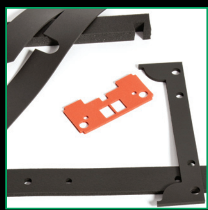






Sealing Design Guide

PORON® Urethane | BISCO® Silicone Materials

ROGERS
CORPORATION

SUCCESSFUL ENCLOSURES RELY ON ALL ASPECTS OF THE DESIGN TO MAKE AN EFFECTIVE SEAL.

This guide presents comparison test data on sealing materials while highlighting essential criteria for long-term sealing solutions in many enclosure applications.

The accompanying research acts as a reference for material selection, while serving to better educate the market on Rogers' materials.

ENCLOSURE STANDARDS

Seals are used in industrial, electrical, and electronic applications to keep in what's meant to be in and keep out what's meant to be out.

Four types of gaskets – strip, die-cut, form-in-place and bulb extrusion – help to seal according to the requirements of four of the most common standards:

- **National Electrical Manufacturer's Association** (NEMA)*: Ratings are numbered. Most common for indoor applications are 12 and 13, while 3, 4, 4x, 6 and 6P are most common for outdoor applications.
- **Underwriters Laboratories®** (UL): Ratings are similar to NEMA.
- **International Electrotechnical Commission** (IEC): IP-XX (ingress protection) codes specify protection required.
- **Canadian Standards Association** (CSA)

*Note: NEMA only provides guidelines, not certification

Multiple factors, including enclosure and gasket design, contribute to successful sealing, but material selection is also critical. If the gasket leaks or must be replaced, enclosure certification can be lost, resulting in lost time and increased expenses, in addition to the damage incurred to the components within.







MATERIAL SPECIFICATIONS

Many engineers prefer to use gasketing materials like PORON® Urethanes and BISCO® Silicones that are already certified for use under several standards, including UL-508 (industrial control equipment), UL-1572 (HID lighting fixtures), and especially UL-50E (electrical enclosures), with testing done to the new periodic recompression standard. These certifications enable designers to evaluate a gasket material without testing the material itself, effectively simplifying the screening process.

MATERIALS

Common materials used to seal enclosures and devices include:

- Silicone
- Neoprene
- Polyurethane
- Polyethylene
- Vinyl Nitrile
- EPDM
- PVC

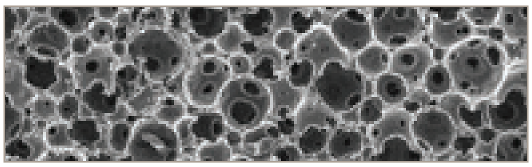
Each chemistry offers various advantages. Enclosure success depends on selecting the best material for the application. Compressibility, environmental exposure, sealing effectiveness, and specifications should be considered when selecting a material.

CELL STRUCTURE

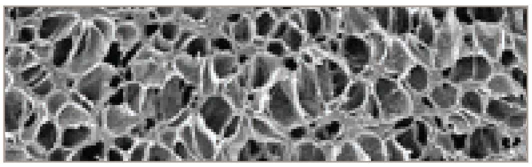
Sealing effectiveness is not dependent on an open or closed cell structure. Material selection should be based on performance, not whether a majority of the cells are completely closed.

Open-cell materials typically resist compression set and force relaxation better than closed-cell materials, but are not as effective at resisting water absorption in an uncompressed state. However, at a certain level of compression the small openings in the cell walls of an open-cell foam will “close off,” resulting in an effective seal.

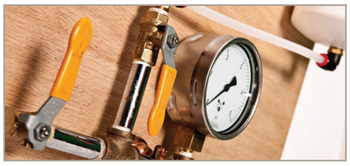
This guide will help determine the appropriate compression needed for “closure” of these cells, while also looking at how other physical properties effect long-term sealing performance.

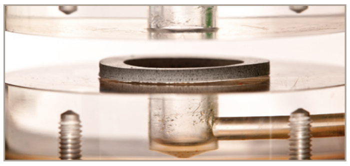


OPEN CELL



CLOSED CELL





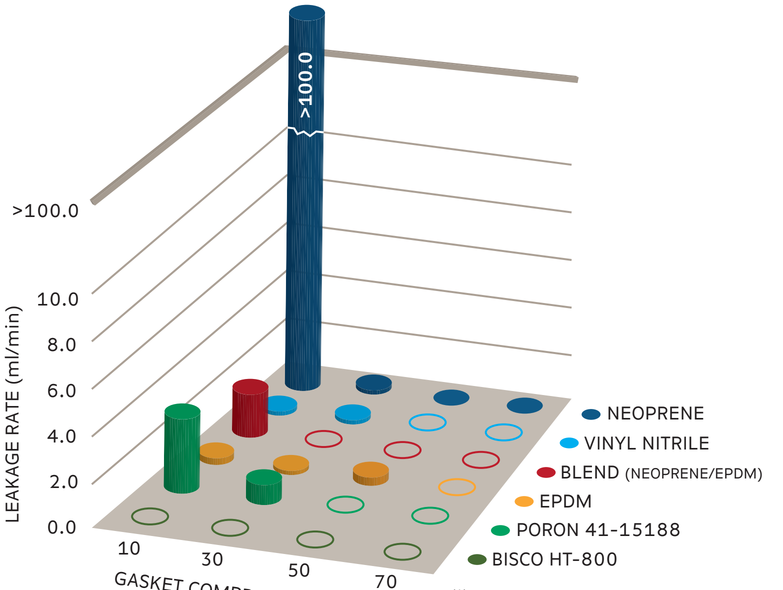
SEALING

Through an extensive water sealing study, many materials were evaluated for initial sealing effectiveness. A high demand scenario was simulated with 1.5 psi (10 kPa) of water pressure on a 0.250 inch (6.35 mm) wide gasket using materials of medium firmness at various compressions. The following chart shows the results:

- At ≥ 50% compression, most materials formed a good seal, but seal quality decreases as compression decreases.

Water Sealing

Pressure: 1.5 psi (10.3 kPa) / Gasket Width: 0.250 in (6.35 mm)
Gasket Thickness: 0.125 in (3.175 mm)[1]



(1) 41-15188 Gasket thickness: 0.188 in (4.775 mm)

LONG-TERM SEALING EFFECTIVENESS

Stress relaxation and compression set resistance are two key attributes that significantly impact long-term performance.

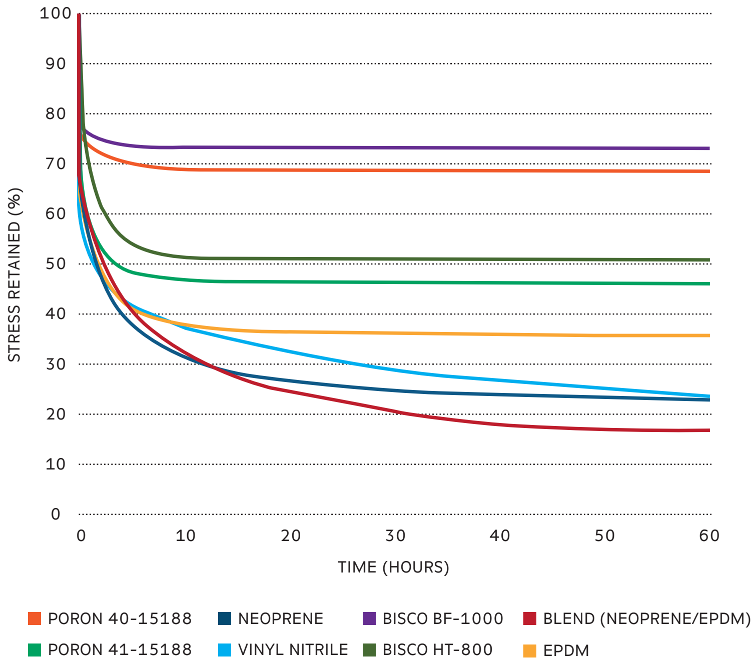
STRESS RELAXATION

Stress relaxation, also known as force relaxation, describes a cellular material's natural tendency to lose its force deflection over time while under continuous compression. Stress relaxation is exhibited by all cellular elastomers, but is more prevalent in certain material types. The curves show multiple material types and the percent of force retention for each over 60 hours of compression.

- Higher performing materials lose less force and level out quickly, maintaining a tighter seal.

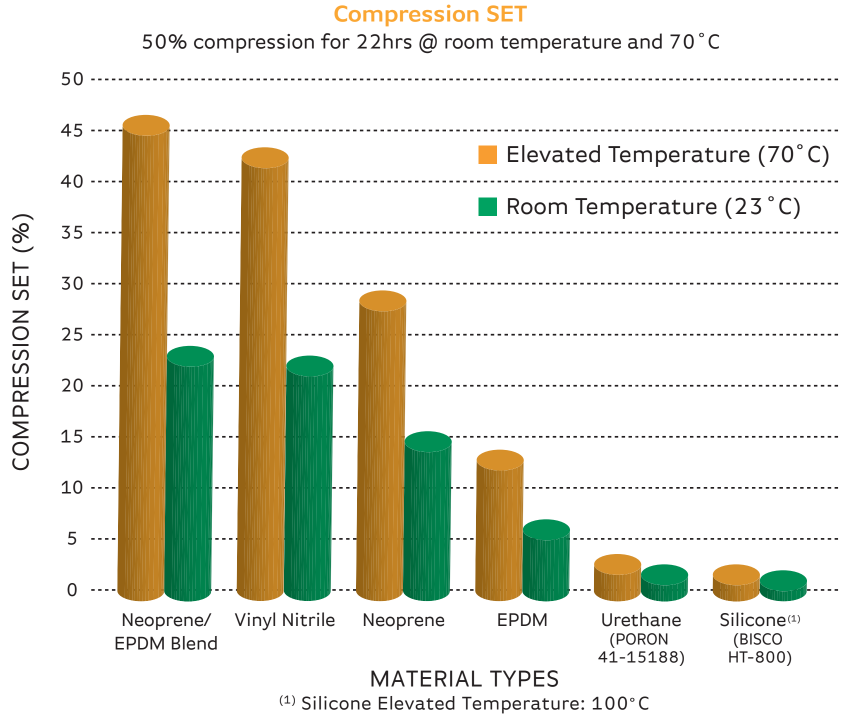
Stress Relaxation Curves

(25% material compression)



COMPRESSION SET RESISTANCE (C-SET)

C-Set resistance is the ability of an elastomer to return to its original thickness after a compression load, under a specified time and temperature, is released.



- Elevated temperature is used to simulate accelerated aging, indicating long-term performance.

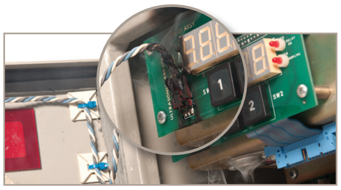
WHAT EFFECT CAN THESE PROPERTIES HAVE ON LONG-TERM SEALING AND PERFORMANCE?

Significant stress relaxation can result in compromised sealing if a gasket no longer fills a gap with sufficient force. Greater force retention helps keep a consistent closure force on a door or panel.

Compression set resistance becomes even more critical when a gasket is exposed to compression cycling. If a gasket takes a significant C-Set, sealing may be compromised as a result of the decreased thickness. This loss of thickness normally takes place over time, and is not always evident during initial testing.

C-SET/STRESS RELAX GASKET

WATER DAMAGE



FIRE DAMAGE

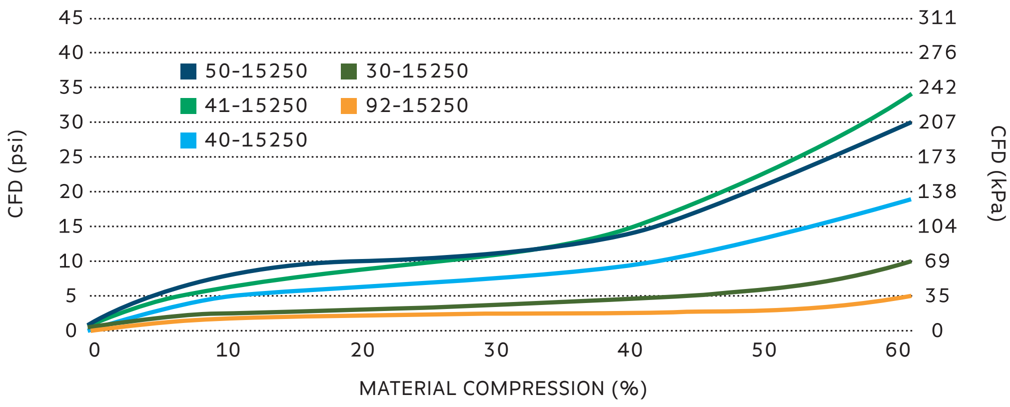
MATERIAL SELECTION

Understanding the key requirements in an application is critical when selecting the right material. Many different application requirements help guide designers to the best material options. When PORON Urethane or BISCO Silicone is determined to be the best material for the application, the optimal grade and thickness must be selected. Two important properties for this determination are compressibility and sealing effectiveness.

COMPRESSIBILITY

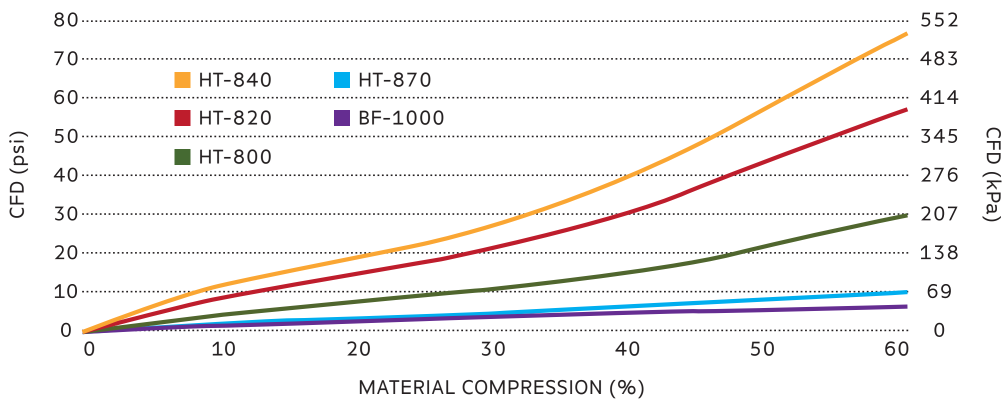
Compression Force Deflection (CFD) curves show the force deflection for each material at various compressions, helping identify when compression resistance may become unmanageable.

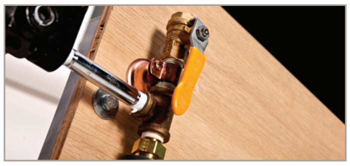
PORON Urethane Compression Force Deflection Curves



- PORON Urethane and BISCO Silicone material offerings are available with a wide range of compression force deflection values and grades ranging from very soft to very firm, making the material selection process much easier.

BISCO Silicone Compression Force Deflection Curves



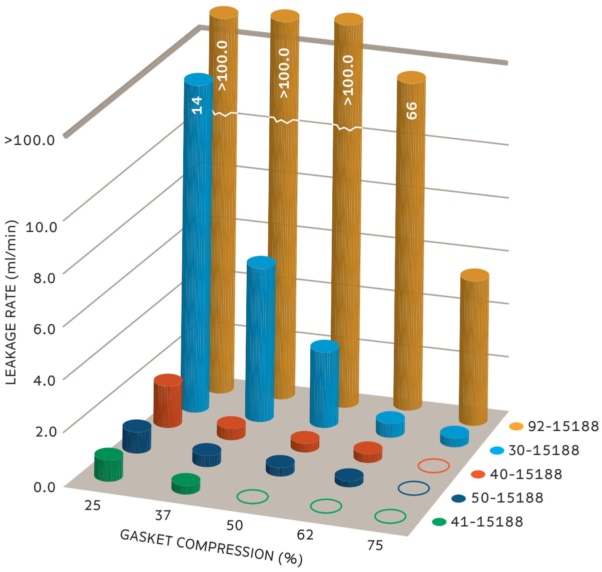


PORON URETHANE / BISCO SILICONE SEALING DATA

The below water sealing graphs indicate the minimum tested compression required to achieve an effective seal at the specified conditions. Sealing results shown are based on a stringent water pressure of 1.5 psi (10.3kPA). With sealing correlating to pressure, results become more favorable as water pressure is decreased. The following graphs show comparisons between the various grades of PORON Urethane and BISCO Silicone.

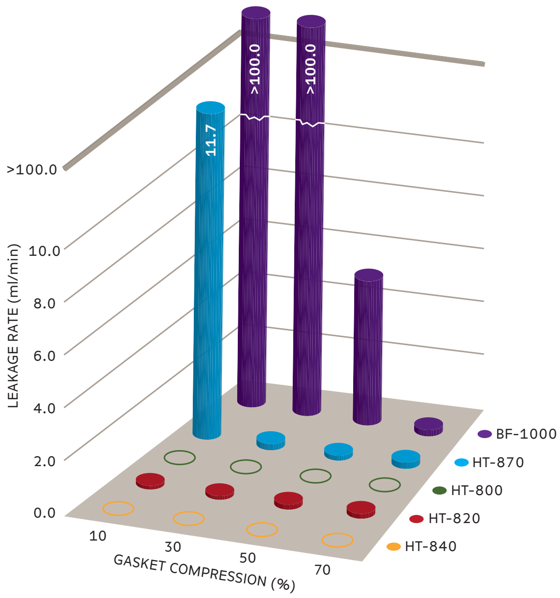
PORON Urethane Water Sealing

Pressure: 1.5 psi (10.3 kPa)
Gasket Width: 0.250 in (6.35 mm)
Gasket Thickness: 0.188 in (4.775 mm)



BISCO Silicone Water Sealing

Pressure: 1.5 psi (10.3 kPa)
Gasket Width: 0.250 in (6.35 mm)
Gasket Thickness: 0.125 in (3.175 mm)



GENERAL SEALING TRENDS

Sealing improves as:

- Compression is increased
- Width is increased
- Water pressure is decreased

CONCLUSIONS

PORON Urethane and BISCO Silicone exhibit superior physical properties and excellent sealing characteristics when compressed, and are certified by UL for gasketing and flame resistance. Both materials provide effective and dependable long-term sealing solutions.

For additional material selection recommendations, contact your local Rogers' Sales Engineer and/or local Rogers' Preferred Converter. Their expertise across a wide range of materials, markets and applications can prove to be helpful in selecting the right solution. Additional information can be found in the Technical Sealing Guide available on the Rogers Corporation website, www.rogerscorp.com.

WORLD CLASS PERFORMANCE

Rogers Corporation (NYSE:ROG) is a global technology leader in specialty materials and components that enable high performance and reliability of consumer electronics, power electronics, mass transit, clean technology, and telecommunications infrastructure. With more than 178 years of materials science and process engineering knowledge, Rogers provides product designers with solutions to their most demanding challenges. Rogers' products include advanced circuit materials for wireless infrastructure, power amplifiers, radar systems, high speed digital; power electronics for high-voltage rail traction, hybrid-electric vehicles, wind and solar power conversion; and high performance foams for sealing and energy management in smart phones, aircraft and rail interiors, automobiles and apparel; and other advanced materials for diverse markets including defense and consumer products. Headquartered in Connecticut (USA), Rogers operates manufacturing facilities in the United States, Belgium, China, Germany, and South Korea, with joint ventures and sales offices worldwide.

For more information visit www.rogerscorp.com/hpf

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