3M™ Dyneon™ Fluoroelastomer FPO 932HB

Features and Benefits

- Low total metal ion content yielding low metal impurities
- Good compression set
- Excellent chemical resistance
- Small clean room packaging size available

Note: Data in this document are not for specification purposes.

Typical Properties

Property	
Specific Gravity	1.91
Color	White
Form	Slab
Fluorine Content	71.0%
Mooney Viscosity ML – (1 + 10) @ 121°C	70

Product Description

3M™ Dyneon™ FPO 932HB is a high purity peroxide curable fluoroelastomer (FKM) that does not rely on traditional fillers to achieve physical properties. This allows the FKM compound to be higher purity than standard filled FKM compounds in terms of total metal ion content.

Safety/Toxicology

Follow recommended handling precautions for use of 3M fluoroelastomers. General handling precautions include: (1) Store and use all 3M fluoroelastomers only in well ventilated areas. (2) Do not smoke in areas contaminated with dust from 3M fluoroelastomers. (3) Avoid eye contact. (4) After handling 3M fluoroelastomers wash any contacted skin with soap and water.

Potential hazards, including evolution of toxic vapors, do exist during compounding or processing under high temperature conditions. Before processing 3M fluoroelastomers, consult the product SDS (Safety Data Sheet) and follow all label directions and handling precautions. You should also read and follow all directions from other compound ingredient suppliers. Safety Data Sheets on 3M products are available online or from your 3M Sales Representative.

ISO 9001

All 3M fluoroelastomers are manufactured at ISO 9001 registered facilities. Our product realization process is also ISO 9001 registered.

Typical Properties of Vulcanizate

Compound	phr
FPO 932HB	100
2,5 Dimethyl 2,5 Di-t-butylperoxy Hexane	1.0
Triallyl Isocyanurate, neat (TAIC®)	2.4

Typical Rheological Properties
Moving Die Rheometer (MDR)
100 cpm, 0.5° Arc, 10 Minutes @ 177°C (350°F)

ML, Minimum Torque, Inch-lb (dN m)	1.1 (1.2)
t_s2, Time to 2 Inch-lb Rise from Minimum - Minutes	0.9
t’50, Time to 50% Cure - Minutes	1.1
t’90, Time to 90% Cure - Minutes	2.3
MH, Maximum Torque, Inch-lb (dN m)	9.0 (10.2)

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Typical Physical Properties [ASTM D412]
Press Cure 6 Minutes @ 177°C (350°F)
Post Cured 16 Hours @ 200°C (392°F)

Tensile, psi (MPa)	1624 (11.2)
100% Modulus, psi (MPa)	290 (2.0)
Elongation at Break, %	318
Hardness, Shore A [ASTM D2240]	65

Dry Heat Resistance of Vulcanizate [ASTM D573]

Temperature Time (Hours)	200°C (392°F) 70	200°C (392°F) 168
Tensile Strength at Break, psi (MPa)	1417 (9.8)	1626 (11.2)
Elongation at Break, %	292	353
100% Modulus, psi (MPa)	349 (2.4)	299 (2.1)
Hardness, Shore A [ASTM D2240]	69	68
Change in Tensile Strength, %	-13	0
Change in Elongation at Break, %	-8	+11
Change in 100% Modulus, %	+20	+3
Change in Hardness, points	+5	+4

Compression Set Resistance [ASTM D395 Method B, -214 O-rings]

70 Hours @ 200°C (392°F)	18
168 Hours @ 200°C (392°F)	28

Chemical Resistance,
Percent Volume Swell - 70 Hours @ Temperature Noted

Glacial Acetic Acid, @ 100°C (212°F)	30
Acetone, @ 50°C (122°F)	217
Ethanol, @ 60°C (140°F)	5
Ethylene Diamine, @ 90°C (194°F)	2
Hexane, @ 60°C (140°F)	4
Methanol, @ 60°C (140°F)	5
Methanol, @ 23°C (73°F)	1
20% Nitric Acid, @ 100°C (212°F)	1
15% NaOH, @ 100°C (212°F)	-2
Toluene, @ 100°C (212°F)	16

Outgassing Rates

Temperature	30°C	100°C	200°C	300°C
Outgassing Rate (torr-liters/second/gram)	6.4 E-02	6.1 E-02	0.2	0.7

Processing Recommendations

3M™ Dyneon™ FPO 932HB is an advanced fluoroelastomer that utilizes polymeric filler technology to provide the reinforcement observed with traditional carbon black or inorganic fillers. For best results and to reduce chances of contamination, dedicated mixing, extrusion, and molding equipment in a clean-room environment is recommended for processing this material.

In order to achieve the highest level of purity it is recommended to use pure (neat) peroxide and coagent. The absence of traditional fillers makes this material difficult to handle on an open mill. Internal mixing is recommended, but only on a piece of equipment that has been thoroughly cleaned or is dedicated to this type of product.

Metal Ion Extraction Analysis:

Press Cure -214 O-rings for 6 Minutes @ 177°C (350°F)
Post Cured 16 Hours @ 200°C (392°F), O-rings are Cleaned Prior to Testing*

	Exposed for 24 hours @ 23°C (73°F) in concentrated Nitric Acid			Exposed for 30 days @ 80°C (176°F) in UHP Deionized Water		
Element	**Concentration** (ppb)[1]	**Variance** (± ppb)	**LOQ**** (ppb)	**Concentration*** (ppb)	**Variance** (± ppb)	**LOQ**** (ppb)
Al	<LOQ		110	90	50	
As	<LOQ		5	<LOQ		5
Ca	<LOQ		20	5	5	
Ba	<LOQ		150	75	10	
Cd	<LOQ		5	0	0	
Co	<LOQ		5	<LOQ		5
Cr	10	5		5	0	
Cu	20	15		<LOQ		
Fe	180	150		120	20	
K	<LOQ		115	15	5	
Li	<LOQ		5	<LOQ		5
Mg	<LOQ		30	20	5	
Mn	<LOQ		5	5	5	
Mo	<LOQ		5	<LOQ		5
Na	<LOQ		105	20	5	10
Ni	5	5		<LOQ		
P	<LOQ		90	690	170	
Pb	<LOQ		5	0	0	
Sb	<LOQ		5	5	5	
Sn	5	0		5	5	
Sr	<LOQ		5	0	0	
Ti	<LOQ		50	5	5	
V	<LOQ		5	0	0	
Zn	15	5		30	15	
Zr	<LOQ		5	<LOQ		5

* Proprietary 3M Technique ** LOQ = Limit of Quantification

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Using an Internal Mixer:

The absence of any other carbon black or inorganic fillers presents difficulties for internal mixing. The risk of the batch breaking apart into a powder is greater because there is no dry filler to partially absorb the liquid curatives. To minimize these risks, consider the following:

1. Add polymer to mixer chamber, lower ram and turn on mixer rotors to 30 to 40 RPM to work the polymer and build heat. A temperature of 50 to 55°C (120 to 131°F) is desirable.
2. Once the polymer has warmed and sticks to the rotors, add the TAIC® portion of liquid additives, lower ram and mix until temperature recovers.
3. Continue to add more of the liquid TAIC in small quantities until it is all incorporated. Lower ram and mix until temperature recovers. Repeat as necessary until all of the TAIC has been added.
4. Follow this same procedure to incorporate the liquid peroxide.
5. Dump compound at normal peroxide cure FKM temperatures (approximately 88 to 93°C [190 to 200°F]) and sheet off on two-roll mill.

Open Mill Mixing:

1. Open the mill gap slightly less than the thickness of the 3M™ Dyneon™ FPO 932HB milled sheet as received. Pass the polymer through the mill and reduce the mill gap with each pass until the tightest setting is achieved.
2. As heat builds, the polymer will begin to band to one roll. Cooling water may be utilized to keep the compound from overheating during the milling. Roll temperatures in the range of 30° to 35°C (85° to 95°F) are common for milling this product. The best compound and mill roll temperature is dependent on batch size and the equipment, and should be determined through experimental optimization.
3. Cut the polymer and pull the bank through the mill-rolls 3 to 4 times to obtain homogeneous temperature in the polymer. Widen the mill-gap to reduce the bank to a minimum while maintaining a band of polymer around the mill roll.

Open Mill Mixing (continued on next page)

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Open Mill Mixing (continued)

4. Incorporation of the liquid curative and coagent can present problems in the absence of other fillers. Too much liquid added at one time will coat the mill surface and cause the polymer to slip off or crumble. To minimize this, it is recommended to carefully add small amounts of the additives to the polymer over a longer period of time, minimizing the number of cut-downs as liquid curative directly on mill rolls will cause slippage. It is also advised to alternate which half of the mill roll to add the liquid additives. Try to keep half of the compound dry and banded when adding a small amount of additive to the other half. Addition of the TAIC® first is recommended prior to the peroxide.

5. Once all the liquid additives have been added, perform a minimum of 6 polymer cuts (3 in each direction) and allow the bank to pass through before re-banding. Remove the compound from the mill.

6. Set the mill to the tightest setting, fold the slab together and cigar-roll the compound through the mill a minimum of three times.

7. Open the gap to about 7 mm (0.23 inches) and pass the gum through the mill. Slowly increase the gap in the mill while passing the polymer through until the desired thickness is achieved. This will minimize potential air entrapment in the milled compound.

Refreshing the Compound:

Due to the viscosity and the polymeric filler, care must be taken when refreshing the compound, especially if the compound is cold.

1. Open the mill-gap slightly more than the compound thickness and pass the compound through the mill. Reduce the mill gap with each pass until the tightest setting is achieved. Note that failure to do so can result in equipment damage.

2. As heat builds, slowly tighten the mill gap to the extent that will enable material to band on the roll. The compound will become smooth in texture. Manually “stretch” the polymer (pulling it as the polymer passes through the mill) 2 to 5 times before banding on the mill.

3. Band the polymer on the mill once the compound sticks to the roll.

4. Cut the polymer and pull the bank through the mill-rolls 5 to 6 times to obtain homogeneous re-mix. Once the compound is deemed refreshed, open the gap on the mill to about 7 mm (0.25 inches) and pass the polymer through the mill. Slowly increase the gap in the mill while passing the polymer through until desired thickness is achieved. This will minimize potential air entrapment in the slab form.

Molding

3M™ Dyneon™ FPO 932HB compounds show excellent moldability. Best practice is to prepare blanks or pre-forms of well-controlled dimension and weight. The recommended molding temperature range is 165° to 185°C (330° to 365°F). At this temperature, the material exhibits good low behavior with good mold release, however a spray mold release may be used with complex shapes or difficult to mold parts. Selection of the mold release agent needs to be determined based on the cleanliness requirements of the final compound as well as the molding location.

Typical molding condition is 6 minutes at 177°C (350°F). The surface-finish and the cleanliness of the mold all affect the appearance of the final molded part. A clean mold with a mold-finish of less than 15 micro inches gives the best results. The mold design including the flash grooves, land length, parting lines and plating material may be critical for complex shapes and/or large diameter cross-sections and should be determined through experimental optimization.

Recommended Post Cure Conditions

This section describes the recommended post cure conditions for production parts using FPO 932HB. For improved tensile and compression set resistance, a full post cure is recommended. The recommended post cure conditions for FPO 932HB will vary depending on the oven load, temperature control of the oven and the thickness of the part being post cured. The typical post cure condition is 4 to 16 hours at 200°C (392°F).

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