Material Selection Guide

On the following pages are descriptions of the elastomers used in seal applications. These elastomers form the base of a wide variety of compounds, designated for specific applications. Every compound has specific characteristics and many compounds have common attributes. Therefore, it is important to consider all aspects of the compound prior to use. Also, as compound availability is customer-driven, lead times may vary.

Aflas™

Trade Names(s):
Aflas . . . Asahi Glass Co., Ltd.

ASTM D1418 Designation: FKM

ASTM D2000/SAE J200 Type, Class: HK

Apple Compound Designation: AF

Standard Color: Black

Description: A copolymer of tetrafluoroethylene/propylene, Aflas can offer a combination of high temperature and chemical resistance.

Key Use(s): Seals for oil field, aerospace, chemical and general industrial environments.

Temperature Range: Standard Compound: -23° to +400°F. (Dry Heat Only)

Hardness (Shore A): 60 to 95.

Features: With good resistance to sour gases and oils, as well as amine corrosive inhibitors, Aflas has outperformed other elastomers in oil field applications. It has also outperformed them in automotive applications involving the new types of oils and fluids that have been developed for higher temperatures.

Limitations: Tests have shown that other FKM elastomers are recommended for automotive fuels since they have less volume swell than Aflas. Also, Aflas has shown to have less than desirable results when exposed to toluene, ethers, ketones, and acetic acid

Buna-N (Nitrile)

see "Nitrile" on page 67

Butyl

Trade Name(s):
Exxon Butyl . . . Exxon Chemical
Polysar Butyl . . . Polysar, Ltd.

ASTM D1418 Designation: IIR

ASTM D2000/SAE J200 Type, Class: AA, BA

Apple Compound Designation: BU

Standard Color: Black

Description: An all-petroleum product, Butyl is a copolymer of isobutylene and isoprene and has largely been replaced by Ethylene Propylene since its introduction.

Key Use(s): Highly effective in vacuum sealing applications. Good seal for hydraulic systems.

Temperature Range: Standard Compound: -50° to +250°F. (Dry Heat Only)

Hardness (Shore A): 40 to 80

Features: With outstanding low permeability to gases, Butyl is especially effective in vacuum sealing applications. It also features good to excellent resistance to ozone and sunlight aging.

Butyl further features excellent shock dampening capabilities.

Only slightly affected by oxygenated solvents and other polar liquids, Butyl is often utilized in seals for hydraulic systems using synthetic fluids. It is good with MEK, and silicone fluids and greases.

Limitations: Because it is a petroleum product, Butyl has poor resistance to hydrocarbon solvents and oils, and diester-based lubricants.

Chemraz®

Trade Names(s):
Chemraz . . . Green,Tweed & Co.

ASTM D1418 Designation: FFKM

ASTM D2000 Designation:

Apple Designation: CZ

Standard Color: Black

Description: Being a member of the perfluoroelastomer family gives Chemraz outstanding resistance to heat and most chemicals and solvents.

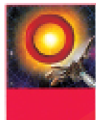
Key Use(s): Seals for use in the chemical and petroleum industries, as well as for the manufacturing of semiconductors and analytical and process instruments.

Temperature Range: Standard Compound: -20° to +425° F. (Dry Heat Only)

Hardness (Shore A): 60 to 90

Features: Because its principle monomer is Teflon®, Chemraz resists nearly all chemical reagents, allowing Chemraz to provide long-term service in the chemical and petro-chemical industries. Compared with other Teflon seals, it does not creep or flow.

Limitations: Chemraz does not have the high temperature capabilities as other elastomers in its class because of its steam resistance and low temperature properties.



Rule of Thumb

*When it is said that an elastomer is good for an application it is meant that some compounds which include that elastomer are acceptable, **not all**. For instance, some compounds of **EP** are good for brake fluid applications, but most are not acceptable.*

Epichlorohydrin

Trade Name(s):
Hydrin . . . B.F. Goodrich
Herclor . . . Hercules Chemical

ASTM D1418 Designation: CO, ECO

ASTM D2000/SAE J2000 TYPE, CLASS: CH

Apple Compound Designation: EH

Standard Color: Black

Description: Available in homopolymer (CO), copolymer (ECO), and terpolymer (GECO) formats, Epichlorohydrins are oil resistant compounds.

Key Use(s): Ideal for fuel and air conditioning system components. Used in the petroleum industry where a little higher temperature capability than NBR is required.

Temperature Range: Standard Compound: -40° to 275°F. (Dry Heat Only)

Hardness (Shore A): 50 to 90

Features: Epichlorohydrin features excellent resistance to hydrocarbon oils and fuels; low solvent and gas permeability; excellent resistance to ozone and weathering; and stable cycling from low to high temperature.

Limitations: Compression set is only "fair" at elevated temperatures (250° to 275°F). Epichlorohydrin is attacked by ketones, esters, aldehydes, chlorinated and nitro hydrocarbons, and is not recommended for exposure to brake fluids.

Material Selection Guide

Ethylene-Propylene

Trade Name(s):
Nordel . . . DuPont Dow Elastomers
Epcar . . . B.F. Goodrich
Vistalon . . . Exxon Chemical Co.
Epsyn . . . Copolymer Rubber
Royalene . . . Uniroyal, Inc.

ASTM D1418 Designation: EPDM

ASTM D2000/SAE J200 Type, Class: AA, BA, CA, DA

Apple Compound Designation: EP

Standard Color: Black

Description: A copolymer of ethylene and propylene (EPR), combined with a third comonomer adiene(EPDM), Ethylene Propylene has gained wide seal industry acceptance for its excellent ozone and chemical resistance characteristics.

Key Use(s): Outdoor weather resistant uses. Automotive brake systems. Automobile cooling systems. Water applications. Low torque drive belts.

Temperature Range: Standard Compound: -60° to +300°F. (Dry Heat Only)

Hardness (Shore A): 40 to 90.

Features: With a working temperature range of -60°F to +250°F, depending upon the compound, EPR/EPDM excels in its resistance to the very same chemical agents that cause rapid and extreme deterioration in Nitriles.

In particular, EPR/EPDM features good resistance to such polar solvents as ketones (MEK and Acetone). It is also highly recommended for effective resistance to steam (to 400°F), hot water, silicone oils and greases, dilute acids and alkalis, alcohols and automotive brake fluids.

EPR/EPDM further features excellent resistance to aging by both ozone and sunlight.

Limitations: With the exception of resistance to polar solvents, EPR/EPDM is not recommended for its overall solvent resistance. And, unlike Nitriles, this elastomer performs poorly when exposed to petroleum oils, diester-based lubricants (MIL-L-7808), or aromatic fuels.

Fluorocarbon (Viton®)

Trade Name(s):
Viton . . . DuPont Dow Elastomers
Fluorel . . . 3M Company
Technoflon . . . Montedison, USA

ASTM D1418 Designation: FKM

ASTM D2000/SAE Type, Class: HK

Apple Compound Designation: VT

Standard Color: Black

Description: Combining high temperature resistance with outstanding chemical resistance, Fluorocarbon-based compounds approach the ideal for a universal O-ring material.

Key Use(s): Seals for aircraft engines. Seals for automotive fuel handling systems. High temperature/low compression set applications. Wide chemical exposure situations. Hard vacuum service.

Temperature Range: Standard Compound: -20° to +400°F. (Dry Heat Only)

Hardness (Shore A): 50 to 95.

Features: Excellent resistance to petroleum products and solvents, with good high temperature compression set characteristics. Fluorocarbon O-rings make ideal seals for aircraft, automobile and other mechanical uses.

Fluorocarbons are highly resistant to swelling in gasoline and gasoline/alcohol blends, as well as resistant to the degrading effects of light and ozone. They are also resistant to acids, silicone fluids and greases, and have a broad chemical compatibility.

With low gas permeability, they are also well suited for hard vacuum service.

Limitations: Fluorocarbons are not recommended for exposure to ketones, amines, low molecular weight esters and ethers, nitro hydrocarbons, hot hydrofluoric or chlorosulfonic acids, or Skydrol® fluids. They are also not recommended for situations requiring good low temperature flexibility.

Fluorosilicone

Trade Name(s):
Silastic LS . . . Dow Corning Corporation
FSE . . . General Electric

ASTM D1418 Designation: FVMQ

ASTM D2000/SAE J200 Type, Class: FK

Apple Compound Designation: FS

Standard Color: Blue

Description: Fluorosilicone combines the good high and low temperature stability of Silicones with the fuel, oil, and solvent resistance of Fluorocarbons.

Key Use(s): Aerospace fuel systems. Auto fuel emission control systems. Primarily for static sealing applications.

Temperature Range: Standard Compound: -75° to +400°F. (Dry Heat Only)

Hardness (Shore A): 50 to 80.

Features: Fluorosilicone is most often used in aerospace applications for systems requiring fuel and/or diester-based lubricant resistance up to a dry heat limit of 400° F.

Although generally specified for aerospace use, due to its excellent fuel resistance and high temperature stability, Fluorosilicone is becoming an increasingly popular material for a wider range of sealing applications.

Featuring good compression set and resilience properties, fluorosilicone compounds are suitable for exposure to air, sunlight, ozone, chlorinated and aromatic hydrocarbons.

Limitations: Due to limited physical strength, poor abrasion resistance, and high friction characteristics, Fluorosilicone elastomers are not generally recommended for dynamic sealing. They are predominately designed for static sealing use. They are also not recommended for exposure to brake fluids, hydrazine, or ketones.

Hypalon®

Trade Name(s):
Hypalon . . . DuPont Dow Elastomers.

ASTM D1418 Designation: CSM

ASTM D2000/SAE J200 Type, Class: CE

Apple Compound Designation: HY

Standard Color: Black

Description: A chlorosulfonated polyethylene, Hypalon offers outstanding resistance to attack by oxygen and ozone, high resistance to degradation by corrosive chemicals, good to excellent heat resistance, and fair to excellent oil resistance.

Key Use(s): For resistance to corrosive or oxidizing chemicals (acids & alkalis). For enhanced weather resistance (when compounded with protective pigments). For resistance to Freon® refrigerants (when compounded with a high chlorine content).

Temperature Range: Standard Compound: -50° to +275°F. (Dry Heat Only)

Hardness (Shore A): 50 to 90.

Features: Depending upon chlorine content, the heat resistance, oil resistance and low temperature flexibility properties of Hypalon compounds can be widely varied to meet specific application needs.

At low chlorine levels, Hypalon compounds exhibit their best heat resistance and low temperature flexibility properties, with fair oil resistance. At high chlorine levels, Hypalon compounds feature excellent oil resistance, with less heat resistance and less low temperature flexibility.

In general, Hypalon compounds are highly resistant to degradation by corrosive chemicals, and are very resistant to oxidation. Taken as a group, CSM compounds are more resistant to corrosive and oxidizing chemicals than are Neoprenes or Nitriles. They are also considered to be tougher than Silicone or Ethylene-Propylene elastomers.

Limitations: Resistance of Hypalon compounds to solvents is limited more by swelling than actual degradation. They are not recommended, however, for exposure to aldehydes, esters, ethers, ketones, aromatic, chlorinated or nitro hydrocarbons. Hypalon has poor compression set.

Material Selection Guide

Kalrez®

Trade Name(s):
Kalrez . . . DuPont Dow Elastomers

ASTM D1418 Designation: FFKM

ASTM D2000/SAE J200 Type, Class:
No Designation at Time of Publication

Apple Compound Designation: KA

Standard Color: Black

Description: Kalrez parts are made from a perfluoroelastomer possessing exceptional resistance to degradation by aggressive fluids and/or gases.

Key Use(s): Seals for use in the chemical and petroleum industries as well as for the manufacturing of semiconductors and analytical and process instruments. It is also used for high temperature applications and for paint and coating operations.

Temperature Range: Standard Compound: -35° to +600°F. (Dry Heat Only)

Hardness (Shore A): 65 to 95

Features: Kalrez combines the toughness of an elastomeric material with the chemical inertness of Teflon™. It resists attack by nearly all chemical reagents and provides long-term service where corrosive additives can cause other elastomers to swell or degrade. In addition, Kalrez parts are less likely to cold flow than Teflon seals.

Limitations: Withstanding degradation by virtually ALL chemicals, Kalrez can swell significantly when exposed to some fluorinated solvents, fully halogenated freons and uranium hexafluoride. In addition, Kalrez parts should not be exposed to molten or gaseous alkali metals.

As the thermal coefficient of expansion for Kalrez is stated by the manufacturer to be "about 50% greater than for fluoroelastomers", gland volume may have to be increased to allow for this expansion in elevated temperature situations.

Because of its high cost, Kalrez is generally used when no other elastomer is appropriate.

Natural Rubber

ASTM D1418 Designation: NR

ASTM D2000/SAE J200 Type, Class: AA

Apple Compound Designation: NA

Standard Color: Black

Description: Natural Rubber is the vulcanized product of the juice of the Hevea tree (latex).

Key Use(s): Seals in brake systems. Seals in food & beverage applications. Most popular material for non-hydraulic sealing applications.

Temperature Range: Standard Compound: -60° to +220°F. (Dry Heat Only)

Hardness (Shore A): 40 to 90.

Features: Natural Rubber features low compression set, high tensile strength, high resilience, high abrasion and high tear resistance properties, with a good friction surface and excellent adhesion to metals. Until the invention of synthetic elastomers in the 1930's, Natural Rubber was the only polymer available for O-ring manufacture.

Still used today in FDA applications for food and beverage seals, Natural Rubber features good resistance to organic acids and alcohols, with moderate resistance to aldehydes.

Limitations: The poor resistance of Natural Rubber to attack by petroleum oils was the primary reason for the research and development of synthetic rubbers beginning in the 1930's.

Also readily deteriorated by exposure to sunlight and ozone, Natural Rubbers have been predominantly replaced by "use specific" synthetic rubbers in the seal industry of today.

Neoprene® (Chloroprene)

Trade Name(s):
Neoprene . . . DuPont Dow Elastomers
Baypren . . . Bayer

ASTM D1418 Designation: CR

ASTM D2000/SAE J200 Type, Class: BC, BE

Apple Compound Designation: CR

Standard Color: Black

Description: One of the earliest of the synthetic materials to be developed as an oil-resistant substitute for Natural Rubber, Neoprene is a homopolymer of chloroprene (chlorobutadiene).

Key Use(s): Numerous component uses in the transportation field. Recommended for exposure to weathering. Preferred sealing material for refrigeration industry. FDA approved for food & beverage industry use.

Temperature Range: Standard Compound: -45° to +250°F. (Dry Heat Only)

Hardness (Shore A): 40 to 90.

Features: Neoprene can be used in innumerable sealing applications due to its broad base of such desirable working properties as: good resistance to petroleum oils; good resistance to ozone, sunlight and oxygen aging; relatively low compression set; good resilience; outstanding physical toughness; and reasonable production cost.

Due to its excellent resistance to Freon® and ammonia, Neoprene is also widely accepted as a preferred material for refrigeration seals.

Limitations: Neoprene is generally attacked by strong oxidizing acids, esters, ketones, chlorinated, aromatic and nitro hydrocarbons.

Because Nitrile is economically competitive with Neoprene, and generally has superior performance characteristics in most situations, it has largely replaced Neoprene in the O-rings of today.

Nitrile (Buna-N)

Trade Name(s):
Chemigum . . . Goodyear
Hycar . . . B. F. Goodrich
Krynac . . . Polysar, Ltd.
Nysyn . . . Copolymer Rubber
Paracril . . . Uniroyal
Perbunan . . . Mobay

ASTM D1418 Designation: NBR

ASTM D2000/SAE J200 Type, Class: BF, BG, BK, CH

Apple Compound Designation: BN

Standard Color: Black

Description: Presently the seal industry's most widely used and economical elastomer, Nitrile combines excellent resistance to petroleum-based oils and fuels, silicone greases, hydraulic fluids, water and alcohols, with a good balance of such desirable working properties as low compression set, high tensile strength, and high abrasion resistance.

Key Use(s): Oil resistant applications of all types. Low temperature military uses. Off-road equipment. Automotive, marine, aircraft fuel systems. Can be compounded for FDA applications.

Temperature Range: Standard Compound: -40° to +250°F. (Dry Heat Only)

Hardness (Shore A): 40 to 90.

Features: Comprised of the copolymer butadiene and acrylonitrile, in varying proportions. Its performance characteristics may be varied over a working temperature range of -65°F to +300°F.

Increasing acrylonitrile content gives Nitrile its better resistance to petroleum-based oils and hydrocarbon fuels, enhancing resistance to the degrading effects of heat, at a cost of reduced low temperature performance. It is also good with silicone greases and oils.

Conversely, decreasing acrylonitrile, while increasing butadiene content, provides better low temperature flexibility...a characteristic most often required by Air Force-Navy (AN) and Military Standard (MS) O-ring specifications.

A carboxylated version of the high-acrylonitrile butadiene copolymer (XNBR) is also available for applications requiring enhanced abrasion resistance.

Limitations: Precautions should be taken to avoid exposure of Nitrile to such highly polar solvents as

Material Selection Guide

acetone, MEK, chlorinated hydrocarbons and nitro hydrocarbons, which are known to cause rapid and extreme deterioration. It should not be used in the presence of strong acids or brake fluids.

Additional limitations on Nitrile use include applications with direct exposure to ozone and sunlight. Not recommended for exposure to ethers, esters, ketones, or chlorinated hydrocarbons.

Nitrile, Hydrogenated (HNBR)

Trade Name(s):
Zetpol . . . Nippon Zeon Co., Ltd.
Therbon ... Bayer
Tornac ... Polysar, Ltd.

ASTM D1418 Designation: HNBR

ASTM D2000/SAE J200 Type, Class: DH

Apple Compound Designation: ZT

Standard Color: Black

Description: HNBR is the product of the hydrogenation of Nitrile, resulting in varying degrees of saturation of the polymeric chain, with accompanying varying degrees of enhanced physical strength and chemical resistance properties.

Key Use(s): ALL oil resistant applications, including exposure to such oil additives as detergents, anti-oxidants and anti-wear agents. Exposure to oil soured with metal sludge. Seals for oil well applications. Seals for automotive fuel handling systems. Seals for general industrial usage.

Temperature Range: Standard Compound: -30° to +330°F. (Dry Heat Only)

Hardness (Shore A): 50 to 90

Features: In the areas of heat resistance, tensile strength, abrasion resistance, and oil additive resistance, HNBR exhibits improved performance characteristics over non-hydrogenated Nitrile, while showing about five times higher sour gasoline and ozone resistance.

Various HNBR compounds have been created with performance characteristics rivaling those of other polymers such as Fluorocarbon, Polyacrylate, Ethylene Propylene and Neoprene. HBNR's ozone and fuel resistance compares favorably with Fluorocarbon. Its excellent heat and oil resistance rivals that of Polyacrylate. Its resistance to steam (to 347°F) is close to that of Ethylene Propylene. Its high abrasion and heat resistance enables it to replace Neoprene in high temperature belts. In most cases, the tensile strength of HNBR is unsurpassed.

Limitations: Like Nitrile, increasing acrylonitrile content improves oil resistance at a cost of reduced low temperature performance. Also, as the degree of hydrogenation increases, with improved heat resistance, comes HNBR's tendency to cold flow or "creep". Increased hydrogenation further brings decreased elasticity at low temperatures. Like Nitrile, HNBR is not recommended for exposure to ethers, esters, ketones, or chlorinated hydrocarbons.

Polyacrylate

Trade Name(s):
Cyanacryl . . . American Cyanamid
Hycar . . . B.F. Goodrich
Krynac . . . Polysar, Ltd.

ASTM D1418 Designation: ACM

ASTM D2000/SAE J200 Type, Class: DH; DF

Apple Compound Designation: PY

Standard Color: Black

Description: Polyacrylates are copolymers (ethyl acrylates) possessing outstanding resistance to petroleum fuels and oils.

Key Use(s): Sealing automatic transmissions & power steering systems. Sealing petroleum oils up to 350°F.

Temperature Range: Standard Compound: 0° to +350°F. (Dry Heat Only)

Hardness (Shore A): 40 to 90.

Features: With excellent resistance to hot oil, automatic transmission and Type A power steering fluids, the greatest use for Polyacrylate is found in automobile manufacture, where O-rings of this material are employed to seal components of automatic transmission and power steering systems.

Highly resistant to sunlight and ozone degradation, Polyacrylate also features an enhanced ability to resist flex cracking.

Limitations: While resistance to hot air aging is superior to Nitrile, Polyacrylate strength, compression set, water resistance properties and low temperature capabilities are inferior to many other polymers.

Polyacrylates are also not generally recommended for exposure to alcohol, glycols, alkalis, brake fluids, or to chlorinated or aromatic hydrocarbons.

Polysulfide

Trade Name:
Thiokol (types A, B, FA, ST) . . . Thiokol Corp.

ASTM D1418 Designation: T

ASTM D2000/SAE J200 Type, Class: AK, BK

Apple Compound Designation: TH

Standard Color: Black

Description: Another of the early developed synthetic elastomers, Polysulfide offers a remarkable combination of solvent resistance, low temperature flexibility, flex crack resistance, oxygen and ozone resistance, and gas impermeability.

Key Use(s): Seals for paint and coatings and insecticide industry use.

Temperature Range: Standard Compound: -50° to +225°F. (Dry Heat Only)

Hardness (Shore A): 50 to 80

Features: Resistant to a wide range of solvents, including ketones, ethers, and aromatic hydrocarbons. Polysulfide has gained wide acceptance as a seal material for paints and coatings, and insecticides.

Limitations: With poor heat resistance, poor mechanical strength and compression set properties, Polysulfides are not as versatile as other elastomers from a performance standpoint. They are also not recommended for exposure to mercaptans, esters, amines, chlorinated or nitro hydrocarbons.

Polyurethane, Cast

Trade Name(s):
Vibrathane . . . Uniroyal
Cyanaprene . . . American Cyanamid
Polathane . . . Polaroid

ASTM D1418 Designation: No designation at time of publication.

ASTM D2000/SAE J200 Type, Class: No designation at time of publication.

Apple Compound Designation: CP

Standard Color: Amber

Description: Cast Polyurethane is outstanding over other O-ring elastomers in abrasion resistance and tensile strength. Additionally, Cast Polyurethane surpasses the performance of Millable Polyurethane in its higher tensile strength, greater elongation, wider temperature range, and lower compression set characteristics.

Key Use(s): Seals for high hydraulic pressures. Situations where highly stressed parts are subject to wear. Used for wheels, rolls, slurry parts, bumpers, couplers, and shock absorbers. Wiper seals for axially moving piston rods.

Temperature Range: Standard Compound: -60° to +225°F. (Dry Heat Only)

Hardness (Shore A): 70 and 90.

Features: With tensile strength of up to 6,000 psi, elongation of 350 to 650%, compression sets of 10 to 25%, and exceedingly high abrasion resistance, the physical properties of Cast Polyurethane are among the best of all O-ring elastomers.

The heat resistance of standard compound Cast Polyurethane (to 225°F) shows a decided improvement over the lesser heat resistance of standard compound Millable Polyurethanes (to 175°F).

Although they swell slightly upon exposure, Cast Polyurethane compounds feature excellent resistance to mineral-based oils and petroleum products, aliphatic solvents, alcohols and ether. They are also compatible with hydraulic fluids, weak acids and bases, and mixtures containing less than 80% aromatic constituents.

Limitations: Cast Polyurethanes are not recommended for exposure to concentrated acids and bases, ketones, esters, very strong oxidizing agents, pure aromatic compounds and brake fluids. With the exception of special compounds, they are also not recommended for exposure to hot water or steam.

Material Selection Guide

Polyurethane, Millable

Trade Name(s):
Adiprene . . . Uniroyal
Vibrathane . . . Uniroyal
Millathane H.T . . . TSE Industries Inc.

ASTM D1418 Designation: AU, EU

ASTM D2000/SAE J200 Type, Class: BG

Apple Compound Designation: MP

Standard Color: Black

Description: Millable Polyurethane is outstanding over most other O-ring elastomers in abrasion resistance and tensile strength.

Key Use(s): Seals for high hydraulic pressures. Situations where highly stressed parts are subject to wear.

Temperature Range: Standard Compound: -60° to +175° F. (Continuous use)

Hardness (Shore A): 40 to 90

Features: Millable Polyurethane offers superior seal performance in hydraulic situations, where high pressures, shock loads, or abrasive contamination is anticipated.

At temperatures up to approximately 158°F, Millable Polyurethane possesses chemical compatibility similar to that of Nitrile, offering good resistance to petroleum-based oils, hydrocarbon fuels and hydraulic fluids, the oxidizing effects of ozone, and the aging effects of sunlight. It also has good tear resistance.

Good low temperature flexibility is also a feature of many Millable Polyurethane elastomer compositions.

Limitations: Unless specially compounded, at elevated temperatures Millable Polyurethane begins to soften, losing its physical strength and chemical resistance advantages over other polymers.

Tending to rapidly deteriorate when exposed to concentrated acids, ketones, esters, chlorinated and nitro hydrocarbons, Millable Polyurethanes are also prone to hot water and steam degradation.

Silicone

Trade Name(s):
Baysoline ... Bayer Corp.
Silastic ... Dow Corning
Silplus ... General Electric

ASTM D1418 Designation: MQ, PMQ, VMQ, PVMQ

ASTM D2000/SAE J200 Type, Class: FC, FE, GE

Apple Compound Designation: SL

Standard Color: Red

Description: A group of elastomers, made from silicon, oxygen, hydrogen and carbon. Silicones are renowned for their retention of flexibility and low compression set characteristics, within one of the widest working temperature ranges for elastomers.

Key Use(s): Static seals in extreme temperature situations. Seals for medical devices, compatible with FDA regulations.

Temperature Range: Standard Compound: -94° to +400°F. (Dry Heat Only)

Hardness (Shore A): 25 to 80

Features: Especially resistant to high, dry heat, special Silicone compounds have been manufactured to resist up to 600°F heat for short periods of time in primary static applications. Also, Silicones are noted for their high resistance to fungus and aging effects of both sunlight and ozone attack, and are non-toxic with neutral odor and taste.

Liquid Silicone Rubber (LSR):

LSR is a low viscosity silicone elastomer intended for use in liquid injection molding (LIM) equipment. It offers high thermal stability and flexibility at low temperatures, high transparency and is easily colored. Also, self-lubricated and electrically conductive grades are available as well as FDA and Class VI medical compliant grades. Liquid silicone rubber is widely used to mold complex profiles because of its excellent flow characteristics. The LIM process is also highly controlled, allowing for the production of high precision parts.

Silicone continued . . .

Medical Grade Silicone:

When properly prepared, possible benefits include fulfillment of Class VI and Tripartite test requirements, resistant to yellowing and embrittlement from gamma sterilization, sterilizable with EtO/steam. Also, this grade of silicone is generally transparent due to class requirements.

Limitations: Generally, low abrasion and tear resistance, and high friction characteristics preclude silicones from effectively sealing some dynamic applications. Silicones are also highly permeable to gases and are generally not recommended for exposure to ketones (MEK, acetone) or concentrated acids. Heat aging of LSR results in an accelerated reduction in physical properties compared to that of conventional silicone.

Rule of Thumb

Material cost does not correlate with performance, it depends on the application.

Styrene Butadiene

Trade Name(s):
Too numerous to list.

ASTM D1418 Designation: SBR

ASTM D2000/SAE J200 Type, Class: AA, BA

Apple Compound Designation: SB

Standard Color: Black

Description: Also known as Buna S, or GR-S (Government Rubber-Styrene), Styrene Butadiene was the elastomer substituted for Natural Rubber during World War II. Compounded properties are similar to those of Natural Rubber.

Key Use(s): Sealing of automotive brake systems.

Temperature Range: Standard Compound: -50° to +212°F. (Dry Heat Only)

Hardness (Shore A): 40 to 90.

Features: The main use for Styrene Butadiene today is in the manufacture of automobile tires because it exhibits excellent resistance to brake fluids. SBR is still used in some brake applications.

Limitations: SBR is not recommended for exposure to petroleum oils, most hydrocarbons, strong acids, or ozone.

This material is seldom used in modern sealing applications. It has been replaced by better performing materials.

Material Selection Guide

Teflon® Virgin

Trade Name(s):
Teflon . . . DuPont Dow Elastomers

ASTM D1418 Designation: FEP

ASTM D2000/SAE J200 Type, Class:
No Designation At Time Of Publication

Apple Compound Designation: TF

Standard Color: White

Description: Teflon is a tough, chemically inert polymer possessing an incredible working temperature range.

Key Use(s): Seals for wide chemical exposure situations, with special emphasis on temperature extremes.

For static and SLOW INTERMITTENT dynamic situations.

Temperature Range: Standard Compound: -300° to +450°F. (Dry Heat Only)

Hardness (Shore A): 98.

Features: Teflon is inert to virtually all industrial chemicals, even at elevated temperatures. Seals fabricated from this material feature outstanding weather resistance, high resistance to ozone, and high resistance to the degrading effects of exposure to such solvents as acetone, MEK, and xylene. Possessing average elastomer characteristics of 2,500 to 3,500 psi tensile strength, and 300% elongation, they are tough, impact resistant, low friction, non-twisting performers over an extremely wide temperature range.

Limitations: Teflon is hampered by very poor elastic memory at room, or low temperatures. This presents problems in O-ring installation, requiring extra care to be taken in control over O-ring I.D. stretch. Heating Teflon in boiling water, or in a controlled oven, to 200°F is said to enable an O-ring stretch of 10 to 20% to be achieved, thereby assisting installation, and helping to assure a tight fit.

Because of its poor tear resistance, during O-ring installation particular care should be taken to avoid nicking or scratching Teflon, as imperfections will cause O-ring leakage.

Finally, the tendency of virgin Teflon to cold flow over time, when used in gasket type applications, may require special material compounding (with fillers) to control such "creep" in critical sealing situations.

Vamac® (Ethylene/Acrylic)

Trade Name(s):
Vamac . . . DuPont Dow Elastomers

ASTM D1418 Designation: AEM

ASTM D2000/SAE J200 Type, Class: EE, EF, EG, EA

Apple Compound Designation: VA

Standard Color: Black

Description: A copolymer of ethylene and methyl acrylate, with a small amount of a third monomer added to provide a cure to active groups in the polymer chain. Vamac exhibits properties similar to those of polyacrylate, but with an extended low temperature limit and better mechanicals.

Key Use (s): Seals for automotive applications, such as automatic transmissions & power steering systems.

Temperature Range: Standard Compound: -40° to +300°F. (Dry Heat Only)

Hardness (Shore A): 50 to 90.

Features: Ideal for automotive sealing uses, Vamac features excellent heat resistance, outstanding resistance to ozone and sunlight aging, moderate resistance to swelling in oils, and very low permeability to gases.

With a maximum reinforced tensile strength of 2,500 psi, Vamac's mechanical properties of adhesion to metals, tear resistance, flex life, abrasion resistance and compression set resistance are all rated as "good".

Resistance to water, engine coolant mixtures (glycols), dilute acids and alkalis is also good.

Limitations: Vamac is not recommended for exposure to concentrated acids, aromatic hydrocarbons, "gasoline", ketones, brake fluids and phosphate esters.

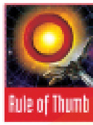
Thermoplastic Elastomers

Description: Thermoplastic elastomers combine the processing advantages of plastics with the rubber-like performance of elastomers. Known as two-phase systems, these copolymers are comprised of both hard (plastic) and soft (elastomeric) molecular regions, with each region contributing advantages and limitations to the final material performance. Chemically, fully-cured thermoset rubber particles are dispersed throughout a continuous thermoplastic matrix. Examples of this class of material are Santoprene™ and Geolast™ from Monsanto and Kraton™ from Shell.

Key Use(s): A broad range of applications that spans from bumpers to bellows, vibrational dampers, couplers, and grommets. Also used throughout the automotive, major and small appliances, and aerospace industries.

Features: In virtually all cases, the substitution of these materials for traditional thermosetting materials results in such benefits as significantly increased production speeds (via conventional plastic injection molding machines) and the ability to reuse clean scrap without a loss in physical properties. This results in a reduced part cost due to minimized scrap loss.

Also, they are available in a broad range of durometers and colors and, by adjusting the percentage of hard (plastic) segments in the copolymer matrix, the physical properties can be modified. For example, as styrene content is increased in polystyrene elastomer block copolymers, they change from weak rubber-like materials to strong elastomers, to leathery materials, to finally hard, glass-like products (with styrene content above 75%).



You must test all seals in their actual environment because every application is unique.

Limitations: The physical properties of thermoplastic elastomers are highly dependent upon the properties of the plastic and elastomeric regions of the copolymer. Consequently, as temperature changes, so does the behavior of the TPE. The low temperature limit is defined by the glass transition temperature of the rubber phase, below which the material is brittle. Likewise, the high temperature limit is defined by the melting point of the plastic phase, above which the material softens and begins to flow. This results in lowering the overall heat resistance of the copolymer.

Also, as temperature increases, compression set increases which limits the overall component size and complexity due to stack-up tolerances. Likewise, the chemical resistance of the thermoplastic is determined by the limits of BOTH materials comprising the system.

Cautionary Note:

There are many different thermoplastic elastomer copolymers on the market today, TAILORED TO SPECIFIC END USES. Because many of these copolymers ARE NOT designed to be used in sealing applications, it is important that you consult us before using them.