Materials

Contents

Parker Engineered Materials for the Fluid Power Industry

There are two basic considerations in specifying a well-designed sealing system, both of which are equally integral to system performance: seal configuration, discussed in Section 2, and material, discussed herein. When selecting from the wide range of material options that Parker offers, there are a number of considerations to be made:

- **Typical Physical Properties**
  give a broad picture of a material's performance.
- **Chemical Compatibility**
  matches the sealing material with the system fluid and operating environment.
- **Thermal Capabilities and Extrusion Resistance**
  define limits of application parameters.
- **Friction and Wear**
  help to determine the performance and life of the seal package.
- **Storage, Handling and Installation guidelines**
  ensure seal integrity for optimal performance.

With in-house material development and compounding for thermoplastic, thermoset and PTFE materials, the ability to maintain control over all variables during the manufacturing process allows Parker to achieve optimal physical properties of its thermoplastic materials. Parker's commitment to offering the highest quality sealing materials is unsurpassed in the industry. To ensure long life and system integrity, it is critical to consider all variables in an application before specifying a material.

Materials Test Lab

Parker EPS Material Classifications

Classes of materials offered by Parker for fluid power profiles include:

- Thermoplastics — Elastomers & Engineered Resins
- Thermoset Elastomers — Rubber (Nitrile, Nitroxile, EPR, FKM, etc.)
- PTFE — Non-filled & filled TFE materials.

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Thermoplastics

All thermoplastics are resins designed to soften and melt when exposed to heat. Utilizing an injection molding process, thermoplastics are melted at high temperature and injected into the mold. It is then cooled causing the plastic to solidify. If high heat is introduced again, the molded part will melt. The molecules of thermoplastics are held together by physical bonds rather than chemical bonding.

Elastomers — Polyurethane (TPU)

Polyurethanes exhibits outstanding mechanical and physical properties in comparison with other elastomers. Specifically, its wear and extrusion resistance make it a popular choice for hydraulic applications. Its temperature range is generally -65°F to +200°F (-54°C to +93°C), with some compounds, such as Resilon HT, having higher temperature ratings up to +275°F (+135°C). Polyurethanes are highly resistant to petroleum oils, hydrocarbon fuels, oxygen, ozone and weathering. On the other hand, they will deteriorate quickly when exposed to acids, ketones and chlorinated hydrocarbons. Unless specifically formulated to resist hydrolysis (Resilon WR), many types of polyurethanes are sensitive to humidity and hot water. Other acronyms polyurethane may be known by are AU, EU, PU, and TPU or may simply be known as urethanes. For typical physical properties, see Table 3-1 on page 3-11.

P4300A90 — Resilon HT

90 Shore A hardness polyurethane manufactured by Parker specifically for sealing applications. This proprietary compound was developed to offer extended temperature capability, excellent resistance to compression set and high rebound characteristics that are unparalleled in the industry.

P4301A90 — Resilon WR

90 Shore A hardness polyurethane formulated for water resistance. This Parker proprietary compound can be used for both water and petroleum based fluids.

P4304D60 — Resilon ER

60 Shore D hardness polyurethane formulated to resist extrusion. This compound offers higher extrusion resistance for seals and anti-extrusion devices.

Figure 3-1. Resilon WR (P4301A90)

P4311A90 — Resilon HR

90 Shore A hardness polyurethane with high resilience. This formulation resists internal heat generated through hysteresis making this compound ideal for shock applications such as bumpers.

P4500A90 — Polyurethane

90 Shore A hardness polyurethane with good abrasion and extrusion resistance to improve the life of the seal. It also has excellent rebound which enhances response time to shock and side loading.

P4615A90 & P4617D65 — Molythane

P4615A90 is a 90 Shore A hardness, general purpose polyurethane, offering high abrasion and extrusion resistance and is an industrial standard sealing compound.

P4617D65 is a harder, 65 Shore D, version of Molythane ideal for use in anti-extrusion devices.

P4622A90 — Ultrathane

90 Shore A hardness polyurethane formulated with internal lubricants for lower friction to help reduce heat build-up and wear.

P4700A90 — Polyurethane

90 Shore A hardness polyurethane formulated to offer enhanced physical properties over Molythane with improved sealing capabilities due to lower compression set and higher rebound.

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P5065A88 — Low Temperature Polyurethane

88 Shore A hardness polyether based polyurethane formulated for an improved low temperature range and higher resilience than Molythane. This compound offers a softer feel for easy installation and is a more cost effective option when compared to P4700A90.

P6000A94 — Polyurethane

94 Shore A hardness polyurethane formulated for an improved abrasion, extrusion, and compression set resistance, as well as higher temperature range than P4700A90.

Elastomers — PolyMyte (TPCE)

PolyMyte is a Parker proprietary polyester elastomer. It has exceptionally high tear strength, abrasion resistance, modulus, and a wide temperature range of -65°F to +275°F (-54°C to +135°C). PolyMyte is resistant to petroleum fluids, some phosphate ester and chlorinated fluids, common solvents and water below 180°F. It is not compatible with cresols, phenols, and highly concentrated acids. Due to its higher hardness and modulus, seals made from this material can be difficult to install. Also, care must be taken not to damage the seal lips during assembly into the gland.

Z4651D60 — PolyMyte

60 Shore D hardness PolyMyte is used for seals in applications requiring extended extrusion resistance and/or fluid compatibility.

Z4652D65 — PolyMyte

65 Shore D hardness PolyMyte is ideal for back-ups and other anti-extrusion devices.

Z4729D55 — Hytrel®[1]

Standard 55 Shore D hardness Hytrel for back-ups and other anti-extrusion devices.

Engineered Resins

Engineered resins such as Nylons and P.E.E.K., sometimes called hard plastics, are generally categorized as compounds with hardness measured on the Rockwell M or R scale. These compounds exhibit high tensile and compressive strength and are typically used in wear rings for bearing support and in auxiliary devices for extrusion resistance. For typical physical properties, see Table 3-2 on page 3-12.

Engineered Resins — Nylons

W4650 — MolyGard

Heat stabilized, internally lubed, 30% glass-reinforced nylon for standard tolerance wear rings.

W4655 — Nylatron®[2]

Wear resistant nylon loaded with molybdenum disulfide (MoS2) for reduced friction. This compound is ideally suited for use in back-up rings. Nylatron is susceptible to water absorption.

W4733 — WearGard

Heat stabilized, internally lubricated, 35% glass reinforced nylon for tight-tolerance wear rings. WearGard is a dimensionally stable compound with high compressive strength and is featured in Parker's distinctive green color.

Engineered Resins — UltraCOMPTM (PEEK)

UltraCOMP engineered thermoplastics are semicrystalline materials manufactured for extreme temperatures, chemicals and pressures. Their excellent fatigue resistance and stability in high temperature environments make them the material of choice where other materials fail. With a melt temperature of over 600°F, UltraCOMP can be used at continuous operating temperatures of -65°F up to 500°F. Superior strength and wear resistance

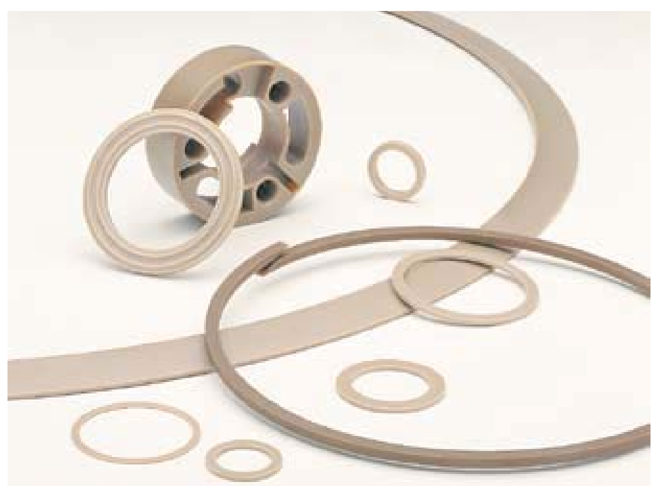

Figure 3-2. UltraCOMP HTP

1 Hytrel® is a trademark of DuPont

2 Nylatron® is a trademark of Quadrant Enginnering.

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properties make it an ideal alternative to metal or metal alloys in applications where weight, metal-to-metal wear or corrosion issues exist. Such capabilities translate into reduced equipment down time and increased productivity. For example, UltraCOMP back-up rings exhibit optimum strength-flexibility for ease of installation and high tensile strength properties for premiere extrusion resistance. UltraCOMP is available in molded geometries, machined geometries and tube stock.

W4685 — UltraCOMP HTP

An unfilled engineered thermoplastic material specified for use in extreme conditions spanning multiple industries. Its excellent tensile strength facilitates its successful use as back-up rings and anti-extrusion devices. In addition, UltraCOMP HTP's elongation properties (>60% per ASTM D638) allow it to be flexed and twisted without breaking.

W4686 — UltraCOMP GF

30% glass filled blend provides enhanced compressive strength over UltraCOMP HTP.

W4737 — UltraCOMP CF

30% carbon fiber blend provides enhanced tensile and compressive strength over UltraCOMP GF.

W4738 — UltraCOMP CGT

10% carbon, 10% glass, and 10% PTFE blend for enhanced compressive strength and reduced friction.

Thermoset Elastomers — Rubber

Unlike thermoplastic elastomers, thermosetting elastomers gain their strength from an irreversible cross linking process that occurs when the compound is subjected to pressure and heat. During this process, or "cure", special chemical agents within the compound react to the heat and pressure to vulcanize the molecules together. Once cured, thermoset compounds obtain the necessary physical properties needed to function in fluid sealing applications. Reheating thermoset compounds will not cause them to melt as thermoplastics do. For typical physical properties, see Table 3-3 on page 3-14.

Nitrile (NBR)

Nitrile rubber (NBR) is the general term for acrylonitrile butadiene copolymer. Nitrile compounds offer good resistance to abrasion, extrusion, and compression set. The acrylonitrile (ACN) content influences the physical properties of the compound. As the ACN content increases, oil and solvent resistance improve, tensile strength, hardness and abrasion resistance increase, while permeability, low temperature flexibility, and resilience decrease. Parker offers a variety of nitrile compounds, formulated with varying ACN content, to provide the best physical properties for a wide range of applications. Typical temperature ratings are -40°F to +250°F (-40°C to +121°C).

Figure 3-3. Thermoset elastomers

N4008A80 — NBR

80 Shore A hardness low temperature nitrile. This is a premium, low ACN nitrile for use when low temperature sealability is the primary requirement

N0304A75 — NBR

75 Shore A hardness low temperature nitrile. This is a low ACN nitrile with an extended upper end temperature formulated for aerospace T-seal applications. N0304A75 is compliant with AMS-P-83461 which supersedes MIL-P-25732.

N4115A75 — NBR

75 Shore A hardness general purpose nitrile with medium ACN content for use where a softer seal is needed.

N4180A80 — NBR

80 Shore A hardness general purpose nitrile with medium ACN content. N4180A80 has good chemical compatibility, sealability and moderate extrusion resistance. N4180A80 has excellent compression set resistance even at higher temperatures.

N4181A80 — NBR

80 Shore A hardness, medium ACN nitrile with fiber added for reinforcement. The fibers also help to retain lubrication for reduced friction. N4181A80 is often used in the 8600 wiper seal to resist extrusion.

N4121A90 — NBR

90 Shore A hardness, high ACN nitrile with an exceptionally high modulus which gives this compound outstanding extrusion resistance. N4121A90 also has good compression set properties.

Nitroxile™ (Carboxylated Nitrile) (XNBR)

Carboxylated nitriles are formed by exposing nitrile polymer to carboxylic acid groups during polymerization. This forms an improvement over nitrile by producing a more wear resistant seal compound with enhanced modulus and tensile strength. Nitroxile offers exceptionally low friction characteristics and has excellent resistance to petroleum oils, hydrocarbon fuels and water. The typical temperature range for Nitroxile is -10°F to +250°F (-23°C to +121°C).

N4257A85 — XNBR

85 Shore A hardness carboxylated nitrile that has an internal lubricant as an aid to reduce friction. It is ideal for pneumatic applications with excellent compression set properties.

N4274A85 — XNBR

85 Shore A hardness carboxylated nitrile that is formulated with a proprietary internal lubricant for exceptionally low friction operation. This is the premier carboxylated nitrile in the sealing industry.

N4263A90 — XNBR

90 Shore A hardness carboxylated nitrile that is formulated for increased hardness, modulus and tensile strength to provide extra toughness in applications requiring nitrile seals. This compound has excellent resistance to extrusion, explosive decompression and abrasion.

Hydrogenated Nitrile (HNBR)

Hydrogenated nitrile offers improved chemical compatibility and heat resistance over standard nitrile by using hydrogen in the formulation to saturate the backbone of the nitrile molecule. However, the compound usually becomes less flexible at low temperatures. This can be offset to some degree by adjusting the ACN content as is done with NBR. Typical temperature ratings are -25°F to +320°F (-32°C to +160°C).

N4032A80 (KB162)[3] — HNBR

80 Shore A hardness hydrogenated nitrile.

N4031A85 (KB183) — HNBR

85 Shore A hardness hydrogenated nitrile formulated for low temperatures.

N4033A90 (KB163) — HNBR

90 Shore A hardness hydrogenated nitrile formulated for improved chemical compatibility.

N4007A90 — HNBR

90 Shore A hardness hydrogenated nitrile featuring excellent resistance to extrusion and explosive decompression to meet Norsok M-710.

Ethylene Propylene (EPR)

Ethylene propylene has excellent dimensional stability in water-based fluids and steam; however, it should never be exposed to petroleum lubricants, water / oil emulsions, solvents or other petroleum based fluids (CAUTION! Do not lubricate the seals with petroleum oils or greases during installation). Ethylene propylene rubber is compatible with Skydrol®[4] and other phosphate ester fluids used in aircraft hydraulic systems. EPR is also the recommended seal material for automotive brake fluids (DOT 3, 4 and 5) as well as many commercial refrigerants. Ethylene propylene rubber is also useful in sealing weak alkalis, acids, and methyl ethyl ketone (MEK). The typical temperature range is -65°F to +300°F (-54°C to +149°C).

3 Compound numbers in parenthesis refer to Parker Seal Group material numbers.
4 Skydrol® is a registered trademark of Solutia Inc.

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E4259A80 — EPR

80 Shore A hardness general purpose EPR with excellent dimensional stability in water-based fluids and steam. This compound has excellent chemical compatibility and compression set resistance.

E4207A90 — EPR

90 Shore A hardness general purpose EPR with excellent dimensional stability in water-based fluids and steam. With its additional hardness it is able to be used at higher pressures than the 80 Durometer compounds. It has excellent compression set properties as well as excellent compatibility with such fluids as DOT 3 brake fluid.

E4270A90 — EPR

90 Shore A hardness EPR formulated for steam/ geothermal environments with an upper temperature range of +600°F (+315°C). Excellent compression set resistance.

Fluorocarbon Elastomers (FKM)

Fluorocarbon elastomers are highly specialized polymers that show the best resistance of all rubbers to chemical attack, heat and solvents. FKM is of critical importance in solving problems in aerospace, automotive, chemical and petroleum industries. FKM is suitable for use in most hydraulic fluids except Skydrol® types and ester-ether fluids. Standard temperatures range from -20°F to +400°F (-29°C to +204°C).

V4205A75 — FKM

75 Shore A hardness general purpose fluorocarbon.

V1289A75 — FKM

75 Shore A hardness fluorocarbon formulated for improved low temperature performance of -40°F to +400°F (-40°C to +204°C).

V4208A90 — FKM

90 Shore A hardness general purpose fluorocarbon.

V4266A95 — FKM

95 Shore A hardness extended wear and extrusion resistant fluorocarbon.

Figure 3-4. PTFE

PTFE

PTFE (Polytetrafluoroethylene) offers the following characteristics over thermoplastic and thermoset compounds, making it a unique problem solving solution for sealing applications:

- Low coefficient of friction
  The low coefficient of friction (.06) of PTFE material results from low interfacial forces between its surface and other materials that come in contact. This behavior of PTFE material eliminates any possibility of stick-slip effects in dynamic sealing applications.
- Wide temperature range
  PTFE's high melting point and morphological characteristics allow components made from the resin to be used continuously at service temperatures to 600°F (315°C). For sealing cryogenic fluids below -450°F (-268°C), special designs using PTFE and other fluoropolymers are available.
- Chemically inert
- Dry running capability
- Resist temperature cycling
- High surface speeds
- Low water absorption
- Low dielectric constant and dissipation factor

Enhancing Performance of PTFE with Fillers

In fluid power applications, it can be beneficial to add fillers to PTFE compounds in order to enhance its physical characteristics. Specific fillers can be incorporated to provide improved compression strength, wear, creep and extrusion resistance.

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Non-Filled PTFE

0100 — Virgin PTFE

Virgin PTFE has no fillers and is considered FDA and potable water safe.

Filled PTFE

0102 — Modified Virgin PTFE

Virgin PTFE modified with custom pigmentation features similar basic properties as virgin, but offers increased wear and creep resistance and lower gas permeability.

0120 — Mineral Filled

Mineral is ideal for improved higher temperatures and offers low abrasion to soft surfaces. PTFE with this filler can easily be qualified to FDA and other food-grade specifications.

0203 — Fiberglass Filled

Glass fiber is the most common filler with a positive impact on creep performance of PTFE. Glass fiber adds wear resistance and offers good compression strength.

0204 / 0205 — Molybdenum Disulfide and Fiberglass Filled

Molybdenum disulfide (MoS_2) increases the hardness of the seal surface while decreasing friction. It is normally used in small proportions and combined with other fillers such as glass. MoS_2 is inert towards most chemicals.

0301 — Graphite Filled

Graphite filled PTFE has an extremely low coefficient of friction due to the low friction characteristics of graphite. Graphite is chemically inert. Graphite imparts excellent wear properties and high PV values to PTFE.

0307 — Carbon-Graphite Filled

Carbon reduces creep, increases hardness and elevates the thermal conductivity of PTFE. Carbon-graphite compounds have good wear resistance and perform well in non-lubricated applications.

0401 / 0402 – Bronze Filled

Bronze is a self lubricated, long-wearing material that offers superior frictional characteristics and high temperature capabilities.

0501 / 0502 — Carbon Fiber Filled

Carbon fiber lowers creep, increases flex and compressive modulus and raises hardness. Coefficient of thermal expansion is lowered and thermal conductivity is higher for compounds of carbon fiber filled PTFE. This is ideal for automotive applications in shock absorbers and water pumps.

0601 — Aromatic Polyester Filled

Aromatic polyester is excellent for high temperatures and has excellent wear resistance against soft, dynamic surfaces. This filler is not recommended for sealing applications involving steam.

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Typical Physical Property Information

There are six significant typical physical properties that affect seal performance. It is important to understand how the physical properties of a compound relate to each sealing application and to know that the fluid being sealed may change these original characteristics. The six critical properties identified below each show detail concerning their impact on sealing as well as measurement techniques.

1 — Hardness.

Hardness, also referred to as durometer, is a property frequently associated with extrusion resistance (see Table 2-4 on page 2-5). It is not a good indication of extrusion resistance when comparing different material classifications. For example, a polyurethane and a nitrile compound with the same hardness will not share the same extrusion resistance. Hardness also relates to low pressure sealability, since the ability of a seal to conform to a mating surface depends, to a high degree, on the hardness of the material. The harder a material, the less it will conform to a sealing surface at low pressure. As hardness increases, modulus and compressive strengths typically increase as well. This means that harder seals are typically more difficult to install and often have greater friction.

Hardness is measured by how easily a specified surface is deformed by an indenter. “Shore A” and “Shore D” are the two most common scales for seal materials. Both scales use a rounded indenter to impact the surface being measured. Shore A is typically used to measure softer materials, while harder materials are measured on the Shore D scale. Although the Shore A scale has a max value of 100, it is recommended to switch to the Shore D scale past 95 Shore A. These two scales overlap one another as shown in Figure 3-5.

Standardized test methods for this physical property are ASTM 2240 and DIN 53505, which corresponds to ISO 48. This test procedure has a repeatability of ±5 points, because its accuracy is dependant on the flatness of the specimen and the skill of the technician. For this reason, measuring material hardness on a seal itself, with its irregular surface, is discouraged and can only be used with caution as a relative value.

A second method of measuring hardness that is seldom used and is only presented here for informational purposes is the International Rubber Hardness Degree (IRHD), as described in ASTM 1414/1415, Din 53519, and ISO 1400/1818. The IRHD and Shore methods do not provide comparable values and should not be used to relate one material to another.

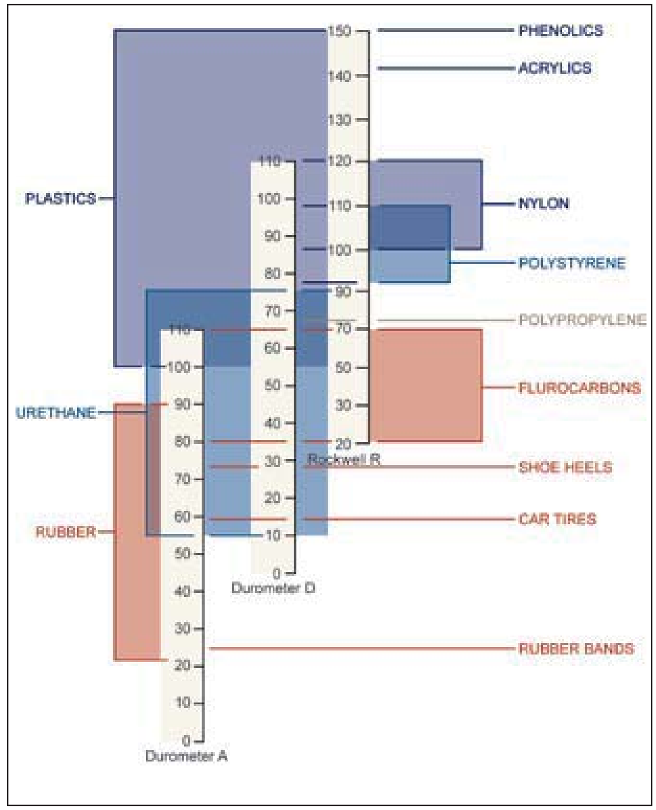


Figure 3-5. Hardness Scale Comparison Between Shore A, Shore D, and Rockwell R

2 — Modulus

Modulus is truly what gives a seal material its extrusion resistance. It is a measure of the force required to stretch an elastomer a certain percentage of its original length. Modulus of a material can more simply be thought of as its stiffness and is also an indication of the ease of installation. Higher modulus materials resist stretching and compression, increasing installation difficulty. (ASTM method D412)

3 — Ultimate Tensile Strength

Ultimate tensile strength is closely related to wear resistance, toughness and therefore service life of the seal. This property is the amount of force required to reach ultimate elongation, physically breaking the material. Polyurethane and filled PTFE compounds generally have very high tensile strength, providing the associated excellent tear and abrasion resistance. Most rubber compounds have much lower tensile strength values, often resulting in one fifth the wear life

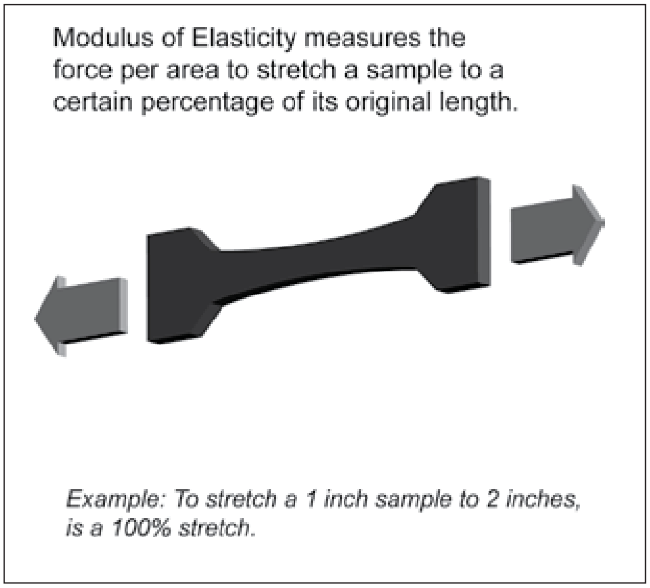


Figure 3-6. Modulus of Elasticity

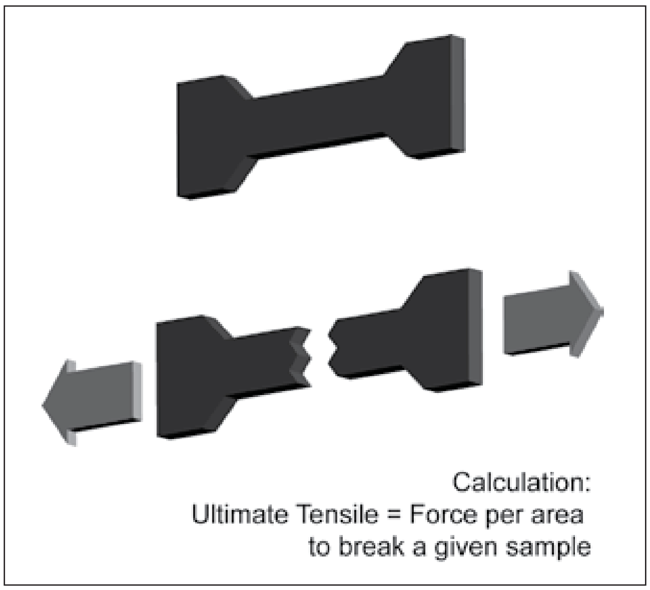


Figure 3-7. Tensile Strength

of higher tensile materials. (ASTM method D412 and DIN 53504) ***It should be noted that values obtained from the DIN standard are typically higher than those from the ASTM standard as there is a difference in the test specimen and the pull rate.***

4 — Ultimate Elongation

Ultimate elongation is most closely associated with installation, but can also be a good indicator of chemical compatibility. This property is the distance a material will stretch before breaking, expressed as a percentage of its original length. It can be important in small diameter seals because it can limit the amount of stretch available for installation. Elongation is also a good indicator of chemical compatibility. If changes are observed after a material sample is soaked in a fluid, it is possible that the seal is being adversely affected. In this situation, the fluid will typically attack and break the polymeric chain, reducing the ultimate elongation. (ASTM method D412)

5 — Resilience

Resilience, also known as rebound, strongly correlates to how quickly a seal will respond to changing conditions in a dynamic environment. This property measures the ability of a material to return to its original shape after being deformed, as well as the speed at which it can achieve this.

Examples of conditions that require seals to exhibit excellent resilience are out-of-round cylinders and rapid side loading situations that cause the rod to move sideways quickly. Applications with high vibration or high stroke speed can also benefit from high resiliency seals. (ASTM method D2632, DIN 53512)

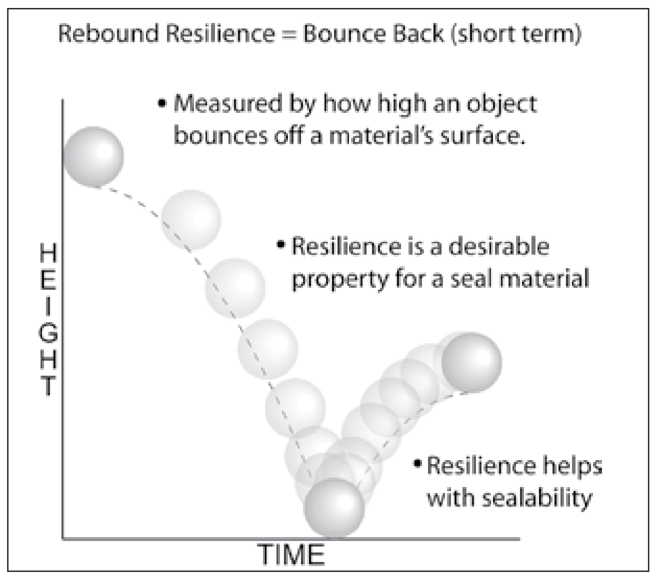


Figure 3-8. Rebound Resilience

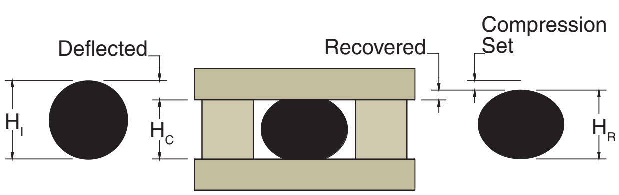
6 — Compression Set

Compression set is the inability of a seal to return to its original shape after being compressed. It is associated with a sealing material's "long-term memory" and is considered to be one of the most critical properties of the seal. For a seal to maintain radial pressure and establish a continuous sealing line, it must resist stress relaxation during the time and at the temperature to which it is exposed. As the seal begins to take a compression set, it loses its inherent ability to seal and may require other influences to maintain a positive sealing force. Examples of such factors would be system pressure or an expander working to energize the sealing lips. The lowest possible compression set value is always advantageous because it represents the least amount of lost sealing force over time.

As defined by ASTM, compression set is the percent of deflection by which the seal fails to recover after a specific deflection, time and temperature (see Figure 3-9). When comparing compression set values between two materials, it is important to note both the time and temperature of the tests being compared. Even though a typical compression set value is based on a 70 hour period, many times a 22 hour period may be used for time and convenience sake. A 22 hour compression set value will always be dramatically better than that of a 70 hour test under the same temperature condition. It is also important to know that each elastomer family is generally tested at a different temperature or series of temperatures. Be sure that the temperatures of the test data closely approximate the temperature the seal will be used in. (ASTM method D395, DIN 53517)

$$\text{Compression Set} = \frac{H_I - H_R}{H_I - H_C} \times 100$$

where:



H_I = Initial height
H_C = Compressed height
H_R = Recovered height

Figure 3-9. Compression set calculation

Parker Materials Typical Physical Properties

Typical physical properties for Parker fluid power product materials are shown in the corresponding tables:

Material Classification		Table (page)
Thermoplastics		
Elastomers		Table 3-1, (pg 3-11)
	TPU Polyurethanes	
	TPCE PolyMyte	
Engineered Resins		Table 3-2, (pgs. 3-12, 3-13)
	Nylons	
	UltraCOMP	
Thermoset Elastomers		
	Rubber Nitriles Nitroxile Ethylene Propylene Fluorocarbon	Table 3-3 (pgs. 3-14, 3-15)
PTFE for Fluid Power Seals		
	Non-filled PTFE Filled PTFE	Table 3-4 (pgs. 3-16, 3-17)
	Rubber energizer materials for PTFE fluid power seals	Table 3-5 (pg 3-18)
	Back-up ring materials for PTFE fluid power seals	Table 3-6 (pg 3-19)

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Table 3-1. Typical Physical Properties: Thermoplastics — Elastomers

Parker Material Code	Material Trade Name (Color)	Typical Applications & Description	Service Temperature Range °F (°C)	Tensile Strength at Break psi (MPa)	Ultimate Elong-ation	Shore Hardness A	Shore Hardness D	100% Modulus psi (MPa)	Compression Set: Set	Compression Set: at°F (°C)	Re-bound	Abrasion Rating Best = 10
Thermoplastic Elastomers — TPU, Polyurethanes												
P4300A90	Polyurethane Resilon HT (Tan)	Proprietary compound offering extended temperature range, high rebound.	-65 to +275 (-54 to +135)	8625 (59.5)	560%	92	-	1793 (12.4)	28.9%	212 (100)	63%	10
P4301A90	Polyurethane Resilon WR (Aqua Blue)	For water or petroleum based fluids.	-35 to 225 (-37 to +107)	7129 (49.2)	514%	90	-	2029 (13.9)	24.8%	158 (70)	45%	8.1
P4304D60	Polyurethane Resilon ER (Brown)	Offers higher extrusion resistance for seals and anti-extrusion devices.	-65 to +275 (-54 to +135)	6521 (44.9)	556%	-	55	2940 (20.3)	32.2%	158 (70)	46%	7.3
P4311A90	Polyurethane Resilon HR (Red)	Formulation resists internal heat generated through hysteresis, ideal for shock applications.	-65 to +275 (-54 to +135)	7229 (49.8)	632%	91	-	1732 (11.9)	33.3%	212 (100)	63%	8.2
P4615A90	Polyurethane Molythane (Black)	General purpose industrial polyurethane offering high abrasion resistance.	-65 to +200 (-54 to +93)	8134 (56.1)	565%	95	-	1755 (12.1)	30.8%	158 (70)	34%	9.4
P4617D65	Polyurethane Molythane (Black)	General purpose industrial polyurethane offering high extrusion resistance.	-65 to +250 (-54 to +121)	5973 (41.2)	544%	-	62	3914 (26.9)	-	-	-	6.7
P4622A90	Polyurethane Ultrathane (Yellow)	Formulated with internal lubricants for lower friction to help reduce heat build up.	-65 to +225 (-54 to +107)	6757 (46.6)	466%	94	-	1755 (12.1)	31.0%	158 (70)	34%	7.6
P4500A90	Polyurethane (Light Green)	Offers good abrasion and extrusion resistance with excellent rebound.	-65 to +200 (-54 to +93)	6740 (46.5)	586%	92	-	1774 (12.2)	32.9%	158 (70)	42%	7.6
P4700A90	Polyurethane (Green)	Enhanced properties over 4615 to improve sealing capabilities from lower compression set.	-65 to +200 (-54 to +93)	5660 (39.0)	511%	92	-	1665 (11.5)	24.7%	158 (70)	35%	6.3
P5065A88	Polyurethane (Dark Blue)	Formulated for an improved low temperature range and higher resilience than 4615.	-70 to +200 (57 to +93)	5033 (34.7)	660%	86	-	1073 (7.4)	27.2%	158 (70) (70)	50%	5.5
P6000A90	Polyurethane (Dark Gray)	Improved abrasion, extrusion and compression resistance as well as higher temp. than 4700.	-31 to +230 (-35 to +110)	6513 (44.9)	491%	93	-	1941 (13.4)	26.2%	158 (70)	44%	7.3
Thermoplastic Elastomers — TPCE, PolyMyte												
Z4651D60	PolyMyte (Orange)	Used in applications requiring extended extrusion resistance and fluid compatibility.	-65 to +275 (-54 to +135)	5748 (39.6)	775%	-	58	2231 (15.4)	43.0%	158 (70)	-	6.4
Z4652D65	PolyMyte (Orange)	Primarily used for back-up rings and other anti-extrusion devices.	-65 to +275 (-54 to +135)	6175 (42.6)	700%	-	62	2611 (18.0)	45.4%	158 (70)	-	6.9
Z4729D55	Hytrel (Tan)	Primarily used for back-up rings and other anti-extrusion devices.	-65 to +275 (-54 to +135)	5609 (38.7)	837%	-	56	2212 (15.2)	46.0%	158 (70)	-	6.9

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Table 3-2. Typical Physical Properties: Thermoplastics — Engineered Resins

Parker Material Code	Material	Color	Typical Applications & Description	Service Temperature Range °F (°C)	Tensile Strength at Break psi (MPa)	Flexural Strength Kpsi (MPa)
Nylons						
W4650	MolyGard	Gray	Heat stabilized, internally lubed 30% glass-reinforced nylon for standard tolerance wear rings.	-65 to +275 (-54 to +135)	17500 (121.0)	22600 (156.0)
W4655	Nylatron	Gray	Wear resistant nylon with molybdenum disulfide for lower friction, suited for back-up rings.	-65 to +275 (-54 to +135)	13000 (89.6)	16000 (110.3)
W4733	WearGard	Green	High compressive strength, 35% glass-reinforced nylon for tight tolerance wear rings.	-65 to +275 (-54 to +135)	18300 (126.0)	25500 (176.0)
UltraCOMP						
W4685	UltraCOMP HTP	Tan	A homogenous engineered thermoplastic used for extreme conditions in many markets.	-65 to +500 (-54 to +260)	14000 (97.0)	23600 (163.0)
W4686	UltraCOMP GF	Tan	30% glass filled engineered thermoplastic with enhanced compressive strength.	-65 to +500 (-54 to +260)	22600 (156.0)	30700 (212.0)
W4737	UltraCOMP CF	Black	30% carbon fiber blend, provides enhanced tensile and compressive strength.	-65 to +500 (-54 to +260)	32400 (224.0)	43200 (298.0)
W4738	UltraCOMP CGT	Gray	Thermoplastic material blended with carbon, glass and PTFE for reduced friction.	-65 to +500 (-54 to +260)	20400 (141.0)	26900 (186.0)
Composite Resins						
0871-0874	Composite Fabric-Reinforced Resins	Multiple	Fabric-reinforced resins to handle severe sideloads, high heat and swell from moisture.	-40 to +250 (-40 to +121)	9500 (65.5)	-

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Table 3-2. Typical Physical Properties: Thermoplastics — Engineered Resins (cont'd)

Parker Material Code	Rockwell Hardness		Notched IZOD Impact Strength Ft-Lbs/In.	Tensile Modulus Kpsi (MPa)	Shear Strength psi (MPa)	Flexural Modulus Kpsi (MPa)	Compressive Strength psi (MPa)	Permissible Compressive Load psi (MPa)	Water Absorption (24 Hour) %
	M	R							
Nylons									
W4650	77	114	1.37	952 (6.6)	9390 (65.0)	860 (5929.0)	21000 (145.0)	21700 (150.0)	0.50 to 0.70
W4655	-	119	1.69	536 (3.7)	9,500 (65.5)	406 (2.8)	12000 (82.7)	-	0.50 to 1.40
W4733	87	117	1.15	899 (6.2)	9820 (68.0)	1,100 (7584.0)	21500 (148.0)	21700 (150.0)	0.50 to 0.70
UltraCOMP									
W4685	-	126	2	507 (3.5)	7687 (53.0)	579 (4.0)	17100 (118.0)	-	0.50
W4686	-	124	2	1653 (114.0)	14068 (97.0)	1334 (9.2)	31100 (215.0)	-	0.11
W4737	-	124	2	3234 (22.3)	12328 (85.0)	2697 (18.6)	34800 (240.0)	-	0.06
W4738	-	100	2	1464 (10.1)	-	1189 (8.2)	21700 (150.0)	-	0.06
Composite Resins									
0871-0874	100	-	10	470 (3.24)	-	280 (1.9)	35000 (241.3)	65200 (449.54)	0.10

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Table 3-3. Typical Physical Properties — Thermoset Elastomers

Parker Material Code	Material	Color	Typical Applications & Description	Service Temperature Range°F (°C)	Tensile Strength at Break psi (MPa)	Ultimate Elongation	Shore A Hardness	100% Modulus psi (MPa)	Compression Set		Abrasion Rating (1) Worst to (10) Best
									Set	at°F (°C)	
Nitrile (NBR)											
N4115A75	Nitrile	Black	General purpose nitrile with medium ACN content for use where a softer seal is required.	-40 to +225 (-40 to +107)	2215 (15.3)	328%	74	641 (4.4)	23.6%	212 (100)	1.9
N4180A80	Nitrile	Black	General purpose nitrile with good chemical compatibility, seal ability and compression set.	-40 to +250 (-40 to +121)	2199 (15.2)	275%	80	1007 (6.9)	19.4%	302 (150)	1.9
N4181A80	Flocked Nitrile	Black	Fiber added reinforcement helps retain lubrication for reduced friction. Used in 8600 wipers.	-40 to +250 (-40 to +121)	2437 (16.8)	345%	80	663 (4.6)	19.4%	302 (150)	2.2
N4121A90	Nitrile	Black	High modulus for outstanding extrusion resistance plus good compression set.	-40 to +250 (-40 to +121)	2415 (16.7)	247%	89	1447 (9.9)	24.0%	212 (100)	2.2
N4008A80	Nitrile	Black	Premium, low ACN nitrile for use when low temperature sealability is required.	-70 to +275 (-57 to +135)	2141 (14.8)	177%	79	1031 (7.1)	26.4%	212 (100)	1.8
N0304A75	Nitrile	Black	Extended temperature range formulated for aerospace T-seal applications.	-65 to +275 (-54 to +135)	1790 (12.3)	213%	75	567 (3.9)	19.4%	212 (100)	1.4
Carboxylated Nitroxile (XNBR)											
N4257A85	Nitroxile	Black	XNBR with internal lubricant to reduce friction. Ideal for pneumatic applications.	0 to +250 (-18 to +121)	2845 (19.6)	249%	80	1223 (8.4)	20.0%	212 (100)	2.7
N4274A85	Nitroxile	Black	Premier XNBR in the industry formulated with proprietary internal lubricant.	-10 to +250 (-23 to +121)	3016 (20.8)	241%	83	1404 (9.7)	31.0%	212 (100)	2.9
N4263A90	Nitroxile	Black	Extra tough XNBR with increased hardness, modulus and tensile strength.	-20 to +275 (-29 to +135)	3103 (21.4)	117%	90	2902 (20.0)	26.4%	212 (100)	3
Hydrogenated Nitrile (HNBR)											
N4031A85 (KA183)	HNBR	Black	Equivalent to Seal Group compound KB183A85, offers low temperature improvement.	-40 to +320 (-40 to +160)	1800 (12.4)	100%	88	1500 (10.3)	25.0%	212 (100)	1.4
N4032A80 (KB162)	HNBR	Black	Equivalent to Seal Group compound KB162A80 offering improved chemical compatibility.	-25 to +320 (-32 to +160)	3335 (22.9)	164%	82	2358 (16.3)	23.0%	302 (150)	3.3
N4033A90 (KB163)	HNBR	Black	Equivalent to Seal Group compound KB163A90 offering improved chemical compatibility	-25 to +320 (-32 to +160)	3219 (22.2)	107%	88	3329 (22.9)	22.0%	302 (150)	3.2
N4007A90	HNBR	Black	Excellent extrusion resistance and explosive decompression to meet Norsok M-710	-20 to +320 (-29 to +160)	4698 (32.4)	207%	92	2006 (13.8)	14.9%	212 (100)	5.0

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Table 3-3. Typical Physical Properties — Thermoset Elastomers (cont'd)

Parker Material Code	Mate-rial	Color	Typical Applications & Description	Service Temperature Range°F (°C)	Tensile Strength at Break psi (MPa)	Ulti-mate Elonga-tion	Shore A Hard-ness	100% Modu-lus psi (MPa)	Compression Set		Abrasion Rating (1) Worst to (10) Best
									Set	at°F (°C)	
Ethylene Propylene (EPR)											
E4207A90	Ethylene Propyl-ene	Black	General purpose 90A EPR, has excellent dimensional stability in water-based fluids and steam.	-65 to +300 (-54 to +149)	2285 (15.8)	135%	87	1453 (10.0)	13.0%	257 (125)	2.0
E4259A80	Ethylene Propyl-ene	Black	General purpose 80A EPR, has excellent dimensional stability in water-based fluids and steam.	-65 to +300 (-54 to +149)	2142 (14.8)	162%	79	1057 (7.3)	12.8%	257 (125)	1.8
E4270A90	Ethylene Propyl-ene	Black	Formulated for geothermal environments and steam up to +600°F.	-65 to +400 (-54 to +204)	3047 (21.0)	145%	89	1800 (12.4)	27.1%	302 (150)	3.0
Fluorocarbon Elastomers (FKM)											
V1289A75	Fluoro-elasto-mer	Black	Fluorocarbon material for-mulated for improved low temperature applications.	-40 to +400 (-40 to +204)	1497 (10.3)	163%	78	920 (6.3)	17.0%	392 (200)	1.0
V4205A75	Fluoro-elasto-mer	Black	70 Shore A general purpose fluorocarbon resistant to chemical attack and heat.	-20 to +400 (-29 to +204)	2161 (14.9)	202%	76	803 (5.5)	6.5%	302 (150)	1.8
V4208A90	Fluoro-elasto-mer	Black	90 Shore A general purpose fluorocarbon resistant to chemical attack and heat.	-5 to +400 (-21 to +204)	1954 (13.5)	152%	90	1327 (9.2)	13.4%	302 (150)	1.6
V4266A95	Fluoro-elasto-mer	Black	Features extended wear and extrusion resistance over general purpose fluorocar-bons.	-5 to +400 (-21 to +204)	2442 (16.8)	102%	92	2210 (15.2)	17.6%	302 (150)	2.2

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Table 3-4. Typical Physical Properties — PTFE

Parker Material Code	Material	Color	Typical Applications & Description	Service Temperature Range °F (°C)	Tensile Strength in psi at Break (bar)	Elongation in %	Hardness Shore D
Non-Filled PTFE							
0100	Virgin PTFE	White	Excellent for cryogenic applications. Good for gases.	-425 to 450 (-254 to 233)	4575 (316)	400	60
Filled PTFE							
0102	Modified PTFE	Turquoise	Lower creep, reduced permeability and good wear resistance.	-320 to 450 (-195 to 282)	4600 (317)	390	60
0120	Mineral Filled PTFE	White	Excellent low abrasion to soft surfaces & improved upper temperature performances. FDA materials.	-250 to 550 (-157 to 288)	4070 (281)	270	65
0203	Fiberglass Filled PTFE	Gold	Excellent compressive strength and good wear resistance.	-200 to 575 (-129 to 302)	3480 (240)	190	67
0204	Fiberglass & Moly Filled PTFE	Gray	Excellent for extreme conditions such as high pressure , temperature and longer wear life on hardened dynamic surfaces.	-200 to 575 (-129 to 302)	3100 (214)	245	62
0205	Fiberglass & Moly Filled PTFE	Gray	Improved compressive strength and wear in rotary applications	-200 to 575 (-129 to 302)	3480 (240)	190	67
0301	Graphite Filled PTFE	Black	Excellent for corrosive service. Low abrasion to soft shafts. Good in unlubricated service.	-250 to 550 (-157 to 288)	3200 (221)	260	60
0307	Carbon-Graphite Filled PTFE	Black	Excellent wear resistance and reduces creep.	-250 to 575 (-157 to 302)	2250 (155)	100	64
0401	Bronze Filled PTFE	Bronze	Excellent extrusion resistance and high compressive loads.	-200 to 575 (-129 to 302)	3200 (221)	250	63
0502	Carbon Fiber Filled PTFE	Brown	Good for strong alkali and hydrofluoric acid. Good in water service.	-200 to 550 (-129 to 288)	3200 (221)	150	60
0601	Aromatic Polyester Filled PTFE	Tan	Excellent high temperature capabilities and excellent wear resistance.	-250 to 550 (-157 to 285)	2500 (172)	200	61

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Table 3-4. Typical Physical Properties — PTFE (cont'd)

Parker Material Code	Coefficient of Friction	Thermal Conductivity (in W/mK)	Coefficient of Thermal Expansion (in/in/°F x 10^{-5} at 203°F)	Permanent Deformation Under Load (70°F 2000 psi in %)	Chemical Compatibility Rating (5 = Excellent, 1 = Fair)	Wear Resistance Rating (5 = Excellent, 1 = Fair)	High Pressure Extrusion Resistance Rating (5 = Excellent, 1 = Fair)	FDA/NSF Compliant
Non-Filled PTFE								
0100	0.05 - 0.10	0.30	6.1	7.0	5	1	1	Y
Filled PTFE								
0102	0.05 - 0.10	0.29	6.1	6.9	5	2	2	Y
0120	0.08 - 0.12	0.23	5.6	4.2	5	3	4	Y
0203	0.08 - 0.12	0.27	5.6	6.0	5	5	5	N
0204	0.08 - 0.12	0.28	6.1	6.0	5	4	4	N
0205	0.08 - 0.12	0.27	5.6	6.0	5	5	5	N
0301	0.07 - 0.09	0.39	6.1	3.5	5	4	3	N
0307	0.08 - 0.11	0.35	4.4	2.5	5	4	4	N
0401	0.18 - 0.22	0.45	5.6	4.4	4	4	4	N
0502	0.09 - 0.12	0.31	7.2	1.8	4	5	5	N
0601	0.09 - 0.13	0.32	5.0	5.5	4	4	4	N

Note: We emphasize that this tabulation should be used as a guide only.

The above data is based primarily on laboratory and service tests, but does not take into account all variables that can be encountered in actual use. Therefore, it is always advisable to test the material under actual service conditions before specifying. If this is not practical, tests should be devised that simulate service conditions as closely as possible.

Parker also offers unique material blends and recipes along with a wide variety of other PTFE filler combinations and colors to enhance seal performance in the most extreme application needs. For guidance on material selection for extreme applications, please contact Application Engineering at 801-972-3000.

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Materials

The following table lists material codes that apply to the rubber energizer used with PTFE fluid power seals. List the corresponding material code in the appropriate location in the part number. Parker has a full range of rubber compounds to suit various temperature, pressure and chemical compatibility requirements. If your application requires an alternate rubber compound, not listed, please consult a Parker application engineer.

Table 3-5. Typical Application Ranges & Recommendations — Rubber Energizers for PTFE Fluid Power Seals

Material Code	Material Description	Shore A Hardness	Temperature Range	Recommended Use	Not Recommend For Use
A	Nitrile (NBR)	70	-30°F to 250°F (-34°C to 121°C)	• Petroleum oils and fluids • Diesel fuel and fuel oils • Cold water • Silicone oil and grease • Mineral oil and grease • Vegetable oil • HFA, HFB and HFC fluids	• Aromatic hydrocarbons • Chlorinated hydrocarbons • Polar solvents (MEK, ketone, acetone) • Phosphate ester fluids • Strong acids • Automotive brake fluid
B	Low Temperature Nitrile (NBR)	75	-65°F to 225°F (-55°C to 107°C)		
C	Clean Grade Nitrile (NBR)	70	-30°F to 250°F (-34°C to 121°C)	• Potable water • Food service	
D	Hydrogenated Nitrile (HNBR)	70	-23°F to 300°F (-32°C to 149°C)	• Diesel fuel and fuel oils • Dilute acids and bases	
F	Fluorocarbon (FKM)	70	-15°F to 400°F (-26°C to 205°C)	• Petroleum oils and fluids • Cold water • Silicone greases and oils • Aliphatic hydrocarbons • Aromatic hydrocarbons • Fuels • Fuels with methanol content	• Glycol based brake fluids • Ammonia gas, amines, alkalis • Superheated steam • Low molecular organic acids
H	Silicone HT (VMQ)	70	-65°F to 450°F (-55°C to 232°C)	• Engine and transmission oil • Animal and vegetable oil and grease • Brake fluid • Fire-resistant hydraulic fluid • Ozone, aging and weather resistant	• Superheated steam • Acids and Alkalis • Aromatic mineral oil • Hydrocarbon-based fuels • Aromatic hydrocarbons
K	Ethylene Propylene Rubber (EPDM)	70	-70°F to 250°F (-57°C to 121°C)	• Hot water • Glycol based brake fluids • Many organic and inorganic acids • Cleaning agents • Soda and potassium alkalis • Phosphate ester based fluids • Many polar solvents	• Petroleum oils and fluids • Mineral oil products
L	Ethylene Propylene Rubber (EPDM)	80	-70°F to 250°F (-57°C to 121°C)		

The following table is a list of back up ring materials for use with PTFE fluid power seals. List the corresponding back up ring material code in the appropriate location in the part number.

Table 3-6. Typical Application Ranges & Recommendations — Back-up Rings for PTFE Fluid Power Seals

Material Code	Material Description	Pressure Rating *	Temperature Range	Recommended Use
A	Nylon, Molybdenum Di-Sulfide Filled	7,500 psi (517 bar)	-40°F to 250°F (-40°C to 121°C)	• Petroleum oils and fluids • Diesel fuel and fuel oils • Phosphate ester fluids • Silicone oil and grease • Mineral oil and grease
B	Nylon Glass Filled	7,500 psi (517 bar)	-40°F to 275°F (-40°C to 135°C)	• Reduced water absorption • Improved thermal stability
C	Acetal	6,000 psi (414 bar)	-40°F to 250°F (-40°C to 121°C)	• HFA, HFB and HFC fluids • Water • Petroleum oils and fluids • Diesel fuel and fuel oils • Mineral oil and grease
D	PTFE PPS Filled	5000 psi (345 bar)	-100°F to 450°F (-73°C to 232°C)	• Extended temperature, pressure and media resistance
• E	PEEK Virgin	10,000 psi (690 bar)	-40°F to 450°F (-40°C to 232°C)	• Extended temperature, pressure and media resistance

* Pressure ratings are a general guide only. Pressure ratings are reduced if wear rings are used.

Table 3-7. Standard (■) vs. Optional (□) materials for PTFE fluid power seal profiles

PTFE Material Code	PTFE Fluid Power Seal Profile													
	S5	R5	CT	CQ	OE	CP	OA	OD	ON	CR	OC	AD	OQ	OR
0100						□				□		□		
0102						□	■	□		□	■			
0120	□	□			□	□		□	□	□			□	□
0203	■	■		□	□				□					
0204			□				□				□		□	□
0205													■	■
0301					□				□				□	□
0307			□		□			□	□				□	□
0401	□	□	■	■	■	■		■	■	■	□	■		
0502												□	□	□
0601					□				□					

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Chemical Compatibility

It is essential to select seal compounds that are compatible with the environment in which they are used. Even if the proper seal material is chosen based on system temperature and pressure, exposure to certain fluids can drastically reduce seal performance by altering a compound's typical physical properties.

Parker has tested thousands of fluids and is continuously testing many new, popular chemicals to ensure seal material compatibility. Appendix D shows the results of many common seal materials in popular test fluids. This information compares the changes in physical properties of each seal material after it has been soaked in a specific fluid for a given temperature and time. For additional compatibility reports not shown, please contact your local Parker representative.

Temperature Limits

When selecting a seal material, temperature is a key factor. Heat affects the seal material in several ways:

- Softens the material which accelerates wear
- Accelerates any chemical reaction between the fluid and the seal
- Damages the bond structure of the material
- Increases compression set
- Higher temperatures for extended periods of time may harden thermoset (rubber) materials

Lower end temperature may be as important as the upper end temperature. This is especially true in mobile hydraulics. As the temperature lowers, the following takes place:

- The seal hardens and is less responsive.
- The coefficient of thermal expansion and contraction is approximately ten times that of metals. Therefore the seal lips could start to pull away from the surface of the bore. This loss of lip compression against the colder sealing surfaces can be offset by seal design and proper material selection.
- The opposite is also true. As a bearing or wear ring heats up, binding can occur if there is not a gap designed into the wear ring.

Storage and Handling

In 1998, the Society of Automotive Engineers (SAE) issued an Aerospace Recommended Practice (ARP) for the storage of elastomer seals and seal assemblies prior to installation. ARP 5316 has been considered by many as the industry standard; however, Parker has taken a conservative approach to ensure to our customers the highest quality. Both the ARP 5316 and Parker standards for shelf life are shown below in Table 3-8.

Table 3-8. Recommended Storage Standards

Chemical Name	Polymer	ARP 5316	Parker
Aflas®	FEPM	Unlimited	7 Years
Ethylene Propylene	EP, EPR, EPDM	Unlimited	7 Years
Fluorocarbon	FKM	Unlimited	7 Years
Nitrile	NBR, HNBR, XNBR	15 Years	7 Years
Polyurethane	AU or EU	-	10 Years
PolyMyte	TPCE	-	10 Years
Polytetra-fluoroethylene	PTFE	-	Unlimited

The values above assume that proper guidelines for storage conditions are followed. If plastic and rubber products are stored improperly, their physical properties may change. Prior to use, all parts should be checked for hardness, surface cracking or peeling. If any of these conditions are observed, the parts should be discarded. Some compounds can exhibit a build-up of powdery film on their surface over time. This natural occurrence is referred to as bloom and does not in any way negatively impact the function of the seal. Guidelines for proper seal storage are shown in Table 3-9, page 3-21.

Table 3-9. Seal storage & handling guidelines

Seal Storage & Handling Guidelines	
Records	Records should be kept to ensure that stock is rotated such that the first seals in are the first out (FIFO).
Temperature	Seals must be stored away from heat sources such as direct sunlight and heating appliances. Maximum storage temperature is 100°F (38°C). Low temperatures do not typically cause permanent damage to seals, but can result in brittleness, making them susceptible to damage if not handled carefully. Ideally, seals should not be stored at temperatures less than 50°F (10°C) and should be warmed to room temperature before installation.
Ultra Violet	Seal must be protected from direct sunlight and any artificial light that generates ultra violet radiation.
Humidity	Care should be taken to ensure seals are always stored in an environment with a relative humidity of less than 65%. Polyurethane seals in particular are very susceptible to damage from exposure to moisture and should be stored in air-tight containers.
Oxygen and Ozone	Ozone-generating equipment and oxygen exposure can be detrimental to seal compounds. Seals should be stored in air-tight containers. Any electrical equipment that generates a spark should not be used near seal storage.
Contamination	Keeping seals free from contamination will assist promote service life. Good housekeeping practices should be maintained.
Distortion	Large seals should be stored flat when possible and not suspended, which may cause distortion over time. Do not store seals on hooks, nails or pegboard.

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