Greene Tweed
The Inside Advantage®

CHEMRAZ®

Superior Chemical Resistance

Chemraz® Perfluoroelastomer

THE VALUE OF CHEMRAZ®

Greene, Tweed partners with customers to provide reliable, efficient answers to their application needs. As a world-class leader in high-performance materials and engineering design skills, we leverage our expertise in a variety of markets and products to give our customers the most innovative and comprehensive solutions to their performance challenges. With our worldwide network of design engineers, Greene, Tweed delivers local technical expertise with a global reach.

Industry knowledge

Our industry knowledge coupled with our understanding of the design requirements, parameters and specifications enable us to develop both standard and custom solutions quickly and cost effectively. Our experience in demanding environments led us to the creation of Chemraz®, our innovative and most chemical-resistant elastomer.

Broad chemical resistance

Greene, Tweed's Chemraz has the broadest chemical resistance of any elastomeric material, combining the resilience and sealing force of an elastomer with chemical resistance approaching that of PTFE. Chemraz O-rings, gaskets and custom elastomeric shapes extend MTBR (mean time between replacement) in harsh environments and withstand a wide range of temperatures (-22°F to 615°F, -30°C to 324°C).

Chemraz's distinctive chemical composition makes it well suited for a wide range of applications. Because of its low compression set, outstanding physical properties and almost universal chemical resistance, Chemraz provides an incredibly high sealing force. Products such as Chemraz extend the reliability and life of your equipment in hostile conditions while protecting people and the environment from emissions.

Cost effectiveness

Chemraz's unique property set and extended MTBR lowers customers' overall cost of operations. Versatile Chemraz seals work in almost all media, allowing our customers to use the same material in a variety of locations in one plant, lowering inventory control costs.

Market expertise

Greene, Tweed's extensive experience and knowledge in a variety of markets and products helps us create the best solution for each individual customer application. Our experience in several markets is particularly advantageous in the fluid handling arena. Because of our experience in the aerospace industry, we understand how to design seals with very close tolerances and exceptionally smooth surfaces, leading to reduced friction and wear while further improving resistance to chemicals and minimizing extractables. Our experience in the semiconductor and pharmaceutical industries enables us to reduce contaminants through cleanroom environments.

Engineering and application know how

With over 100 years of experience, we have perfected techniques that ensure our customers receive the optimal solution to their performance challenges. Our application engineers are experienced in polymer specialties and equipped with the most up-to-date technology such as 3D modeling, 3D rapid prototyping and FEA capabilities. We partner with our customers—from collaboration on concepts through testing of prototypes to validation and production of finished parts. These close customer relationships give our customers the information they need as we work together throughout the decision-making process.

Chemraz components are available in standard shapes such as O-rings and gaskets, as well as in customer-specific designs, including flat seals, diaphragms, tubing, valve seats and rubber-to-metal connections.

Assurance of quality

All Chemraz components can be traced back through Greene, Tweed's production processes. Each product's bar code carries a unique lot identification number enabling traceability throughout the manufacturing process, from the compounding stage to the completed part.

COMPETITIVE ADVANTAGE IN ANY ENVIRONMENT

Because Chemraz® components withstand a broad spectrum of chemicals and temperatures, they perform well in an array of applications and environments.

Chemicals and refining

Chemraz components offer almost universal chemical resistance, making them ideal for chemical and refining plants where aggressive chemicals are processed. Chemraz prolongs service intervals, enhances plant safety and protects the environment. Chemraz is ideal for a range of equipment, from mechanical seals and pump housings to compressors and valves.

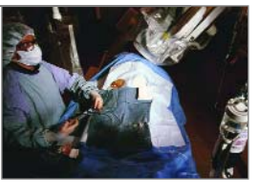
Oil and gas production

Chemraz meets the critical requirements necessary for pumps, safety valves and other oilfield equipment. When ED (explosive decompression) is a concern we have specialty formulated material available.

FDA compliant

Products manufactured under the strictest regulatory standards, including FDA (U.S. Food and Drug Administration) and/or USP (United States Pharmacopoeia) Class VI, require components that provide unceasing reliability, feature total lot traceability, are fabricated using GMPs (good manufacturing practices) and contain minimal extractables. Components made from Chemraz deliver the safety and cleanliness demanding industries require.

Biotechnology



For the biotechnology market, reliability, safety, security and the ability to withstand extreme pressure and chemicals are paramount. Chemraz components provide resistance to a wide range of chemical solvents, extreme pressures and repeat sterilization. From HPLC and lab-on-a-chip to advanced laboratory and analytical equipment and solenoid valves, Greene, Tweed has experience meeting strict performance standards and design guidelines.

Power generation

In modern power stations pressure to keep costs down and heightened environmental awareness demand greater efficiencies, resulting in ever-increasing temperatures. At the same time, power station operators demand optimum reliability and long time between service intervals. Chemraz components help increase MTBR for a variety of applications, including pumps, valves and fittings in conventional and nuclear power stations and in nuclear fuel processing plants.

Paints, lacquers and adhesives

The manufacturing and processing of paints, lacquers and adhesives requires aggressive solvents and cleaning products. Silicone-free Chemraz components resist these media, leading to significantly longer time between service intervals.

HIGH-PERFORMANCE MATERIALS AT A GLANCE

Greene, Tweed's extensive portfolio of Chemraz® materials ensures customers the best compound available for each unique application.

Chemraz 555, 605 and 600—broad chemical resistance

Chemraz 555, our newest compound, offers broad chemical resistance in an extremely wide temperature range, outstanding physical properties and superior compression set resistance. Chemraz 605 and 600 provide the same chemical resistance as Chemraz 505 but with a higher temperature range.

Compound	555	605	600
Shore A Hardness	80	80	90
Temperature Range	10°F to 600°F (-12°C to 316°C)	-4°F to 500°F (-20°C to 260°C)	
Color	Black		

Chemraz 505, 504 and 510—low compression set and low temperature

Chemraz 505 offers broad chemical resistance for a wide range of applications. Chemraz 504 and 510 are softer and harder versions of Chemraz 505. Chemraz 504 is ideal for applications experiencing low forces, while 510 is perfect for high-pressure applications.

Compound	505	504	510
Shore A Hardness	75	65	90
Temperature Range	-22°F to 446°F (-30°C to 230°C)		
Color	Black		

Chemraz 615—for high temperatures

Ideal for continuous high temperatures up to 615°F (324°C) because of its low compression set and outstanding mechanical properties.

Compound	615
Shore A Hardness	80
Temperature Range	0°F to 615°F (-18°C to 324°C)
Color	Black

Chemraz 514 and 517—white compounds

White compounds used wherever carbon black contamination must be avoided.

Compound	514	517
Shore A Hardness	70	80
Temperature Range	-22°F to 428°F (-30°C to 220°C)	
Color	White	

Chemraz 584 and 585—specific media

Ideal for use in strong oxidizing media and hot aqueous solutions.

Compound	584	585
Shore A Hardness	70	80
Temperature Range	-22°F to 428°F (-30°C to 220°C)	
Color	Cream	

Chemraz SD625, SD517 and SD585—compliant compounds

These specialty compounds are USP Class VI and FDA compliant. Additionally, SD625 and SD517 meet 3-A® Sanitary Standards.

Compound	SD625	SD517	SD585
Shore A Hardness	80	80	80
Temperature Range	-4°F to 500°F (-20°C to 260°C)	-22°F to 428°F (-30°C to 220°C)	
Color	Black	White	Cream

Chemraz 526—explosive decompression resistant

Explosive decompression resistant Chemraz with the same chemical resistance as Chemraz 505.

Compound	526
Shore A Hardness	95
Temperature Range	-4°F to 482°F (-20°C to 250°C)
Color	Black

SPECIALTY COMPOUNDS FOR SPECIFIC REQUIREMENTS

Greene, Tweed's engineering experts work side by side with customers to find the best possible material and design for every application. The following sections highlight some specialty elastomers that were designed to meet the needs of specific challenging applications.

	FDA and USP Class VI Compliant	3-A Sanitary Standards
Chemraz® SD625	X	X
Chemraz SD517	X	X
Chemraz SD585	X	

Compliance to U.S. FDA regulations is critical for those manufacturing products for the food and drug market. Greene, Tweed constantly strives to provide seal components that optimize both mechanical and physico-chemical (absorption and extractables) performance. As a result, we do things for our customers that other companies are not able to offer. For complete and uncompromising solutions to pharmaceutical or hygienic fluid handling applications, only Greene, Tweed has virtual prototype and test capabilities in house. Our FEA design validations use mock-up equipment to deliver solutions that meet all your compliance needs in innovative ways.

At Greene, Tweed we take compliance seriously. Our reputation is built on the reputation of our customers. All of our compounded materials are third-party compliance tested. No matter what pharmaceutical or hygienic fluid handling process you are working with—or what part of the world you operate in—we deliver the most effective solution possible.

The FDA approves the use of food contact substances via the FCN process (Food Contact Substance Notification) described in Section 409(h) of the Federal Food, Drug and Cosmetic Act (21 U.S.C Section 348(h). In publishing FCNs 000245 and 000247, the FDA confirmed that articles made from the Chemraz perfluoroelastomers SD625, SD517 and SD585 comply with the requirements for repeated use in contact with foods.

Extraction data

All extraction data have been determined by an independent certified test laboratory according to the descriptions in the FDA paragraph 21 CFR, part 58 Good Laboratory Practice for Nonclinical Laboratory Studies:

- Total extractions according to 21 CFR 177.2400(d)(1) (0.2 mg/in² = 3,1 mg/dm²)
- Fluoride extractions according to 21 CFR 177.2400(d)(2) (0.03 mg/in² = 0,47 mg/dm²)

Parts made from these materials can be supplied with a certificate of conformity if required.

Note: For perfluoroelastomers the very strict extractive limitations of FDA article 21 CFR 177.2400 Perfluorocarbon Cured Elastomers should always be applied. FDA article 21 CFR 177.2600 is effective for most other elastomers like EPDM, FKM and NBR. FDA article 21 CFR 177.2400 has much stricter requirements for the total extractions, including limitations for fluorides. As a matter of course, Chemraz SD625, SD517 and SD585 fulfill the extraction limitations of the stricter article.

USP Class VI

The biocompatibility between a plastic or elastomer and a living organism is regulated with tests defined by the USP. Cytotoxicity is determined in the test tube (in vitro), while toxicity to the living organism is determined in the body (in vivo). Chemraz SD625, SD517 and SD585 are USP Plastic Class VI compliant; therefore, they are biocompatible.

Chemraz SD625 has also passed USP Physicochemical Testing <661> and has also been successfully tested to USP Elastomeric Closures <381>. This makes it the most comprehensively tested perfluoroelastomer for the food, drug and biomedical technology markets today.

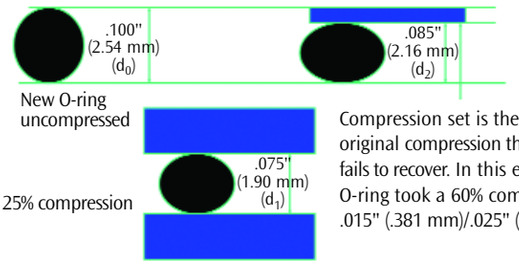
3-A® Sanitary Standards

3-A® SSI (3-A Sanitary Standards, Inc.) is a nonprofit organization serving the U.S. public health community through the development of standards for the advancement of food sanitation and hygiene. Chemraz SD625 and SD517 have passed the 3-A Sanitary Standards for Multiple-Use Rubber and Rubber-Like Materials Used as Product Contact Surfaces in Dairy Equipment, Number 18-03, meaning these perfluoroelastomers meet strict hygienic criteria applicable to dairy equipment and systems.

COMPRESSION SET

Generally, an elastomer's compression set is determined according to ASTM 395B. All tests are carried out in air at a temperature of 400°F (204°C) over 70 hours unless otherwise stated.

Compression set is as follows:



Compression set is the % of the original compression that the O-ring fails to recover. In this example the O-ring took a 60% compression set: .015" (.381 mm)/.025" (.635 mm)=60%

$$\text{Compression set} = \frac{d_0 - d_2}{d_0 - d_1} * 100\ (\%)$$

ASTM 395B states that compression set must be measured on a test body with a diameter of 1.14" (29 mm) and a thickness of .49" (12.5 mm). Although the value for compression set obtained by this method is very low, it is of little significance for parts used in the field. Greene, Tweed's data reflects the compression set obtained on O-rings of size -214 (.98" x .14"/ 24.99 mm x 3.53 mm). These percentages are larger than those obtained on the test body but are more practical for the user.

The table below compares compression set measurements on three Chemraz® materials, first on the size -214 O-ring and second on the ASTM 395B test body, at otherwise identical conditions (70hr, air, 400°F/204°C). Depending on the particular material, the compression set measured in air can be very different from that measured in nitrogen. Chemraz materials deliver superior performance in a wide range of environments.

	With O-ring -214	With test body
Chemraz 505	25%	13%
Chemraz 510	30%	17%
Chemraz 605	20%	11%

Resilience, temperature changes

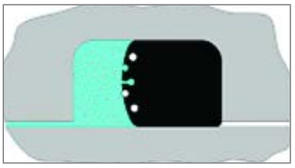
Most methods for measuring compression set only measure resilience. They do not take into account the time taken by a seal to recover or its response to changes in temperature. Many dynamic applications, e.g., mechanical seals or quick-release couplings, require the rapid recovery of an elastomer for the safe functioning of a seal. Chemraz materials excel in these environments by delivering the type of rapid recovery usually associated with rubber.

EXPLOSIVE DECOMPRESSION RESISTANT—CHEMRAZ® 526

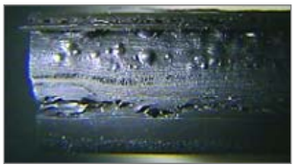
The severe consequences of ED (explosive decompression) occur in elastomers when there is a sudden drop in the pressure of gases, gas compounds or liquefied gases.

All elastomers are more or less permeable. When an elastomer is exposed to a high gas pressure for a certain length of time, it absorbs the gases that settle in the interstices between the elastomer's molecule chains. This process continues until the pressure inside the seal equals the pressure in the surrounding system. The higher the pressure, the more gas is absorbed. If the system depressurizes rapidly, the gas in the elastomer will expand under its own high pressure. If pressure cannot escape from the elastomer fast enough or if the elastomer's structure is not stable enough, bubbles or cracks will form, destroy the seal and lead to a loss of functionality. These problems will continue to occur hours after the drop in pressure. The seal's rapid increase in volume may also cause extrusion phenomena.

The photo below shows an O-ring that has been exposed to rapid depressurization in natural gas extraction at high pressure and high temperature. The ruptures and blisters caused by the sudden and rapid drop in pressure are visible.



Gases penetrating a seal



O-ring exposed to rapid depressurization

When ED is an issue, consider the following when choosing an elastomer: type of gas, temperature, pressure (pressure level, pressure progression, rate of pressure drop) and seal material (hardness, polymer architecture, cross-section diameter and compression).

Components made from ED resistant Chemraz 526 withstand the challenging conditions caused by the mix of high pressures and high temperatures. Chemraz 526 offers superior explosive decompression properties, broader chemical compatibility and an improved low-temperature operating window. Its compression set delivers improved sealing and leak prevention unmatched by the leading competitive material. In addition, the hardness of ED resistant Chemraz 526 significantly reduces the risk of gap extrusion.

COLLABORATING TOWARD SUCCESS

At Greene, Tweed our goal is satisfied customers who look forward to partnering with us again and again. In our efforts to meet and exceed customer expectations we constantly strive to formulate and produce better, more efficient materials that anticipate our customers ever-changing needs.

With fully qualified engineering, sales and support personnel located throughout the Americas, Europe and Asia, Greene, Tweed delivers innovative solutions to individual customer challenges on a global scope. This consistent high level of experience and skill creates a unique customer experience. Our success is based on providing products and services that make our customers successful. We are committed to providing local service and technical expertise to help our customers thrive.

Chemraz® Perfluoroelastomer

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