AFLAS®

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

ASTM D1418 Designation: FKM

ASTM D2000/SAE J200 Type, Class: HK

Standard Color: Black

Description: A copolymer of tetrafluoroethylene and propylene, AFLAS exhibits excellent chemical resistance properties, and good to fair high temperature retention of physical properties.

Key Use(s): Seals for oil field, industrial and chemical applications.

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

Hardness (Shore A): 60 to 95.

Features: With good resistance to petroleum fluids; steam; a number of acids and alkalies; amines (anti-freeze); phosphate esters and brake fluids, AFLAS has generated considerable interest as a seal material for oil field, industrial and chemical applications.

Laboratory tests have demonstrated a high degree of heat resistance (to 400°F) with retention of slightly below average (2,500 psi) tensile properties. Tests have further shown abrasion resistance to be about the same as Fluorocarbon; cracking to appear after 100 to 200 flexes at 400°F; and no change in material properties after one year of weathering.

Limitations: Seven day immersion, at room temperature, in solvents indicates such significant volume changes as 50% in Acetone; 58% in MEK: 95% in MIK; 112% in Chloroform; 125% in Methyl Chloroform; and 249% in Trichlorotrifluoroethane.

Compression set of 52% after 30 days at 400°F may be considered too high for some sealing applications.

BUNA-N (NITRILE)

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

ASTM D1418 Designation: NBR, XNBR

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

Standard Color: Black

Description: Presently the seal industry's most widely used 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, by varying the relative proportions of these two base monomers, depending upon the compound, Nitrile performance characteristics may also 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.

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 Acetone, MEK, Chlorinated Hydrocarbons and Nitro Hydrocarbons, which are known to cause rapid and extreme deterioration.

Additional limitations on Nitrile use include applications with direct exposure to ozone and sunlight.

Suggested precautions for storage include keeping Nitrile O-rings out of direct sunlight, as well as away from ozone-generating electrical equipment.

ETHYLENE-PROPYLENE

Trade Name(s):
Nordel . . . E.I. du Pont de Nemours & Co.
Epcar . . . B.F. Goodrich
Vistalon . . . Exxon Chemical Co.
Epsyn . . . Copolymer Rubber
Royalene . . . Uniroyal, Inc.

ASTM D1418 Designation: EPM; EPDM

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

Standard Color: Black

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

Key Use(s): Outdoor weather resistant uses. Hydraulic & automotive brake systems. Automobile cooling systems. Water appliances. 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 +300°F, depending upon the compound, EPM/EPDM excels in its resistance to the very same chemical agents that cause rapid and extreme deterioration in Nitriles.

In particular, EPM/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 alkalies; alcohols and automotive brake fluids.

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

EPM/EPDM can also be compounded for FDA approved applications.

Limitations: With the exception of resistance to polar solvents, EPM/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

Trade Name(s):

Fluorel . . . 3M Company
Technoflon . . . Montedison, USA

ASTM D1418 Designation: FKM

ASTM D2000/SAE J200 Type, Class: HK

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: Featuring 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 U.V. light and ozone.

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

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, FS 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 predominantly designed for static sealing use.

They are also not recommended for exposure to brake fluids, hydrazine, or ketones.

HYPALON®

Trade Name(s):
Hypalon . . . E.I. du Pont de Nemours & Co.

ASTM D1418 Designation: CSM

ASTM D2000/SAE J200 Type, Class: CE

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 & alkalies). 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.

KALREZ®

Trade Name(s):
Kalrez . . . E.I. du Pont de Nemours & Co.

ASTM D1418 Designation: FFKM

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

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 severe chemical exposure and high temperatures. Used extensively in oil exploration and refining. Seals for chemicals processing & transportation. Seals for paint and coatings operations. Seals for analytical and process control instrumentation.

Temperature Range: Standard Compound: −35° to +500°F. (Dry Heat Only)

Hardness (Shore A): 65 to 95.

Features: Kalrez parts combine the high temperature toughness of a fluorocarbon elastomer (such as Viton®), with the chemical inertness of Teflon® . As a group, Kalrez parts resist attack by nearly ALL chemical reagents. They provide long term service in virtually ALL chemical and petrochemical process streams.

Compared with Teflon seals, Kalrez parts are much less likely to cold flow (''creep'').

Kalrez parts are offered in several compounds, with varying tensile, elongation, hardness, compression set and temperature ranges. For example, tensile strengths vary by compound from a low of 1,850 psi to a high of 3,800 psi, with elongation likewise varying from a low of 120% to a high of 190%.

Limitations: In general, Kalrez compression set properties range from ''fair'' (32 to 54%) at 212°F, to ''poor'' (66 to 82%) at 400°F, for 70 hours of test duration.

Withstanding degradation by virtually ALL chemicals, nonetheless Kalrez parts can be made to significantly swell upon exposure to some fluorinated solvents; fully halogenated freons; and uranium hexafluoride. Because a highly exothermic reaction could occur, Kalrez parts SHOULD NOT be exposed to molten or gaseous, alkali metals (such as sodium).

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.

Despite the desirable characteristics of Kalrez, because of its high cost it is generally used when no other elastomer is appropriate.

NATURAL RUBBER

ASTM D1418 Designation: NR

ASTM D2000/SAE J200 Type, Class: AA

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-O-ring 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

sion 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, alcohols and automotive brake fluid, with moderate resistance to aldehydes and ketones.

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 . . . E.I. du Pont de Nemours & Co.
Baypren . . . Bayer

ASTM D1418 Designation: CR

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

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. F.D.A. 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: moderate resistance to petroleum oils; good resistance to ozone, sunlight and oxygen aging; relatively low compression set; good resilience; 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.

POLYURETHANE, Cast

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

ASTM D1418 Designation: No designation at time of publication

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

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.

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 Polyurethanes (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.

SILICONE

Trade Name(s):
Silastic . . . Dow Corning
Silplus . . . General Electric
Rhodorsil . . . Rhone Poulenc

ASTM D1418 Designation: MQ, PMQ, VMQ, PVMQ

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

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: −75° to +450°F. (Dry Heat Only)

Hardness (Shore A): 25 to 80.

Features: Especially resistant to high, dry heat, in primarily static applications, special Silicone compounds have been manufactured to resist up to 600°F heat for short time durations. Maximum elevated temperature for continuous service, however, remains at 450°F. At the opposite end of the temperature scale, the low limit for Silicone flexibility is −75°F.

In addition to their resistance to degradation at temperature extremes, Silicones are noted for their high resistance to the aging effects of both sunlight and ozone attack.

Silicones are also fungus resistant, odorless, tasteless and non-toxic.

Limitations: Poor tensile and tear strength, low abrasion resistance and high friction characteristics preclude Silicones from effective sealing use in most dynamic situations.

Many Silicone compounds also exhibit higher than normal mold shrinkage, resulting in undersized, molded finished parts (from standard molds).

Unless specially compounded, Silicones swell considerably in aliphatic and aromatic hydrocarbon fuels. They should also be considered NON-resistant to petroleum oils, although they can be used in high aniline point oils.

Silicones are highly permeable to gases, and are generally not recommended for exposure to ketones (MEK; acetone), concentrated acids, or steam.

STYRENE BUTADIENE

Trade Names(s):
Too numerous to list.

ASTM D1418 Designation: SBR

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

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 hydraulic brake systems.

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

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

Hardness (Shore A): 40 to 90.

Features: Exhibiting excellent resistance to brake fluids, SBR is still used in some brake applications. With good water resistance, and resilience up to 70 durometer, it is also used in plumbing.

The main use for Styrene Butadiene, however, is in the manufacture of automobile tires . . . a decidedly non O-ring application.

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

TEFLON® Virgin

Trade Names(s):
Teflon . . . E.I. du Pont de Nemours & Co.

ASTM D1418 Designation:
No Designation At Time Of Publication

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

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, under gasketing pressures, may require special material compounding (with fillers) to control such "creep" in critical sealing situations.