MOMENTIVE®

FLUOROSILICONES

ELASTOMERS FOR HARSH & DEMANDING ENVIRONMENTS

CONTENTS

EVOLUTION OF FLUOROSILICONES IN AUTOMOTIVE

For synthetic elastomers, the applications themselves, including the media, temperature exposures, and underlining technical requirements, become more challenging every year. Automotive manufacturers endeavor to build their global platforms and systems to withstand a variety of country specific legislations, temperature requirements and fuels.

Designers have recognized that Fluorosilicones cover a broad temperature range while keeping most mechanical properties stable when exposed to harsh conditions. Fluorosilicones’ broad resistance against automotive fluids, including blow-by-gas-condensate and the variety of fuels, oils and transmission fluids, globally - make Fluorosilicones desirable for static and dynamic seals, membranes and gaskets under the hood.

Over the last several years, the trend in the marketplace for molded silicone rubber parts has moved toward the use of liquid silicone rubber (LSR) due to its ease of processability, design versatility, excellent quality, and productivity gains. Fluoromethyl co-polymer LSR’s offer intermediate fuel and solvent resistance; however, in very harsh environments, Fluorosilicone HCE (heat cured elastomer) is still the material of choice due to its higher fluorine content and superior solvent resistance.

Momentive is well known as an experienced manufacturer of these high-tech elastomer grades and continues their evolution together with customers and end-users in new developments.

As used herein, the Fluorosilicones in the drawings include FVMQ, MFQ and FMQ. This document uses “FSE” for Fluorosilicone HCE and “FSL” for Fluorinated liquid silicone rubber.

STRONG PRODUCTS FROM A STRONG GLOBAL PARTNER

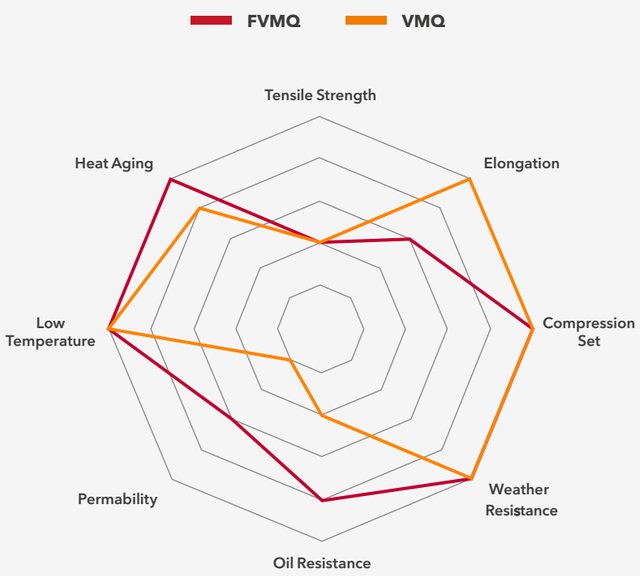
Fluorosilicone materials are at the forefront of technical development and provide:

- Excellent resistance in automotive fluids like engine and hydraulic oils, fuels and various mixtures
- High thermal stability
- Lowest temperature flexibility of all Fluoroelastomers
- Constant modulus over a wide temperature range
- Low hardness without the addition of plasticizers
- Good tear strength
- Low compression set

Flourosilicone elastomers by Momentive are segmented into two categories:

FSE - Heat Cured Elastomers can be processed with conventional high consistency rubber processing equipment. They can be injection, transfer or compression molded, extruded or calandered.

FSL - Liquid Silicone Rubber can be processed with conventional LSR injection molding equipment.



Primary uses of Momentive fluorosilicones are in fuel systems at temperatures up to +177°C (+350°F) and in demanding applications where the dry-heat resistance of the elastomer is required (+204°C/400°F). Fluorosilicones may also be exposed to petroleum based oils and/or hydrocarbon fuels. In some fuels and oils; however, the high temperature limit in the fluid list is more conservative because fluid temperatures approaching 200°C (390°F) may degrade the fluid, producing acids which can attack fluorosilicone. For low temperature applications, fluorosilicones seal at temperatures as low as -73°C (-100°F).

Silicones (VMQ) have good heat resistance and cold flexibility, weathering resistance, and good insulating properties. Compared to silicone, fluorosilicones (FVMQ) have fluorinated side chains for good oil and fuel resistance.

- Excellent thermal and heat stability properties
- Outstanding cold flexibility when compared against other fluoroelastomers
- Excellent weather, aging and ozone stability
- Good resistance in oils and hydraulic fluids
- Temperature range from –50°C to +200 °C

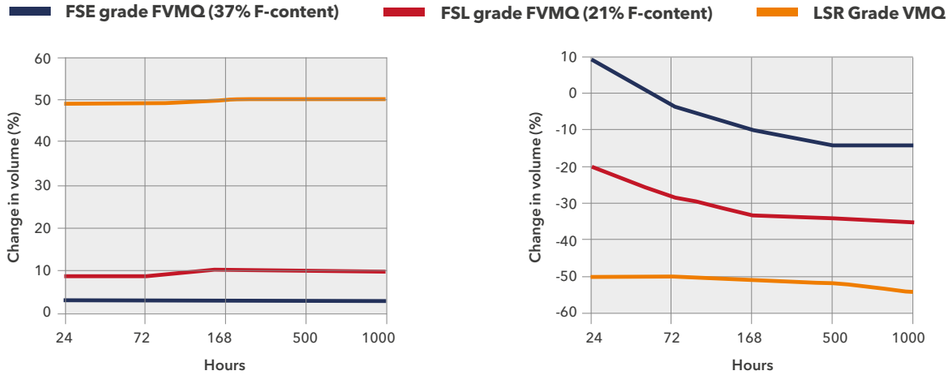
CHEMICAL RESISTANCE

Momentive fluorosilicone elastomers are the excellent choice for applications involving chemical, fuel or solvent contact under wide-ranging temperatures.

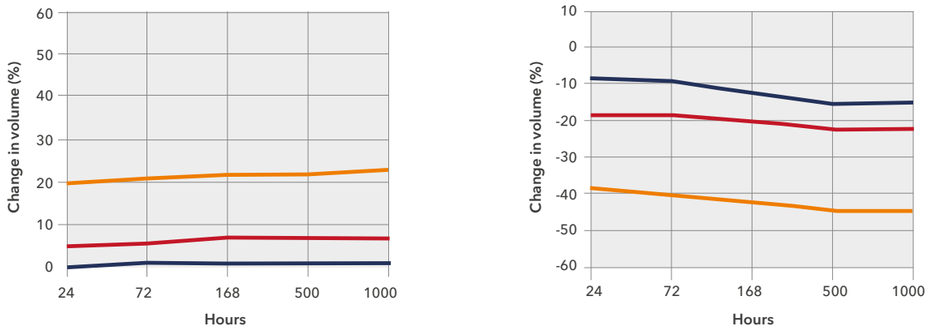
They are also virtually unaffected by ozone, UV and gamma radiation and harsh weather conditions like rain, frost and snow.

LONG LASTING IN ENGINE OILS

In a wide variety of mineral or synthetic engine oils, Momentive fluorosilicone elastomers remain almost unaffected and provide long lasting performance.



Immersion in test oil “IRM 903” at 150°C (40 Sh A grades)

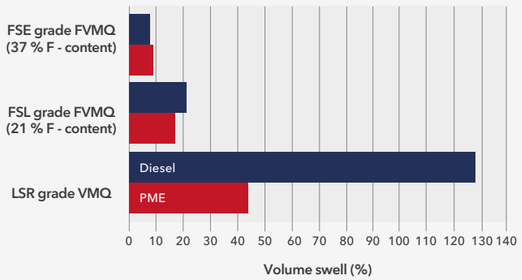


Immersion in test oil BP”C20” at 150°C (40 Sh A grades)

LOW SWELL IN FUELS

Fluorosilicones from Momentive have excellent resistance against automotive and aircraft fuels and are used in static and dynamic seals around the fuel system like O-rings, membranes and other gaskets.

In diesel fuels and PME (Palm methyl ester) partly fluorinated grades like FSL also show excellent performance.

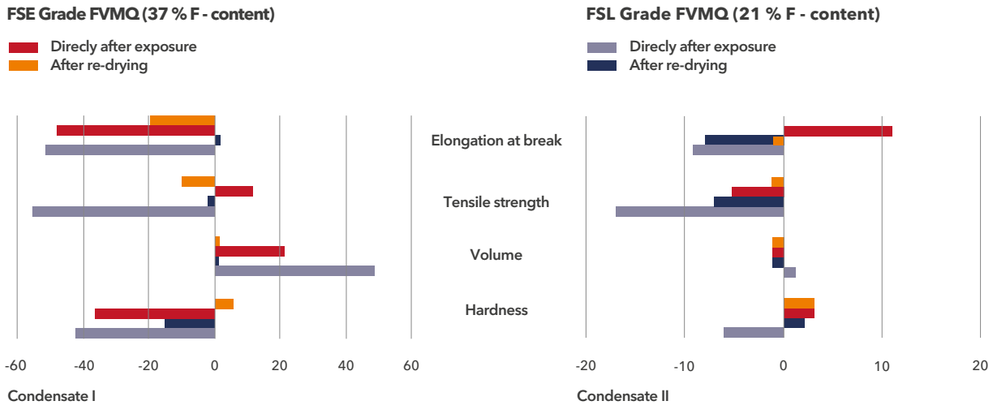


Immersion test in Diesel and PME 72 h at 120°C

FLUOROSILICONES CAN HANDLE "BLOW-BY GAS"

In modern engines, materials used for many membrane and diaphragm applications have to resist "blow-by-gas".

Blow-by-gas is a mixture of exhaust gases, unburnt fuel, combustion by-products like water and even acids together with oil mist from the oil sump of the engine. Their compositions vary with driving conditions and even between engine-designs greatly. In order to standardize testing, some automotive companies have defined artificial blow-by-gas compositions. Fluorosilicones show good resistance against the standardized blow-by-gases. Also in real applications with even more demanding original fluids from engine test rigs, Momentive fluorosilicone grades have shown outstanding performance.



Resistance against blow-by-gas condensates C1 and C2., 72 hours at 120°C in autoclave

PERFORMING OVER A WIDE TEMPERATURE RANGE

Over a wide temperature range, fluorosilicone elastomers from Momentive provide unequalled thermal performance.

Useful temperature range	**-55 to 200°C**
Thermal conductivity *(can be modified by compounding)*	**0.25 W/m.K**
Coeffcient of thermal expansion	**2 x 10-4 K-1**

They remain flexible for long periods when exposed to elevated temperatures and provide excellent mechanical properties at high temperatures. Despite extreme temperatures as low as –55°C, Momentive fluorosilicone elastomers can retain their performance and help to provide reliable function for prolonged periods. Hardness and modulus show relatively little change and make fluorosilicone elastomers the first choice for applications like membranes and diaphragms.

EXCELLENT MECHANICAL PROPERTIES

Special compounding techniques and the unique polymer nature of Momentive fluorosilicone elastomers enable low hardness grades. No additional, free plasticizers are needed to achieve exceptional values down to 20 Shore A, which are very diffcult to reach for other elastomers. High strength grades offer strength comparable to many high performance elastomers for almost any application. Physical properties are usually equal or superior to organic fluoroelastomers especially at elevated temperatures in the range of 95 to 180 °C. Low compression set types find use in sealing applications like O-rings and gaskets with complex design.

Momentive fluorosilicone elastomers also show excellent dielectrical strength and arc resistance.

BROAD SPECTRUM OF APPLICATIONS

Momentive fluorosilicone elastomers are used in almost all industries ranging from automotive and aircraft industry to chemical processing including oil and gas exploration. Fluorosilicones are used for sealing applications in the aerospace industry requiring resistance to hot fuels, oils, and diester based lubricants. They are often a good choice for static sealing systems for a wide temperature range.

Applications include:

- O-rings and gaskets
- Membranes and diaphragms
- Seals in contact with fuel and oil
- Check-valves
- Turbo-charger hoses

EASY TO PROCESS, EASY TO COLOR

Fluorosilicone rubber (FSE) is easy to handle in typical relevant manufacturing processes found for elastomers like

- Molding (compression, transfer and injection molding)
- Extrusion (for profiles, tubes, hoses)
- Calendaring of sheets or on textiles

Depending on process and application needs, special compounding is recommended. In addition, for LSR-process, fluorinated silicones (FSL) are available. The LSR technology is characterized through very short cycle-time, waste- and flash-less, fully automated injection molding. It energizes innovation, not only in 2-component-molding on a variety of substrates including engineering plastics, thermosets, and metals. All fluorosilicones are off-white / translucent. They are easy to pigment with Momentive color pastes.

SERVICE

Momentive manufactures fluorosilicone (FSE) rubber base materials. However, many companies prefer “ready-to-use compound”. These compounds are available through our local compounding centers or through a global network of partner companies, please ask Momentive for details.

Momentive helps customers to tailor compounds fitting the application (e.g. physical properties) and the processing equipment (e.g. specific pre-forms).

The fluorinated liquid silicone rubbers (FSL) are supplied ready-to-use in drum and pail-kits.

Momentive is experienced in application development, so customers benefit from an existing end-user network in various markets (such as automotive or healthcare). The application development centers support customers with screening trials and first prototyping. The existing network to suppliers of molds and process equipment helps to shorten development times and to accelerate innovations.

APPLICATION VERSATILITY

Automotive
Components such as seals, O-rings, quick-connect seals, gaskets, diaphragms, membranes, flexible valves, and turbocharger hose liners

Aviation/Aerospace
Parts including gaskets, seals, hoses, bellows and connectors

Railway
parts including gaskets, seals, hoses, bellows and connectors

Petrochemical/Oil & Gas
Components, such as sealing elements for pumps, valves and pipelines exposed to liquid or gas hydrocarbons or corrosive chemicals

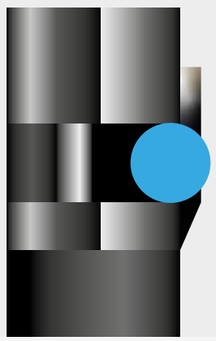
Industrial
Gaskets exposed to high temperature condition in addition to oil or solvents

APPLICATION OVERVIEW: O-RINGS

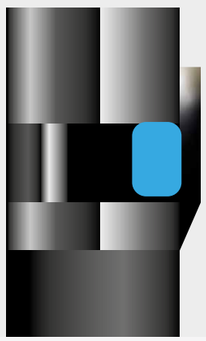
An O-ring seal is used to prevent the loss of a fluid or gas.

The seal assembly consists of an elastomeric O-ring and a gland. An O-ring is a circular cross-section ring molded from rubber. The gland - usually cut into metal or another rigid material - contains and supports the O-ring. The combination of these two elements; O-ring and gland - constitute the classic O-ring seal assembly.

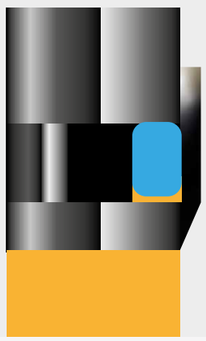
The fluorosilicone should be considered as an incompresible fluid and viewed more so as a viscous fluid which possesses a very high surface tension. Whether by mechanical pressure transmitted through hydraulic fluid, the fluorosilicone is forced to flow within the gland to produce “zero clearance”. This in turn generates a seal and blocks the flow of the less viscous fluid which is being sealed in application. The fluorosilicone has excellent elastic memory and recovery and will maintain the sealed position.



O-RING SEATED ON PISTON

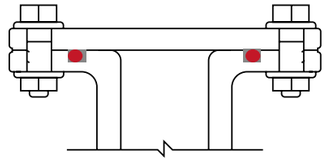


PISTON AND O-RING INSTALLED IN BORE



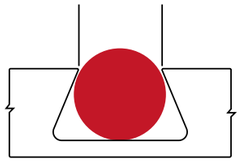
O-RING SEALING FLUID TOWARD THE PRESSURE SOURCE

O-RING TYPES



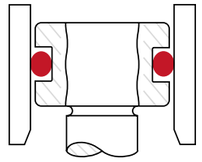
FACE SEAL TYPE (Axial Seal)

Typically a groove is cut/placed in a flat surface, such as a flange. The O-ring is placed in the groove or flange and the mating flat surface compresses the O-ring creating a seal.



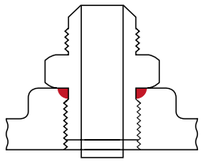
DOVETAIL GROOVE TYPE

Used in applications where it is a necessity to mount/ install an O-ring in a face type groove in a manner in which it has limited ability to fall out due to the dovetail groove.



STATIC MALE OR FEMALE TYPE (Radial Seal)

In a static seal, the mating gland parts are not subject to relative movement.



BOSS SEALS

Utilized in straight thread sealing applications fitting a straight thread tube into a boss.

Advantages/benefits of O-rings

- O-rings seal over a wide range of pressure, temperature and tolerances.
- Ease of service, no smearing or retightening.
- O-rings normally require minimal space and are light in weight.
- No critical torque on tightening, therefore unlikely to cause structural damage.
- O-ring possess the potential to be reused, an advantage over non-elastic flat seals and crush-type gaskets.
- O-ring failure is normally gradual and easily identified.
- Flat gasket designs have a direct relationship to the compression of the gasket itself; varied amounts of compression will effect the gaskets seal functionality. An O-ring by design is not impacted because metal to metal contact is generally allowed for.
- O-ring are cost effective sealing options.

Fluorosilicone O-rings provide great jet fuel resistance with high and low temperature performance, in addition to strong resistance to oxygen plasma, FVMQ fluorosilicone O-rings also feature excellent flexibility, compression resistance, aging and sunlight resistance, and overall wide range of basic chemical resistance. The specialized properties of Momentive’s fluorosilicone provide many of the benefits of silicone while adding additional resistances to non-polar solvents, fuels, oils, acids, and alkaline chemicals. These benefits make it the right solution for the formation of O-rings, gaskets, tubing, and seals used in many industrial, automotive, aerospace and aviation applications.

Fluorosilicone O-rings Features and Resistances:

- Excellent flexibility and resistance to compression set
- Excellent resistance high-level aging, weather, and UV resistance
- Resistance to oxidizing chemicals, animal and vegetable oils, fuels, aromatic and chlorinated solvents
- Capacity to withstand aliphatic and aromatic fluorocarbons, diluted alkalis, toluene, benzene, ozone, diester oils, silicone oils, and oxidative environments.

LIQUID SILICONE RUBBER (LSR) FLUOROSILICONES

	Appearance	Density g/ cm3	Hardness/ Durometer Shore A	Tenmsile Strength, Mpa	Elongation, %	Tear Strength, Die B N/mm	Compression Set, % (post-cured)
Flourinated LSR							
FSL 7641	Translucent	1.23	40	6	500	20	17
FSL 7651	Translucent	1.23	50	6	400	20	15
FSL 7661	Translucent	1.26	60	7	300	32	23

	Appearance	Density g/ cm3	Hardness/ Durometer Shore A	Tenmsile Strength, Mpa	Elongation, %	Tear Strength, Die B N/mm	Compression Set, % (post-cured)
Self-lubricating Fluorosilicone							
FSL 7586/40	Translucent	1.23	40	6	380	20	17

Fluid Resistance Data	Hardness/ Durometer Shore A	Tenmsile Strength Change %	Elongation Change %	Volume Change %
3 d 150 °C				
IRM 903	-6	-26	-21	+9
Castrol "SLX OW30" [1]	-3	-12	-11	-0.1
Mobil "OW30" [2]	-2	-14	-11	+2.2
BP "C20" [3]	-3	-22	-8	+2.4
3 d 120 °C				
Diesel (EN 590)	-13	-47	-26	+21
RME - Bio disesel	-8	-41	-35	+17
3 d 70 °C + 24h RT				
Fuel C	+5	+41	+25	-11

HCR FLUOROSILICONES

	Peroxide	Appearance	Density g/ cm3	Hardness/ Durometer Shore A	Tenmsile Strength, Mpa	Elongation, %	Tear Strength, Die B N/mm	Compression Set, % (post-cured)
General Purpose								
FSE7520	X	White	1.36	26	7.7	550	16	15
FSE7540	X	White	1.39	44	8.3	380	13	8
FSE7560	X	White	1.42	62	9.2	290	18	10
FSE7570-D1	X	Off-White	1.47	66	8.2	350	35	15
High Tear Resistance								
FSE7340	X	Pale Yellow	1.43	43	11.2	500	42	8
FSE7360	X	Pale Yellow	1.47	62	10.5	400	38	12
Low Compression Set								
FQE205U	X	Pale Yellow	1.42	52	9.2	290	17	4
FQE206U	X	Pale Yellow	1.45	61	11.2	280	22	5
FQE207U	X	Pale Yellow	1.53	71	8.5	190	17	3
Low Compression Set / High Strength								
FQE307U	X	Pale Yellow	1.45	70	10.5	260	14	4

All Fluorosilicones are available as customizable ready-to-use compounds | "X" Denotates the catalyst system

LIQUID SILICONE RUBBER (LSR) FLUOROSILICONES

Fluorosilicone Specification callouts: Mil-DTL-25988C, Mil-R-25988, and AMS-R-25988 are frequently used to specify fluorosilicone rubber. Momentive offers materials specifically formulated to meet the aforementioned specifications.

In addition AMS 3325 through AMS 331 also specify/ identify fluorosilicone materials. Momentive's Applications Development Engineering team can assist and support in meeting your fluorosilicone compound specification needs whether it be via a base fluorosilicone recommendation or a ready-to-use compound.

HCR Fluorosilicone Compounds: MIL-DTL-25988C, TYPE 1/CLASS 1

MIL-DTL-25988 Grade 60

MIL-DTL-25988 Grade 70

MIL-DTL-25988 Grade 80

Compounds Meeting Department of Defense Specifications meeting and/or exceeding the Physical Properties listed in the table below

MIL-R-25988/3 – Rubber, Fluorosilicone Elastomer, Oil- and Fuel-Resistant, O-rings, Class 1, Grade 60

MIL-R-25988/1 – Rubber, Fluorosilicone Elastomer, Oil- and Fuel-Resistant, O-rings, Class 1, Grade 70

MIL-R-25988/4 – Rubber, Fluorosilicone Elastomer, Oil- and Fuel-Resistant, O-rings, Class 1, Grade 80

	MIL-DTL-29588: CLASS 1		
	GRADE 60	**GRADE 70**	**GRADE 80**
Original Properties			
Hardness, points	60 ±5	70 ±5	80 ±5
Tensile strength, psi, min.	700 (4.83 kPa)	750 (5.17 kPa)	750 (5.17 kPa)
Elongation, %, min.	150	125	70
Temperature retraction, °F, max.	–70 (–56.7 °C)	–70 (–56.7 °C)	–70 (–56.7 °C)
After air aging 70 hours @ 75 ±5 °F (23.9 ±2.8 °C) Compression set, %, max.			
Under 0.110 inch (2.79 mm) 20 15 25	20	15	25
Over 0.110 inch (2.79 mm) 15 15 20	15	15	20
After aging 70 hours @ the temperatures	392 ±5 °F (200 ±2.8 °C)	392 ±5 °F (200 ±2.8 °C)	392 ±5 °F (200 ±2.8 °C)
Hardness change, point, max.	+10, -5	+10, -6	+10, -7
Tensile strength decrease, %, max.	25	25	20
Elongation decrease, %, max.	25	25	20
Weight loss, %, max.	2	2	2
After air aging 22 hours @ 347 ±5 °F (175 ±2.8 °C) Compression set, %, max.			
Under 0.110 inch (2.79 mm)	45	30	50
Over 0.110 inch (2.79 mm)	40	30	45
After aging 70 hours in AMS 3021 @ the temperatures	302 ±5 °F (150 ±2.8 °C)	302 ±5 °F (150 ±2.8 °C)	302 ±5 °F (150 ±2.8 °C)
Hardness change, points, max.	±15	±15	±15
Tensile strength decrease, %, max.	45	40	30
Elongation decrease, %, max.	30	25	15
Volume change, %	1 to 15	1 to 15	1 to 15
Compression set, %, max.			
Under 0.110 inch (2.79 mm)	50	30	65
Over 0.110 inch (2.79 mm)	45	30	60
After aging 22 hours @ 75 ±5 °F (23.9 ±2.8 °C) in AMS 2629, Type 1			
Hardness change, points, max.	-20	-20	-20
Tensile strength decrease, %, max.	50	45	30
Elongation decrease, %, max.	40	35	30
Volume change, %	1 to 25	1 to 25	1 to 25

MOMENTIVE®
inventing possibilities

Defense and Government Expertise

Cage Code: 01139
DUNS: 789994014
NAICS Codes: 325199, 332812
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