

# 3M™ Dyneon™ Fluoroelastomers: Processing Information

## Features and Benefits

- Mill Mixing
- Internal Mixing
- Calendering
- Extruding
- “Barwell” Preforming of Fluoroelastomers
- Injection Molding
- Mixing Equipment – Sizes, Capacities, Power Requirements

**Note:** The purpose of this guide is to provide basic information to product users for use in evaluating, processing, and troubleshooting their use of certain 3M products. The information provided is general or summary in nature and is offered to assist the user. The information is not intended to replace the user's careful consideration of the unique circumstances and conditions involved in its use and processing of 3M products. The user is responsible for determining whether this information is suitable and appropriate for the user's particular use and intended application. The user is solely responsible for evaluating third party intellectual property rights and for ensuring that user's use and intended application of 3M product does not violate any third party intellectual property rights.

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

## General Considerations

3M™ Dyneon™ Fluoroelastomers are currently available in forms which allow development of products that require chemical resistance and thermal stability. Selection of the appropriate fluoroelastomer product and compound formulation will provide fluoroelastomer rubber stocks that are processable by standard techniques currently used in the rubber industry.

The first consideration in determining processability is gum viscosity. Gums are available with Mooney Viscosity values of 10 to 150 (ML 1+10 at 121°C /250°F). For most applications, a Mooney Viscosity in the range of 20 to 60 is preferred for a balance of processability and physical properties. Extremely high viscosity gums are more difficult to mix due to heat buildup and their flow characteristics limit the usage in some types of rubber processes. Compound viscosity depends not only on the gum viscosity but also upon filler selection, both type and level.

A second important consideration in determining processability is compound stability and safety. These are affected most strongly by choice of compounding ingredients and the appropriate cure system.

Most fluoroelastomer compounds start with gums containing incorporated cure systems. There is a wide selection of incorporated cure fluoroelastomer products to choose from depending on the processing and property requirements. We recommend these fluoroelastomers as the best starting point for the processor concerned with optimizing processability.

## Processing Techniques

Dyneon fluoroelastomers can be processed on any conventional rubber processing equipment. Due to variations in both equipment and compounds, it is difficult to develop a single process standard for the exact procedures to be followed. The following guidelines should assist in determining the parameters that should be monitored and/or adjusted during the various processing operations.

Contamination of the fluoroelastomer with a variety of ingredients that will adversely affect both the rheological and physical properties is the single most important concern. Minor adjustments in equipment conditions and/or

modifications of the compound will usually solve any processing problems.

If any difficulties arise, do not hesitate to contact a 3M technical representative to obtain suggestions to correct the problem.

## Mill Mixing Procedure for Fluoroelastomers

### Raw Material Storage

Store all critical ingredients (magnesium oxide, calcium hydroxide, calcium oxide, etc.) in sealed containers in a dry storage area at room temperature. Set age limits on these ingredients and rotate inventory. To ensure that all raw materials are active and free from moisture and contamination, keep all containers sealed and properly labeled. Keep all fluoroelastomers in a specific dry storage area at room temperature. It is advisable to rotate stock and keep track of both lot and box number, although fluoroelastomers generally have shelf lives well over three years.

### Mill Mixing

Compounds of fluoroelastomer can be readily mill mixed on any conventional two roll water cooled rubber mill. The equipment must be free of contaminants such as: other polymers, additives, some talcs, oil, grease, sulfur, and water or condensation. A clean-out batch of raw gum (without accelerators or curatives), such as nitrile, EPDM or crude natural rubber should be utilized to clean mill rolls. Remove any condensation from mill rolls prior to milling the fluoroelastomer. Heat buildup can be a problem in mixing multiple large batches. Chilled water should always be circulated through the rolls to keep heat to a tolerable level and to ensure enough shearing action to obtain a good dispersion as well as to minimize sticking and scorch. If heat buildup becomes a problem, monitor temperature with pyrometer. Stock temperature should not exceed 100°C (212°F). If necessary, allow rolls to cool by expanding time between batches. For best mixing and dispersion, the

compound ingredients should be preblended prior to being added to the elastomer. If polymer blends are required, the polymer with the higher viscosity should be banded first, followed by the lower viscosity to assure that a uniform stock is obtained. Several rolling cuts are required to obtain a uniform blend, sufficiently warm up the stock, reduce the polymer nerve and improve filler take-up.

**Milling Procedure**

Clean the drop pan, mill rolls, and area under the guides to eliminate all potential contamination. Use the clean-out rubber to remove any contamination and/or condensation from the mill rolls. Premix fillers (MT Black, magnesium oxide, calcium hydroxide, etc.) in a clean polyethylene bag or suitable container. Do not premix more than eight hours before use. Turn mill on, check all safety devices, and ensure all devices are functional. Open mill nip to approximately 1/4 inch. Turn cooling water on full, but do not allow moisture to condense on mill rolls prior to the actual milling operation. Add polymer to mill in appropriate size blocks until a uniform band and bank is formed. Make three (3) rolling cuts from each side of the mill so the polymer is uniform and sufficiently warmed up. (A visual indicator is polymer loss in “nerve”. In the milling process, a nervy material will want to shrink or retract after going through the mill nip instead of staying as a flat sheet.) Add the premixed fillers uniformly across the entire bank/nip area of the mill. Add the filler at a rate slightly greater than the ability of the polymer to absorb. Allow any loose filler to fall in the drop pan to be reincorporated later. Continue adding the filler and making rolling cuts, as required, on the mill until all of the fillers are incorporated into the compound. After all fillers have been added, make six to eight rolling cuts from each side to finish the mixing cycle. Visually inspect a sample of the compound to ensure that all the fillers and polymer are well dispersed. Sheet stock off from mill and allow to air cool and keep free of contamination. Cool sheets from both sides. Do not fold or stack hot sheets since heat transfer is poor and heat will be retained in the compound, which may result in some viscosity advance. If water cooling is utilized to cool the sheet stock, forced air (free of oil) should be employed to ensure stock is devoid of all excess water before storage or shipment. Depending on filler systems, polymer blends and mill size, actual milling time should require approximately 25 to 40 minutes.

Although the heat history of fluoroelastomer compounds is an additive function, it is customary to remill and refine compounded stock several days or weeks after the compound was originally mixed. This helps freshen stock for improved processing and eliminates surface bloom on the compound. The refining process follows basically the same recommended procedure as mill mixing, but the mixing time is shorter – 5 to 10 minutes – allowing stock temperatures to be in the 70°C to 90°C (158°F to 194°F) range.

**Comments**

Mill Mixing can be successfully and routinely accomplished under a variety of conditions, polymer viscosity and filler loading, including colored compounds. There should be some quality control methods employed to ensure compound consistency and uniformity. An ODR (oscillating disc rheometer) or MDR (moving die rheometer) run at 177°C (351°F), indicates cure characteristics by showing viscosity, time to a specified torque, slope of the curve and maximum torque. Another possible test to conduct is a Mooney scorch run at 121°C (250°F) for 25 minutes; this test provides an indication of processing safety.

In some cases there may be a need to test some basic physical properties: press cure time and temperature may vary according to compound or cure system. See Table 1 at the end of this document for recommended rheological and physical property tests.

A typical QC (quality control) compound for fluoroelastomer based on 100 parts per hundred of elastomer giving a 75 ± 5 durometer hardness is:

- Incorporated cure base gum ..... 100
- MT carbon black ..... 30
- Magnesium oxide ..... 3
- Calcium hydroxide ..... 6

Batch weights will vary for different size mills depending on the type and level of filler(s) but the suggested weights, based on 1.04 and 1.84 specific gravity stock, are shown as follows.

Mill Size (inches)	Total Compound Weight (pounds)	
	Specific Gravity 1.04	Specific Gravity 1.84
36	25 – 35	44 – 62
48	35 – 70	62 – 121
60	75 – 125	134 – 223
84	150 – 250	268 – 447

Fluorocarbon elastomers typically have a specific gravity of 1.80 to 1.86 in standard compounds but can exceed a specific gravity of 2.0 with certain fillers.

Due to differences in mills, it is recommended to start with the low compound weights and increase quantities until a satisfactory dispersion of filler is obtained.

**Internal Mixing**

Internal (e.g. Banbury type) mixing can be successfully accomplished with a variety of compounds that includes various filler systems and blends of gum viscosities (even high viscosity stocks) containing the commercially available crosslinker systems for fluoroelastomers (diamines, dihydroxies and peroxides). Special care must be exercised with amine-based cure systems, which tend to be very scorch sensitive and could start curing during the mixing process if it gets too hot. Most fluoroelastomer compounds can be mixed in “one-pass” in an internal mixer if the proper steps are followed. This one pass technique for fluoroelastomers can generally be completed in a 3 to 10 minute cycle.

**Mixing Procedure**

To ensure a proper mix, the internal mixer must be clean and free of any contamination from prior batches such as other synthetic compounds, condensation on rotors and chamber, oil and grease, or residual sulfur. The drop pan, conveyor system, take-off, and two roll rubber mill must also be free of such contamination. It is advisable to run a cleanout batch with raw gum (without accelerators or curatives) like EPDM prior to mixing.

Turn full cooling water on the rotors and chamber. Set ram pressure at 60–80 psi, rotor speed slow (30–40 RPM). Premix fillers in a clean polyethylene bag or suitable container before addition. Add the pre-weighed fluoroelastomer to the internal mixer, lower ram and run polymer breakdown for 30 to 60 seconds or until temperature reaches 49°C to 54°C (120°F to 129°F). Raise ram and add the premixed fillers.

Lower ram and continue mixing until temperature reaches 70°C ± 5°C (158 ± 9°F). Check to ensure ram height gauge indicates proper chamber volume, since at a proper charge volume indicator will oscillate. Raise ram and sweep ram and throat. Lower ram and continue to mix until temperature reaches 75°C to 90°C (167°F to 194°F). Raise ram and sweep ram and throat. Continue to mix until temperature reaches 80°C to 105°C (176°F to 221°F) or until audible indication (sucking sound) that the batch is together. Dump batch onto mill and mix to a uniform smoothness before batching off (for refinement to obtain ultimate dispersion, physical and rheological properties).

**Comments**

Internal mixing can be successfully accomplished with a variety of conditions and compounds (viscosity + filler loading). The internal mixer must be clean and have no condensation on the rotor or chamber. Residual sulfur or sulfur compounds, some talcs, oil, grease, or condensation may have significant adverse effects on the fluoroelastomer cure system. Overloading or underloading the internal mixer will result in a poorly dispersed batch. Care must be taken to avoid a batch temperature exceeding 110°C (230°F), which may result in a scorched stock. In general the internal temperature thermocouple (recorder) will indicate a temperature which is lower than the actual stock temperature, defined as thermal lag. To account for thermal lag, determine the actual stock temperature with pyrometer at drop and correlate this to the recorder reading.

Care must be taken when calculating the batch size for internal mixers. The calculation involves:

$$\text{Chamber Volume} \times \text{Specific Gravity} \times \text{Load Factor} = \text{Batch Size}$$

$$(\text{___ in.}^3 \times 16.39 \text{ cc/in.}^3) \times (\text{___ g/cc}) \times (.67 \text{ to } .70) = \text{___ g}$$

$$(\text{___ g}) \times (1 \text{ lb}/454 \text{ g}) = \text{___ lbs}$$

Typical batch weights for fluoroelastomers are:

Banbury Size	Volume (in. <sup>3</sup> )	Batch Weight (lbs)
No. 3	4,300	190 – 220
No. 9	11,400	545 – 585

Adjustments in batch size may be necessary to account for increased chamber volume due to wear and for compound specific gravity.

**Compound Storage**

Compounded stock should be thoroughly cooled and dry before storing. Stock may be stored under ambient conditions in most cases although climate controlled areas are preferred.

If the stock is to be kept in a refrigerated environment, it is advisable to have the compound sealed in plastic before storing. Upon removal from cold storage, the stock should be allowed to come to room temperature while still sealed in plastic to prevent condensation formation on the compounded stock. If stock is not sealed with plastic, all condensation must be allowed to evaporate prior to milling, preforming or molding.

**Note:** Inclusion of surface moisture will cause scorch.

**Procedure for Calendering of 3M™ Dyneon™ Fluoroelastomers**

**Warm-Up Mill Procedure**

The warm-up mill should be cleaned and dried – no residual sulfur or other elastomer or talc in the pan or on the mill rolls and no condensation. The warm-up mill for Dyneon fluoroelastomers should have full cooling water on both rolls. Mill setting thickness should be at approximately 1/4 inch. Since the feed stock from the mill to the calender must be warm, the elastomer must be transferred directly from the mill to the calender. Approximately 1/3 of the total mill capacity is used; do not overload the mill with too much stock since that may result in excess stock temperature. Once 1/3 of the mill is loaded and banded. Make about four or five rolling cuts from each side to ensure that a uniform stock viscosity and a temperature of 49°C to 60°C (120°F to 140°F) is obtained. When more stock on the mill is needed for the calender feed, the diminishing amount of warmed up stock should be shifted to one side of the mill and fresh stock added to the other side of the mill. In approximately two minutes or less after banding, the fresh stock can be uniformly blended with the warm stock on the mill by cutting the batch from side to side. Do not overmix the stock since heat buildup can affect compound viscosity or scorch the stock.

**Note:** If there should be interruptions affecting down-time during the course of the run, the stock should be sheeted off the mill and allowed to air cool from both sides.

**Calender Conditions**

Conditions may vary based on compound viscosity and filler system. High viscosity stocks may require 88°C (190°F) roll temperature. Suggested conditions for calendering Dyneon fluoroelastomers are as follows:

Top Roll	60°C ± 5°C (140°F ± 9°F)
Middle Roll	60°C ± 5°C (140°F ± 9°F)
Bottom Roll	Full cooling water

Calender speed should be 3 to 5 feet per minute. Under these suggested conditions, proper coordination between warming up fresh stock and feeding warmed-up stock to the calender should be maintained.

**Calender Feed**

Uniform feed in the form of a rolling bank must be maintained to produce a smooth calendered sheet. The rolling bank must not exceed 2 to 3 inches in diameter to produce a good air-free calendered sheet. The calender should be strip fed across the entire roll to maintain a rolling bank and ensure uniform roll pressure. Roll stock feeding is not suggested as a technique for adding warmed-up stock to the calender, but may sometimes work satisfactorily.

## Comments

Calendering can be successfully accomplished with a variety of conditions and compounds (viscosity, filler loading, etc.). In general, a 11°C (52°F) temperature range or plateau can be utilized. Too low of a temperature will result in rough, nervy surface while too high of a temperature will result in stock sticking to the calender.

Roll temperature will affect caliber of sheet and all conditions must be maintained during the entire length of the run.

## Procedure for Extruding 3M™ Dyneon™ Fluoroelastomers

Dyneon fluoroelastomers can be successfully extruded in either cold or hot feed extrusion processes. As would be expected, gum choice, filler composition and incorporated process aids must be taken into consideration. The following procedure is a suggested guideline for operating conditions.

### Cold Feed

Screw speed will vary with extruder type/size and extrudate volume required. Suggested condition is to start at slow, 10–20 RPM, with zone temperatures of:

Screw	27°C (81°F)
Rear Zone (hopper)	38°C (100°F)
Mid-Zone	60°C (140°F)
Front Zone	82°C (180°F)
Die/Head	93°C (199°F)

The most important temperature is that of the extrudate itself. The stock temperature should be in the range of 80°C to 100°C (176°F to 212°F) for best surface appearance and rate of extrusion. This temperature must be monitored and extruder conditions may have to be optimized to maintain proper extrudate temperature. Failure to control the heat history on the polymer can lead to scorched material due to heat caused by internal shearing that takes place in the extruder.

Once the temperatures of the extruder are set and extrudate is at proper temperature, the screw speed can be adjusted to obtain desired production needs. This can normally be done without dramatically changing surface appearance of the extrusion. At this point the pressure build-up at the die should be monitored, since as the RPM is increased, higher pressures will be apparent. The pressure generally is to be kept below 7000 psig or below blow out plug or shear pin rating.

### Hot Feed

The procedure for a hot feed process differs from cold feed only in regard to how the stock is handled prior to contact with the extruder.

Although equipment (i.e. warm-up and feed mills) will vary at different production facilities, typical conditions of mill and stock temperatures are:

#### Warm-up and Feed Mill Conditions

Full cooling water on both rolls

#### Stock Temperatures

Warm-up mill	60 – 82°C (140 – 180°F)
Feed mill	71 – 93°C (160 – 199°F)
Hopper/Extruder	60 – 77°C (140 – 171°F)

## Comments

As mentioned before, polymer choice, filler types and levels, and also the process aids utilized, all play an important role in the extrudability and overall processing characteristics of a given compound. The suggested conditions are starting points to be considered and final adjustments should be made as experience on the particular compound and equipment is obtained.

During start-up the extrudate should be carefully watched since too much heat or too little heat or temperature will result in a rough finish on the extrudate. There is a temperature region, or transition zone, usually a range of 5°C to 11°C (41°F to 52°F) where the extrudate will be smooth; above or below this zone (outside this temperature range), the extrudate will not exhibit a smooth finish.

Cure system type and level will affect the extrudability of the compound. In order of scorch resistance, the dihydroxy or incorporated cure is the best, followed by peroxides and finally diamines.

## Preforming Fluoroelastomers “Barwell” Preform Preparation

Initial preparation of the “Barwell” preform should include preheating the barrel to the desired temperature, barrel 71°C to 82°C (160°F to 180°F), head 71°C to 93°C (160°F to 199°F), spraying the barrel with mold release if needed and selecting and installing the proper dies. When set up and ready for use, the fluoroelastomer should be mixed, rolled and placed in the barrel.

Caution should be exercised in regards to screw speed since high shear and/or high temperature conditions can initiate exothermic decomposition in the barrel.

### Fluoroelastomer Preparation

Preparations for preforming fluoroelastomers should begin by mixing the elastomer, either by using an internal mixer or a mill. When fully mixed, the compound should be banded on the mill, and milled until the desired temperature of 70°C to 90°C (158°F to 194°F) is achieved. The band is then cut laterally and rolled to form a large tight roll of the size (diameter) needed for the preformer. This roll is then placed in the preformer previously prepared. The correct stock temperature is important for lowering the viscosity to obtain proper throughput, and a tight roll is needed to eliminate trapped air which could form voids in the preforms.

### “Barwell” Use

When loaded, the “Barwell” preform head is locked in, a vacuum is drawn on the cylinder, and the ram is closed. The ram pressure is adjusted to regulate the extrusion rate, and as the preforms are extruded, the die’s position and cutter speed are adjusted to give the proper preform size and weight. The preforms are then extruded as needed. When completed, the ram pressure is relieved, the head is opened and the remaining material is pressed out with the ram. This material can be saved for future use but should be cooled to room temperature as soon as possible. The “Barwell” preform should then be cleaned and reset for later use.

## Injection Molding – Fluoroelastomer Compound Considerations

In any elastomer molding operation – compression, transfer or injection – knowledge of viscosity, scorch safety, cure rates, flow rates and part demoldability for a given compound is essential.

Compounds based on fluoroelastomers are being used successfully for injection molding of O-rings, shaft seals, mechanical goods, and numerous other parts for various applications. As modern injection molding machines and equipment are largely automated, a higher demand is placed on processing safety of the compounds.

A first area of attention is scorch safety. It is essential that no significant cure has occurred before flow of the compound in the molding process has completely halted. Compounds must therefore tolerate a residence time of several molding cycles at temperatures of 80°C to 110°C (176°F to 230°F) in the barrel of the injection molding machine. Additionally, no cure should occur during the flow into the mold at molding temperatures of 170°C to 210°C (338°F to 410°F). These conditions preclude the use of diamine cured fluoroelastomers in injection molding as they may result in material scorch in the injection barrel. Serious part defects or even complete halting of the molding can occur. The compound viscosity cannot be allowed to change significantly as a result of being maintained at 80°C to 110°C (176°F to 230°F) in the injection molding machine. 3M™ Dyneon™ Fluoroelastomers with proprietary incorporated cure systems deliver this required performance.

A second area of attention is the compound Mooney viscosity. Compounds with Mooney scorch minimum (small rotor 121°C/250°F) in the range of 30 to 40 have proven to give adequate flow behavior in injection molding. Compounds with higher viscosity may require molds with shorter flow paths.

A third area of attention is the cure speed at molding temperature. For economic reasons cure time should be very short. In practice, a balance between fast cure reaction at molding temperature and sufficient scorch safety has to be achieved. This balance is not only determined by the choice of compound; but also the mold design and actual injection molding machine used may have a detrimental impact.

Many grades of Dyneon fluoroelastomers have been successfully injection molded. The physical property requirements, mold design and geometric shape of the part generally dictate the grade of fluoroelastomer to be used. Very often a low viscosity incorporated cure grade of Dyneon fluoroelastomer compounded with an internal flow and mold release agent such as Carnauba Wax is recommended for injection molding.

Typical Injection-Moldable Compounds	O-Ring Formulation	Molded Goods
Dyneon FE 5620	100	–
Dyneon FC 2122, FC 2123 or FE 5622Q	–	100
MT Black	25	25
MgO	3	3
Ca (OH) <sub>2</sub>	6	6
Carnauba Wax	0.5 – 0.75	0.5 – 0.75

Due to the many variables encountered in equipment and in the design of injection molding equipment, the following guidelines will only provide an initial starting point. Modification of conditions may be required on specific equipment being utilized.

### Machine Condition Guidelines

Critical Machine Variables	Recommended Molding Conditions
Screw-Barrel Temperature	50 – 80°C (122 – 176°F)
Injection Barrel Temperature	80 – 100°C (176 – 212°F)
Injection Pressure	1,500 – 2,500 bar (20,000 – 35,000 psi)
After Injection Pressure	10 – 50% of injection pressure
After Injection Pressure Time	2 – 15 seconds
Injection Rate	1 – 10 seconds depending on part geometry and volume
Back Pressure on Feeding	2 – 15% of injection pressure
Screw RPM	30 – 60 RPM
Mold Temperature	170 – 210°C (338 – 410°F)
Heating Time	20 seconds to several minutes depending on part thickness

## Mixing Equipment Sizes, Capacities, Power Requirements

### Open Roll Mills

Roll Size (inches)	Approximate Batch Capacity (lbs.)	Motor	
		HP	RPM
6 × 13	1.25 – 2	7.5	190
8 × 16	2.5 – 4	10 – 15	190
10 × 20	5 – 8	15 – 20	190
12 × 24	10 – 18	30 – 40	190
14 × 30	20 – 30	40 – 50	600 – 720
16 × 42	30 – 50	60 – 75	600 – 720
18 × 48	45 – 70	75 – 100	600 – 720
22 × 60	75 – 125	125 – 150	600 – 720
24 × 72	125 – 200	150 – 200	600 – 720
26 × 84	150 – 250	150 – 200	600 – 720
28 × 84	175 – 300	200 – 250	600 – 720

### “Banbury” Mixers

Size of Machine	Net Volume of Chamber (inches <sup>3</sup> )	Approximate Batch Capacity (lbs)			Motor Horsepower		Cooling Water (Gallons/min)	Compressed Air on Ram (ft <sup>3</sup> /cycle)
		Specific Gravity			Standard Speed	Double Speed		
		1.25	1.50	2.0				
B	103	3	4	5	8.5	17	–	–
00	263	5	6	8	15	30	–	–
1A	1193	27–33	32–40	44–52	50	100	25	4
3A	4315	100–115	120–140	160–180	150	300	75	10
9	11443	250–300	310–360	410–500	200	400	150	18
11	14940	340–410	400–500	550–650	300	600	150	20
27	37709	700–800	850–1000	1000–1500	1250 or 1500	–	200	16

**Table 1 Suggested Rheological and Physical Property Tests**

Rheological Properties	Physical Properties
<p><b>Mooney Scorch, MS @ 121°C (250°F) [ASTM D1646]</b> Minimum Point rise at 25 minutes</p>	<p><b>Press Cure 10 Minutes @ 177°C (351°F)</b></p>
<p><b>ODR (2000) @ 177°C (351°F) 100 CPM, 3° ARC, 12 Minutes [ASTM D2084]</b> ML, Minimum Torque inch-lb (N•m) t<sub>2</sub>, Time to 2 inch-lb rise from minimum t<sub>50</sub>, Time to 50% cure - minutes t<sub>90</sub>, Time to 90% cure - minutes MH, Maximum Torque inch-lb (N•m)</p>	<p><b>Post Cure 16 Hours @ 232°C (450°F)</b> Tensile, psi (MPa) 100% Modulus, psi (MPa) Elongation at break, % Hardness, Shore A [ASTM D2240] Tear Strength Die C, psi (MPa) Shrinkage, %</p>
<p><b>MDR (MDR 2000™) @ 177°C (351°F) 100 CPM, 0.5° ARC, 6 Minutes [ASTM D5829]</b> ML, Minimum Torque inch-lb (N•m) t<sub>2</sub>, Time to 2 inch-lb rise from minimum t<sub>50</sub>, Time to 50% cure - minutes t<sub>90</sub>, Time to 90% cure - minutes MH, Maximum Torque inch-lb (N•m)</p>	<p><b>Heat Aged 70 Hours @ 270°C (518°F)</b> Tensile, psi (MPa) 100% Modulus, psi (MPa) Elongation at break, % Hardness, Shore A [ASTM D2240]</p>
<p><b>Mooney Viscosity ML 1 + 10 @ 121°C (250°F)</b></p>	<p><b>Compression Set 70 Hours @ 200°C (392°F)</b> [ASTM D395 Method B (O-Rings)]</p>

### Safety/Toxicology

Follow recommended handling precautions for use of 3M™ Dyneon™ Fluoroelastomers. General handling precautions include:

- (1) Store and use all Dyneon fluoroelastomers only in well ventilated areas.
- (2) Do not smoke in areas contaminated with dust from fluoroelastomers.
- (3) Avoid eye contact.
- (4) After handling Dyneon 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 Dyneon fluoroelastomers, consult the product Safety Data Sheet (SDS) 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 from your 3M Sales Representative.

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