Greene Tweed: pushing the boundaries of materials innovation

Greene Tweed, a family-owned company with origins dating back to 1863, has consistently demonstrated leadership in advanced materials and high-performance solutions across diverse industries. Headquartered in Lansdale, Pennsylvania, U.S., Greene Tweed specializes in designing and manufacturing high-performance elastomers, composites, and engineered components that tackle some of the most demanding challenges in hydrogen applications and beyond. With a steadfast commitment to innovation, the company is well-positioned to drive technological advancements that support the global transition to clean energy.

By Matjaž Matošec

A legacy of continuous innovation

Founded by the Greene brothers and Henry A. Tweed, Greene Tweed has grown from its beginnings into a global leader in high-performance materials. "Being a privately held, family-owned company allows us to focus on long-term goals rather than short-term financial metrics, which is crucial in the hydrogen sector where development cycles can be extensive," says Philippe Allienne, Business Development Manager – Clean Energies. This ownership structure underpins Greene Tweed's ability to sustain significant investments in research and innovation – a necessity in sectors like hydrogen where rapid advancements are key.

Philippe elaborates on how this long-term perspective drives their operations: "In an industry like hydrogen, patience and sustained investment are essential. The projects we engage in often span years, from the early concept phase to commercialization. A short-term approach would never allow for the level of commitment required to bring meaningful solutions to market."

This commitment to innovation is further strengthened by Greene Tweed's integrated approach to material science and application development. By embedding material formulation expertise within the company, Greene Tweed can tailor solutions to specific industry challenges. "We fine-tune our material recipes based on application needs," Philippe explains. "Our iterative development process involves testing solutions directly with customers and refining them based on feedback, enabling faster innovation cycles – essential in a fast-evolving market like hydrogen."

"Our materials and components enable new technologies and applications previously unattainable."

Advancing PEEK through cross-linking

At the core of Greene Tweed's advancements in hydrogen applications is its pioneering work with PEEK (Polyether Ether Ketone), a high-performance thermoplastic polymer known for its exceptional mechanical strength, chemical resistance, and thermal stability. "We found a way to improve the performance of PEEK materials by cross-linking them," Philippe explains. "This process creates additional bonds between molecules, enhancing chemical compatibility,

The founders of Greene Tweed: J. Ashton Greene (left), John W. Greene (center), and Henry Tweed (right)

"We are not just a supplier – we are a partner in innovation."

mechanical strength, and temperature resistance."

This innovation has been foundational to the development of the Arlon® XT family of materials, which includes Arlon 3000XT® and its variants, Arlon® 3555XT and the recently launched Arlon® 3160XT. These materials are tailored to address the specific requirements of hydrogen applications across the value chain, addressing challenges such as high pressures, extreme temperatures, and hydrogen's high diffusivity.

Evolution of Arlon 3000XT®

One of Greene Tweed's flagship materials, Arlon 3000XT®, was initially developed for the oil and

The Arlon® XT family consists of PEEK materials cross-linked by Greene Tweed to enhance performance

gas industry. "About ten years ago, we worked with customers in oil and gas who were drilling deeper and encountering higher pressures and temperatures," Philippe recalls. "They were

Arlon® 3160XT: a groundbreaking material

Arlon® 3160XT is a new glass-reinforced, cross-linked PEEK material designed for fuel cell, electrolyzer, and valve components, launched in January 2025. With exceptional creep resistance and electrical insulation properties, Arlon® 3160XT represents a significant advancement in materials science, addressing critical needs in hydrogen applications.

Arlon® 3160XT tackles significant material challenges in scaling hydrogen production, storage, and utilization by enhancing performance and reliability in key hydrogen systems. Building on the capabilities of Arlon 3000XT®, this new grade delivers improved performance in the most demanding environments.

Arlon® 3160XT offers several key features that set it apart. Its creep resistance is over 20 times greater than that of non-cross-linked glass-filled PEEK, ensuring long-term durability under sustained mechanical loads. It also demonstrates significant improvements in elevated temperature mechanical properties (tensile, flex, and shear), with a 30–70% enhancement compared to standard glass PEEK materials. In addition, Arlon® 3160XT maintains excellent electrical insulation properties, resisting degradation in critical electrochemical cells and enabling long operational lifespans. Laboratory tests also indicate improved flame resistance, with enhanced structural integrity following flame exposure.

reaching the limits of standard PEEK materials, so we developed Arlon 3000XT® as a solution."

This cross-linked virgin PEEK material provided the necessary chemical and mechanical properties for downhole connectors. The transition to hydrogen leveraged this experience. "The high pressures, temperatures, and aggressive media in hydrogen applications are similar challenges," Philippe notes. "3000XT became a foundational material for critical components like valve seats and seals."

However, as Philippe points out, hydrogen's unique demands have driven the evolution of the material into variants like Arlon® 3555XT and 3160XT. "Arlon® 3555XT is a lubricated grade designed for wear and friction applications, such as in reciprocating compressors, while 3160XT offers superior creep resistance, making it ideal for high-pressure environments."

Arlon 3000XT®, one of Greene Tweed's flagship materials

Discover Arlon® 3160XT's breakthrough capabilities

Greene Tweed invites industry professionals to join an engaging webinar on 26 February 2025 at 9:00 AM EST (GMT+9). This session will provide an in-depth introduction to Arlon® 3160XT and its applications, highlighting the role of the company's innovations in advancing hydrogen technologies.
If you cannot attend live, a recording will be available on the company's website. Visit the Greene Tweed webinar page to register or view the recording.

Boosting efficiency and durability in electrolyzers and fuel cells

Hydrogen production through water electrolysis is one of the most promising methods for generating clean hydrogen, but it presents specific material challenges. Electrolyzers operate under demanding conditions, often involving aggressive electrolytes like potassium hydroxide (KOH) or acids, coupled with increasing pressures and temperatures aimed at improving efficiency. Traditional materials often fail to withstand such demanding environments.

Elaborating on this, Philippe explains: "Electrolyzers face a host of challenges, from chemical compatibility to mechanical strength, particularly as operating conditions push the limits of existing materials. Our engineered solutions address these issues, ensuring long-term durability and efficiency in these systems. For example, Arlon 3000XT® and its variants provide exceptional resistance to high pressures and temperatures, while maintaining superior containment of the highly diffusive hydrogen molecule. This reliability has made Greene Tweed's materials a standard for components like seals and gaskets in electrolytic systems."

The small molecular size of hydrogen adds another layer of complexity, with its high diffusivity often leading to leaks and efficiency losses. Greene Tweed's advanced materials minimize permeability, ensuring system integrity and durability, even in the most aggressive chemical environments. These solutions contribute directly to improving the scalability and efficiency of clean hydrogen production systems.

In fuel cells, contamination from extractables in materials can poison the system, while creep resistance becomes critical as designs move toward higher pressures and temperatures to boost efficiency. "Fuel cells are a prime example of where the right material choice can make or break a design," Philippe notes. "Our materials are tailored

Greene Tweed's Xycomp® composite impeller

"Together with our customers, we are creating solutions that will power the transition to clean energy."

to meet these needs, ensuring reliability in everything from thin gaskets to structural components."

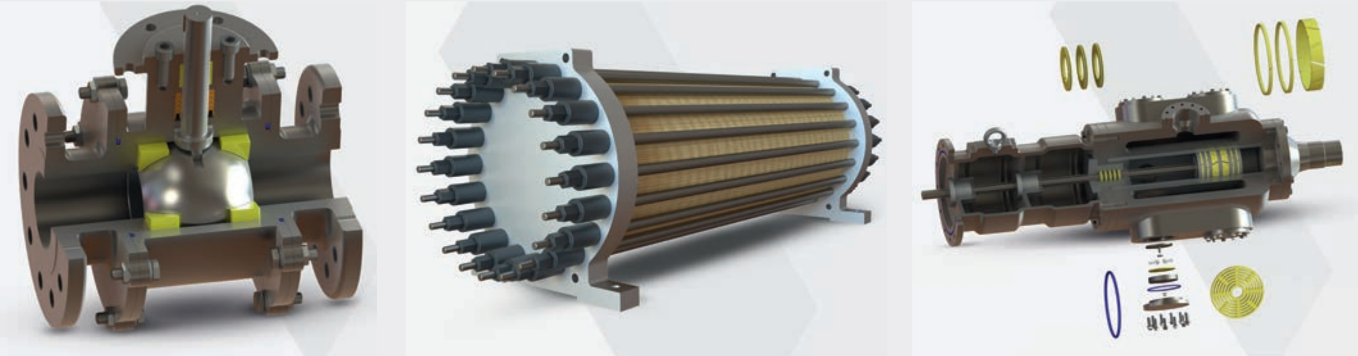
Meeting the increasing demands of hydrogen storage and distribution

Hydrogen storage, transport, and refueling require materials that can reliably handle extreme pressures and temperatures. In these segments, Greene Tweed's materials have proven indispensable. "One of our customers was developing a pressure relief valve for hydrogen refueling stations, targeting pressures up to 1,300 bar and temperatures of around 150°C," Philippe recounts. "Every other material tested failed under these conditions. Our Arlon 3000XT® was the only solution capable of meeting these harsh requirements, and it has since become the default material in their new valve design."

Enhancing hydrogen compression with cutting-edge materials

Compression is a critical step in the hydrogen value chain, with hydrogen's distinctive properties posing significant challenges for traditional systems. Greene Tweed is rising to meet these challenges with cutting-edge materials designed to redefine performance standards.

"The hydrogen molecule has very low lubricity, and these compressors need to be oil-free; otherwise, you risk contaminating the hydrogen," explains Philippe. "This creates a very dry environment, which exacerbates wear and friction issues in reciprocating compressors. At the same time, there is a push to increase



Valve seats and electrolyzer frames are among the key applications of Arlon® 3160XT, while Arlon® 3555XT is targeting dynamic seals and wear parts in reciprocating or hydraulic compressors, among other applications.

operating pressures, but the materials currently used are reaching their limits. Our Arlon® 3555XT, a lubricated, cross-linked PEEK grade, tackles these challenges by enabling reciprocating compressors to handle higher pressures and wear conditions more effectively. This advancement is key, as reciprocating compressors offer greater flow rates compared to diaphragm compressors, which, while effective at high pressures, are inherently limited in flow capacity."

On the centrifugal compressor side, Philippe highlights another challenge: "Hydrogen's very low molecular weight makes it difficult to compress the gas in a centrifugal compressor. Indeed, the compression ratio between impeller stages is a square function of the impeller's tip speed and inversely proportional to the molecular weight of the gas. For hydrogen compression it is therefore necessary to increase the tip speed beyond the strength of current metallic impellers as their high density induces destructive centrifugal forces."

This is where Greene Tweed's Xycomp® composite impellers come in. Developed using unique PEEK-based materials, these lightweight, high-strength components overcome the limitations of metal impellers. "Our second-generation composite impellers have already surpassed tip speeds of 500 meters per second," Philippe says. "We are collaborating with compressor OEMs to refine our designs further, aiming for 620 meters per second – a goal that remains out of reach for traditional metals. These impellers not only improve efficiency but also extend the lifespan of compressor systems by mitigating embrittlement and wear."

The company's R&D teams in the U.S. and Switzerland continue to advance this technology, with a third iteration of composite impellers already under development.

Shaping the hydrogen economy

As hydrogen gradually establishes itself as a key element in the clean energy transition, Greene Tweed is committed to enabling its growth through innovation and collaboration. "Existing materials are often inadequate for the demands of hydrogen applications," Philippe observes. "That's where we come in. Our materials and components not only solve problems but also enable new technologies and applications previously unattainable."

By addressing the challenges across production, storage and transportation, and utilization, Greene Tweed plays a vital role in shaping the future of hydrogen. "We are not just a supplier – we are a partner in innovation," Philippe says. "Together with our customers, we are creating solutions that will power the transition to clean energy."