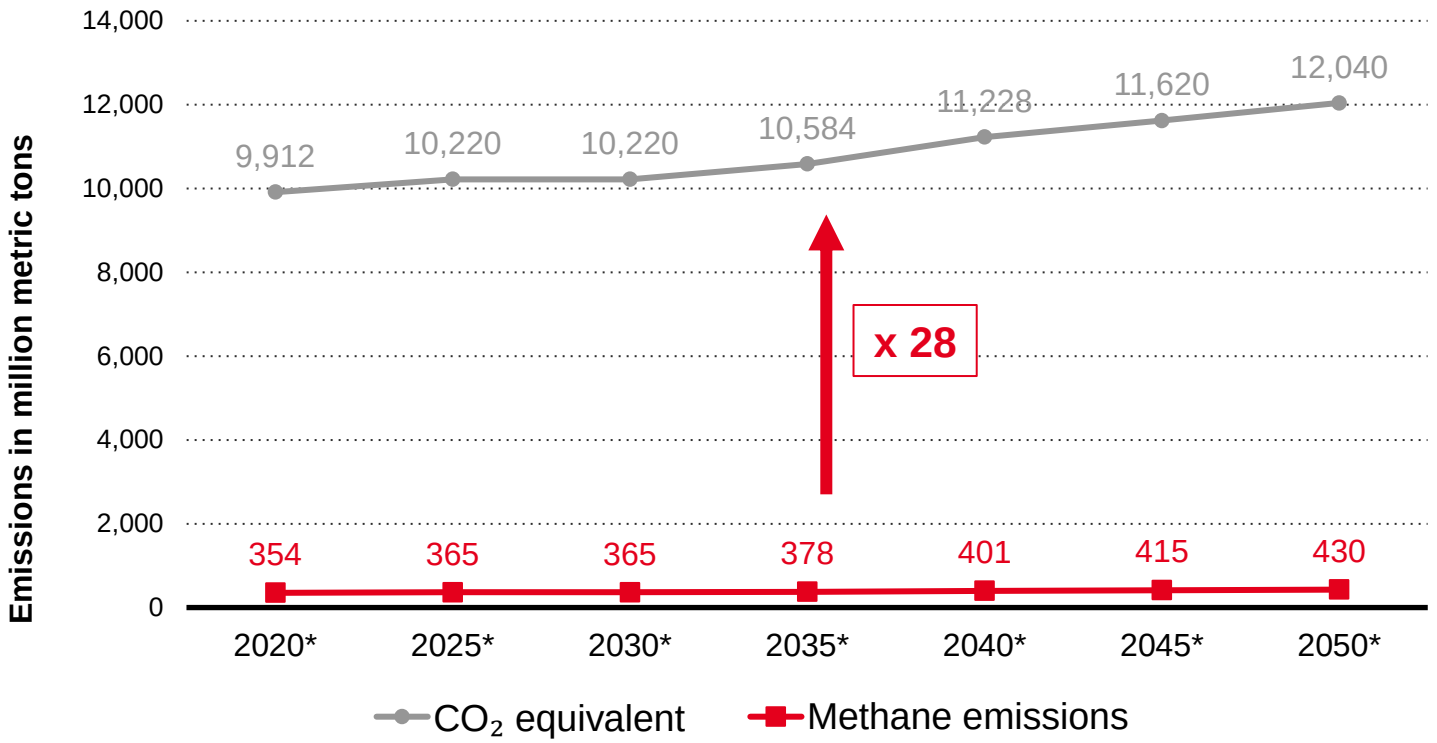
Methane: 28 times more harmful than CO_2

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 CO_2**.

By 2050, an estimated 430 million tonnes of **Methane emissions will become the equivalent of 12,040 million tonnes of CO_2**.

Source: Greenhouse Gas Protocol (Link)

Real vs. CO_2 equivalent[1] Methane emissions worldwide
from 2020 to 2050 (million metric tons)



[1] Conversion into CO_2 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 CO_2.

Oil & Gas: dramatic decrease of methane by 2030

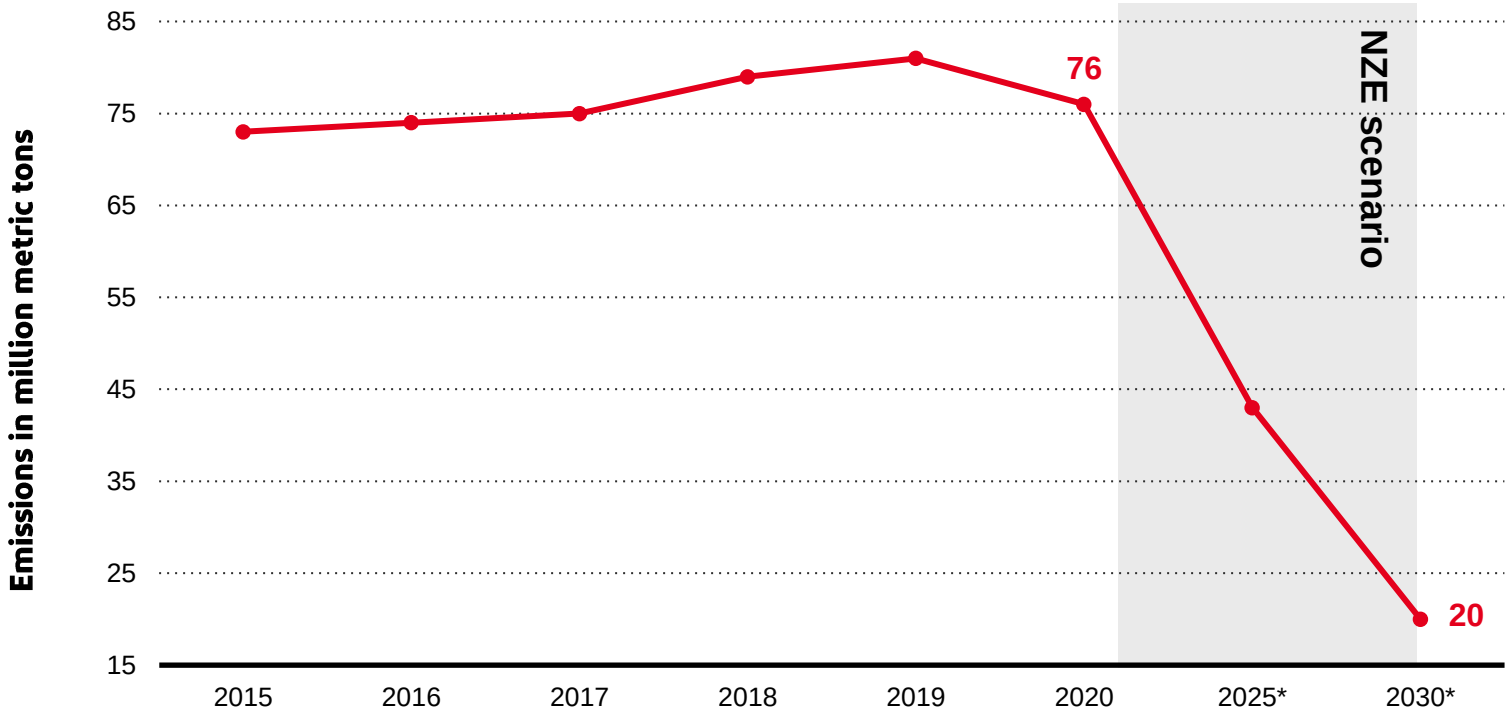
Oil & Gas operations worldwide account for around **20% of global methane emissions**. This total, **equivalent to more than 1960 million tonnes of CO_2**, broadly corresponds to the entire energy-related CO_2 emissions from the European Union.

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)

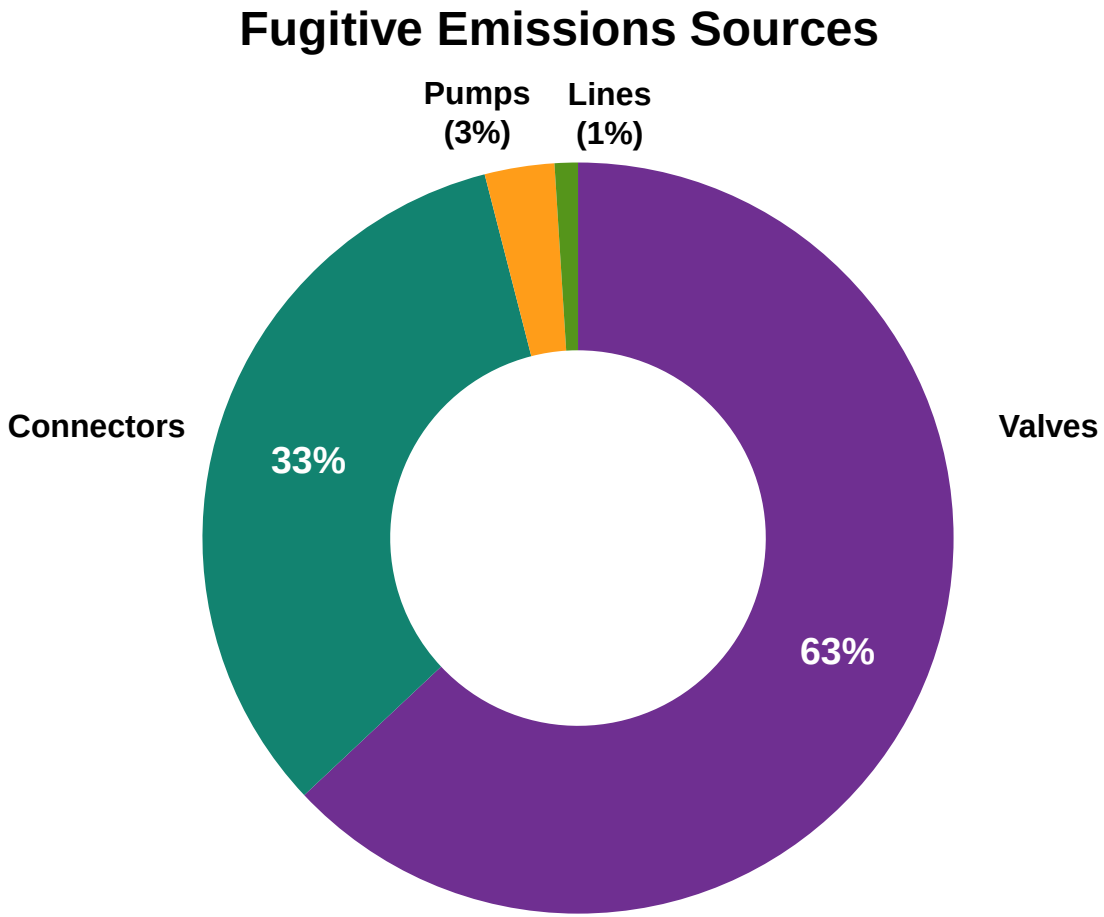
Gas valves, the main source of fugitive emissions

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)



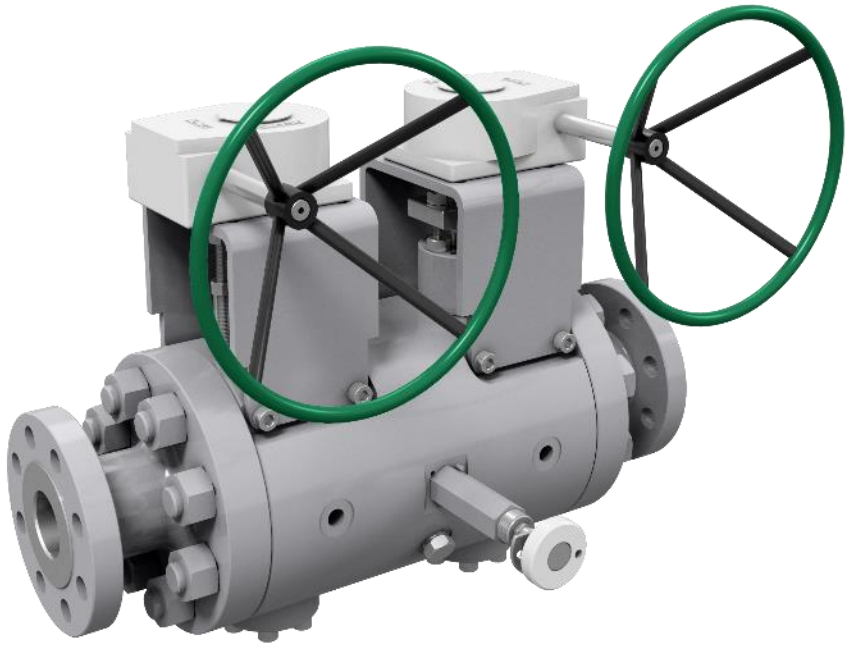
Source: valveuser (e-magazine) Website

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

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

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 MESC 77/300 fugitive emissions class B standard at a temperature range of -50 to +350 ºC**

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



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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 MESC 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*

Stem Ring Material	Pros	Cons	Conclusions
Braided Graphite	▪ Wide temperature range ▪ Dimensional stability ▪ Availability	▪ Pervious to Helium. Does not meet the acceptable leakage rate even at ambient temperatures ▪ Its sealing effectiveness diminishes as the number of operations increases.	▪ Not adequate to meet MESC 77/300 fugitive emissions class B standard of 7.12×10^{-5} mbar.l/s
Graphite + Carbon filled PEEK	▪ Excellent sealing properties at ambient temperature, even after repeated operation cycles. ▪ Within the MESC 77/300 fugitive emissions class B standard at temperatures up to 300 ºC	▪ Past 300 ºC, unable to meet acceptable leakage requirement due to excessive extrusion. ▪ Lower dimensional stability: excessive leakage remains at ambient temperature, after +300 ºC cycle.	▪ Acceptable solution for max 300 ºC ▪ 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 x 10-5 mbar.l/s

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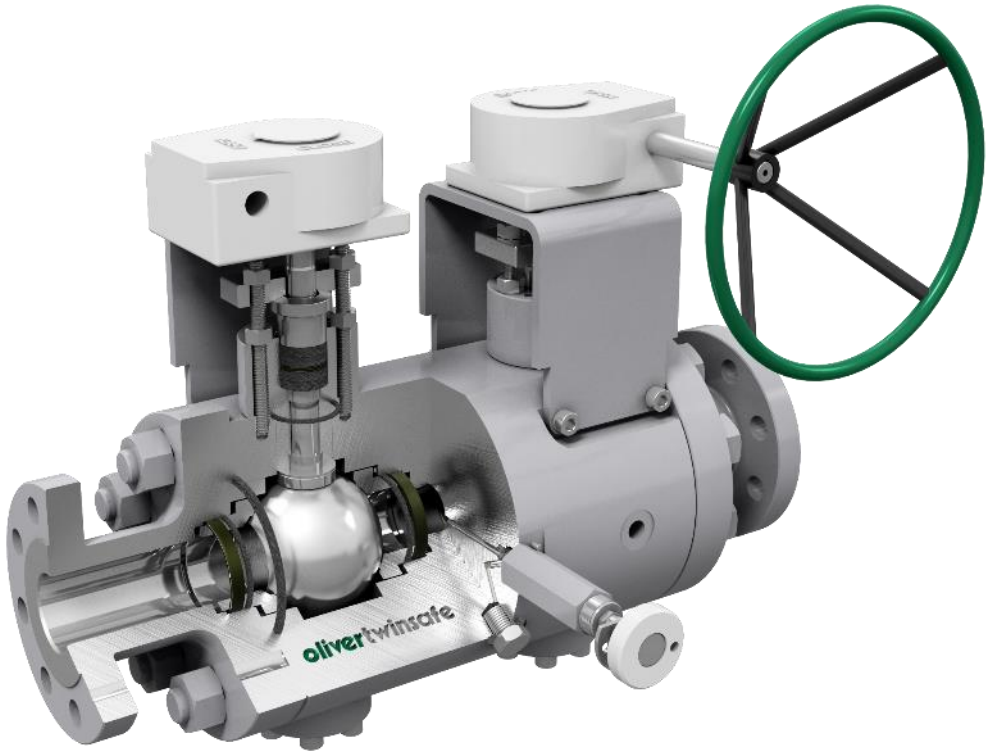
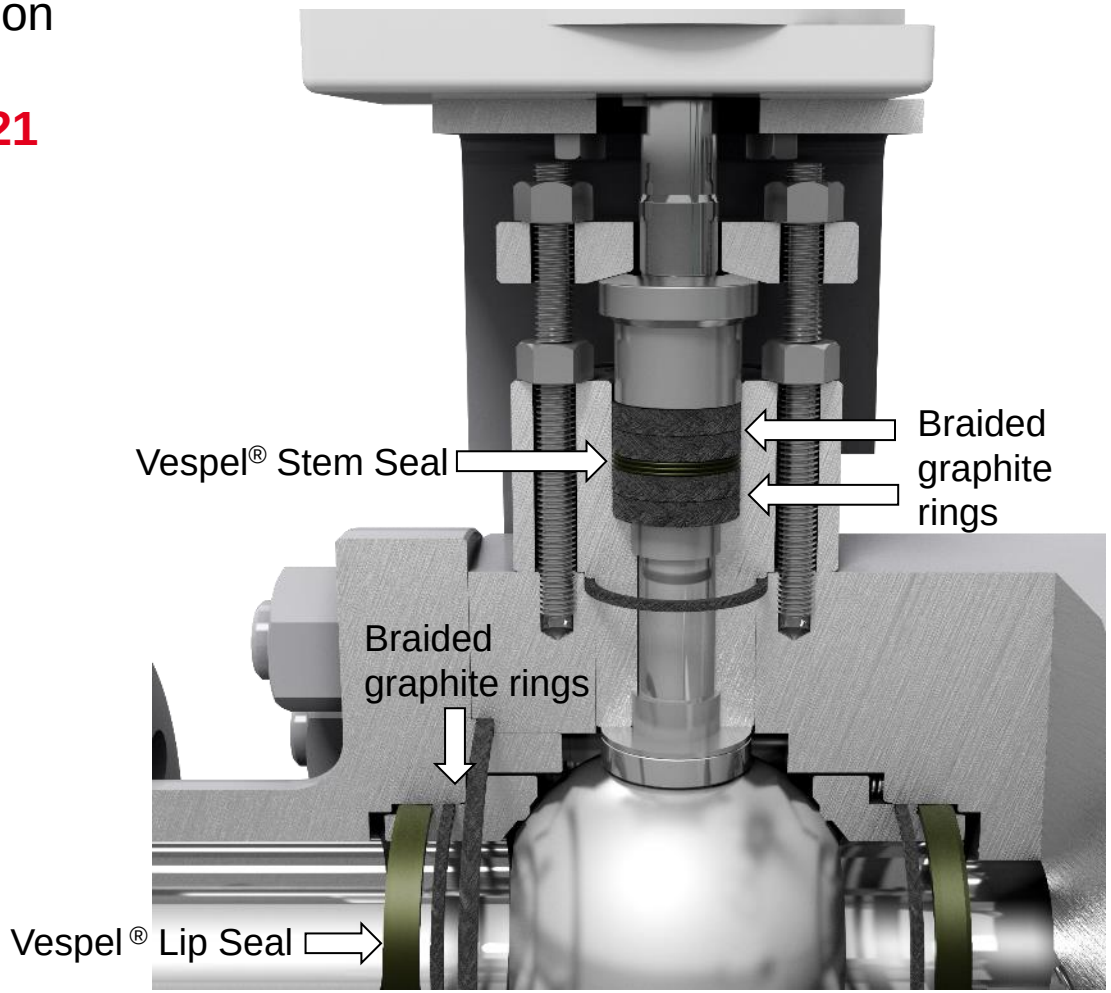
DuPont™ Vespel® SP-21 stem pack

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

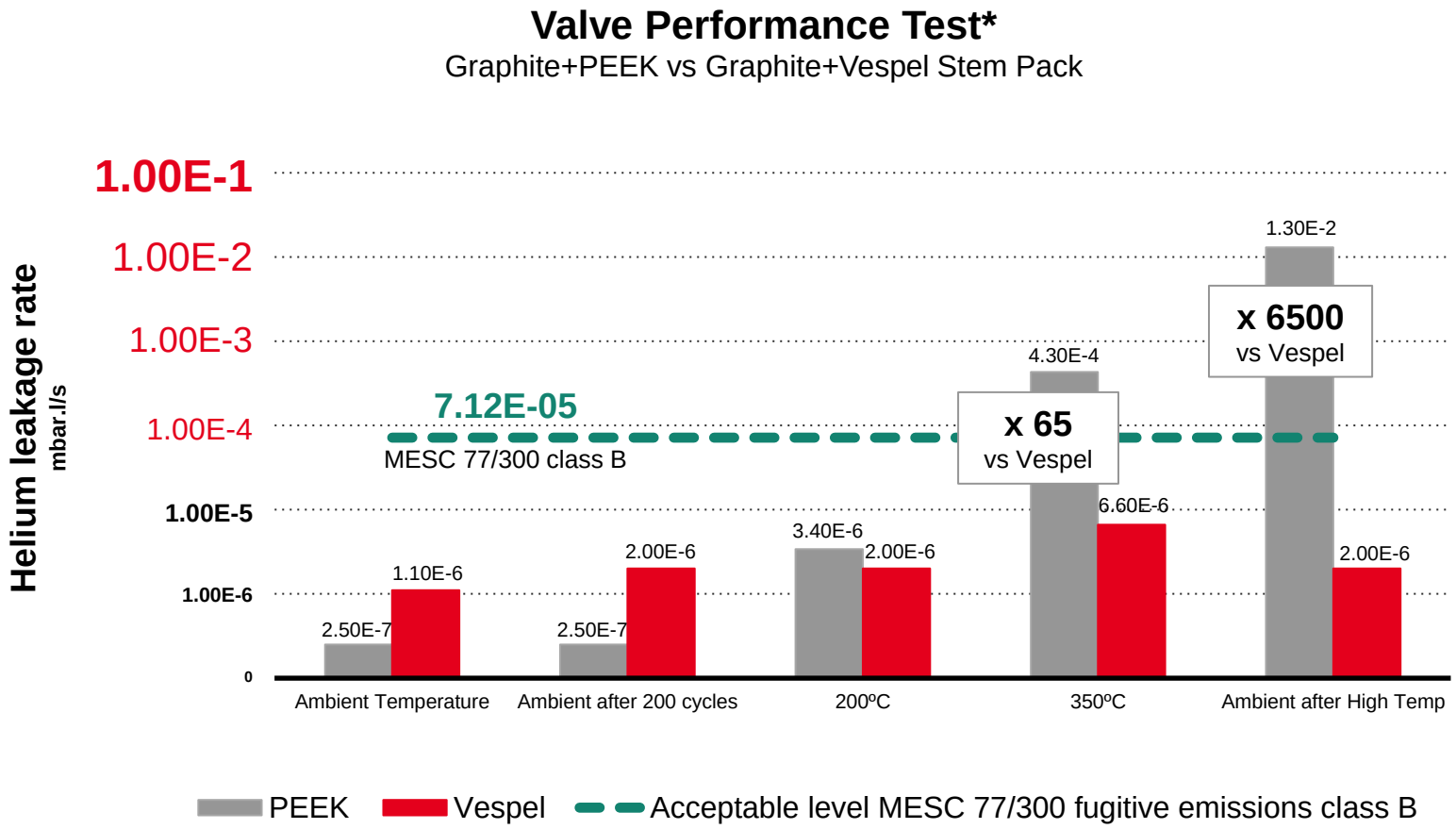




DuPont™ Vespel® SP-21: substantial performance improvement

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

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

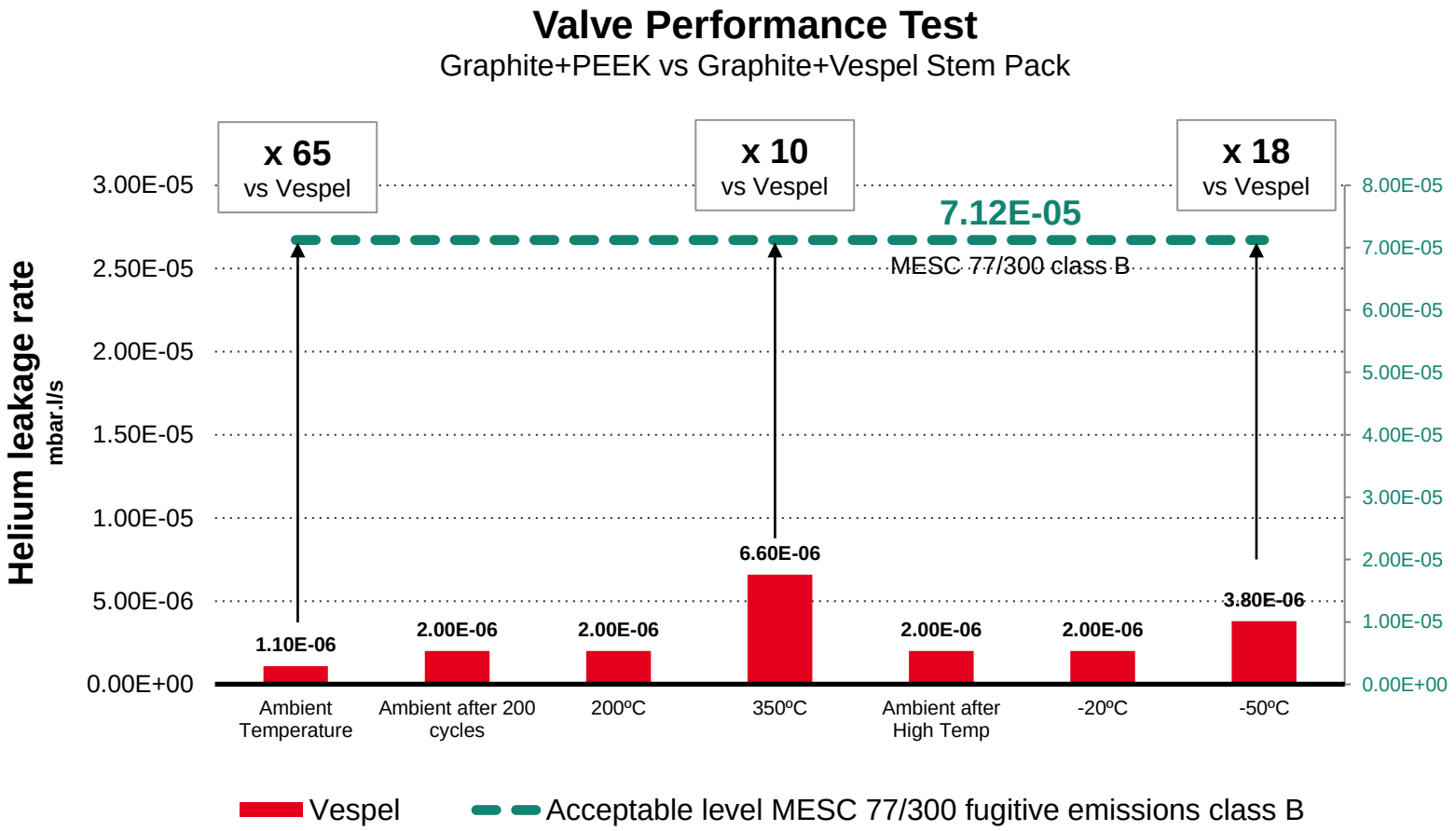


*Test details: 1-13/16” 10,000psi valve with nominal stem diameter of 40mm. Test pressure = 300 Class. Test media =Helium 97% minimum purity. Acceptable leakage rate - 7.12 x 10-5 mbar.l/s

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 MESC 77/300 class B standard at ambient temperature
- **Preserves its sealing capability at 350 ºC, reducing 90% of leakage** vs. acceptable level.
- **The same is true at -50 ºC**, 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**



*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

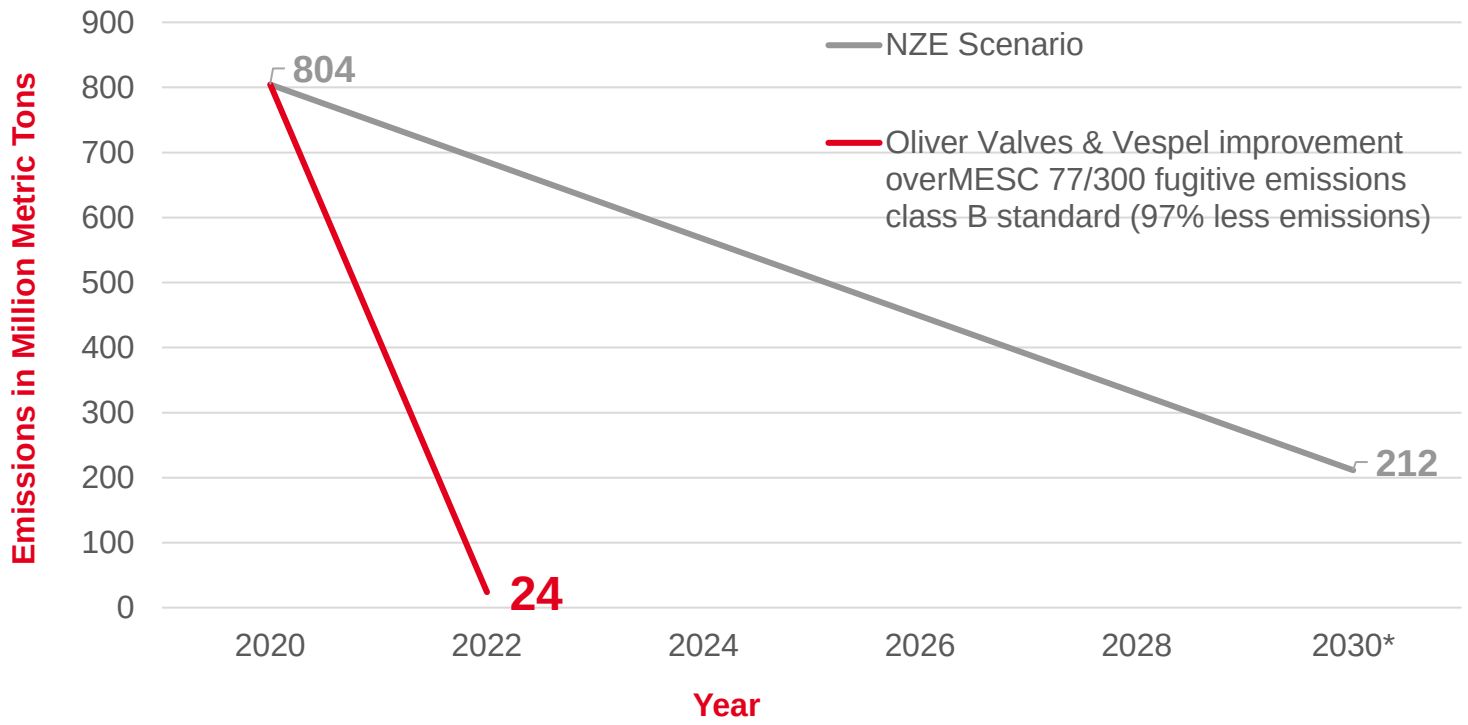
Oliver Twinsafe® Valves & Vespel® Parts: a benchmark for the industry

Oliver Twinsafe® Valves with Vespel® SP-21 parts have demonstrated that it is possible to far exceed the acceptable leakage rate of 7.12 x 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.

CO_2 equivalent[1] Methane emissions from Liquid Gas Natural Gas Valves[2]



[1] Conversion into CO_2 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 CO_2.

[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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