

The Essential Role of Sealing Solutions in a Decarbonizing World: Enabling Cleaner Energy with Advanced Low-Emission Technologies

As global industries accelerate their transitions toward net-zero emissions, a large focus is on renewable energy technologies, carbon capture, alternative fuels, and innovations that reduce the overall carbon footprint across the energy value chain. Behind each of these innovations in decarbonization lies a foundational component that often goes unseen: sealing. Reliable sealing solutions, gaskets, packing, and other components are essential to ensure safety, efficiency, and environmental integrity in the systems driving the energy transition.

Whether minimizing fugitive emissions from valves or maintaining safety in hydrogen systems, advanced sealing solutions help industries navigate the transition to a more sustainable future.

BY ANGELICA PAJKOVIC, JOSMAR CRISTELLO, AND JOHANNES MÜLLER

Containment: A Critical Factor in Clean Energy

Decarbonization refers to the process of reducing carbon dioxide (CO₂) and other greenhouse gas emissions resulting from human activities, with the goal of limiting the impact of climate change. This involves transitioning away from fossil fuels, such as coal, oil, and natural gas, which release CO₂ when burned, and moving toward cleaner, low-carbon, or carbon-free energy sources like wind, solar, and hydro, as well as energy carriers such as hydrogen, and reliable baseload options like nuclear power. Decarbonization also includes improving energy efficiency, electrifying industrial and transportation systems, and implementing technologies like carbon capture, utilization, and storage (CCUS).

At the core of decarbonization is the principle of containment, keeping gases and fluids where they belong, without loss, leakage, or emissions. As governments and industries commit to increasingly strict emissions



standards, the ability to reliably seal process systems becomes a key enabler of progress.

Advanced sealing solutions are thus essential enablers of some of the most promising decarbonization pathways, particularly in high-integrity systems like hydrogen infrastructure. After all, the environmental benefits of hydrogen are undermined if the gas is allowed to leak into the atmosphere, where it acts as an indirect greenhouse gas with global warming potential. Likewise, in nuclear power, effective containment is critical—not

only for operational safety but also to ensure long-term environmental protection.

Supporting the Energy Transition

Hydrogen is a powerful enabler of clean energy and is rapidly becoming a cornerstone of global energy policy. However, its extremely small molecular structure makes it difficult to contain. In electrolyzers, pipelines, compressors, and storage systems, sealing components must perform flawlessly under pressure, temperature, and chemical exposure.

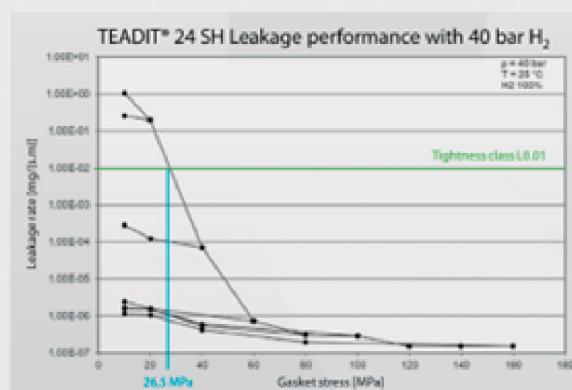
The use of structured and expanded PTFE gaskets offers improved mechanical strength and reduced creep, making gaskets such as TEADIT®'s 24 SH particularly well-suited for demanding environments found in both proton exchange membrane (PEM) and alkaline electrolyzers. These improved material properties help ensure long-term seal integrity under operational stress, boosting the efficiency and reliability of hydrogen production. In addition, PTFE fluoropolymers exhibit excellent dielectric properties, making them well-suited for use in electrically sensitive environments within electrolysis systems.

In the nuclear sector, containment is equally vital. Reactors, cooling systems, and auxiliary infrastructure rely on sealing technologies to operate safely over long periods. As interest in nuclear energy resurges in regions looking for carbon-free baseload power, dependable sealing solutions remain an indispensable part of the conversation. Sealing products must be designed to withstand the high temperatures, radiation, and pressures found in nuclear facilities. While the nuclear sector's presence varies globally, it remains a key part of the clean energy mix, particularly in countries like France, Poland, Canada, and the U.S.

Low Emissions: Mitigating Impact During the Transition

Despite the shift in the global energy mix, conventional energy sources, such as oil, gas, and chemical processing, will continue to play a vital role in meeting global demand. Therefore, low-emission sealing remains a critical component of decarbonization strategies, as it reduces the environmental impact of current operations.

Improved sealing minimizes the fugitive emissions of greenhouse gases and pollu-



Pictured left to right: Leakage performance curve of the TEADIT® 24 SH gasket under 40 bar hydrogen. The TEMESfl. ai test bench is used to test the sealability of gaskets with hydrogen. This is an example of how TEADIT® tests a gasket to understand its performance when sealing hydrogen.



tants from equipment like valves, flanges, and pressure vessels. Low-emission valve packing and spiral wound gasket designs routinely deliver leakage rates far below industry norms, directly reducing the release of methane (CH₄) and volatile organic compounds (VOCs) into the atmosphere. These technologies enable customers to meet stringent environmental regulations while operating more efficiently and sustainably. Though not a decarbonization strategy in the strictest sense, minimizing fugitive emissions is a critical part of lowering the overall carbon footprint of existing infrastructure.

Looking forward

Emerging industries like e-fuels, e-methanol, e-fertilizers, and power-to-liquid technologies are expanding rapidly. Though these sectors are still developing, these industries will require robust sealing solutions tailored to their unique fluid and gas handling needs. From reformers to purification systems, compressors to storage tanks, effective sealing is fundamental to reliability and success.

The same applies to sectors like carbon capture, utilization, and storage (CCUS). While the specific needs may vary, the demand

for safe, high-performance seals remains consistent. These technologies depend on our industry's ability to provide containment under a wide range of pressures, temperatures, and chemical environments.

A Force Behind Clean Energy

Sealing solutions may not be the first technology that comes to mind when considering clean energy, but their role is undeniable. Without effective sealing, hydrogen systems leak, carbon capture fails, and low-emission targets are missed. In short, sealing enables progress, making energy systems safer, cleaner, and more efficient.

As the energy landscape evolves, the role of sealing will only become more essential. From traditional industries adapting to new regulations to frontier technologies leading the charge into a net-zero future, engineered sealing solutions provide the reliability and performance needed to move forward with confidence. Decarbonization is not just about new energy. It is about ensuring every connection, every joint, and every system is sealed for a safer and greener tomorrow.