Northstar Polymers (Div. of Tandem Products, Inc.)
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FFM-1

Firm-Grade Flexible Open-Cell Foam

This foam formulation is particularly designed to make flexible but firm open-cell foam by either hand-mixing or machine casting. This material may be suitable for products that require some load bearing property but need to be flexible. The firmness of this material is similar to that of microcellular foams, but it is lighter than microcellular foams. This material may also be suitable for some bumper or vibration dampening parts.

The components are liquid at room temperature. It has relatively long pot life (40 seconds) for a flexible foam material, so it is easier to handle by a manual hand-mixing method. This material can be open-cast into a slab for farther fabrication or molded in a compression mold. The free-rise density of the foam is 8.5 pounds per cubic foot, and the cell structure is open-cell.

The isocyanate component for this formulation is MDI, which is generally considered safer than TDI. This formulation does not use auxiliary blowing agent. Only normal handling for typical industrial chemicals is required. Relatively safe and easy handling and the physical properties of this foam satisfy the requirements for a variety of custom applications.

Physical Properties of the Cured Foam

Property Tested	**Typical Values**
Foam Density (Free Rise)	8.5 LBS/Cuft
Tensile Strength	60 psi
Ultimate Elongation	40 %
Tear Resistance (Die-C)	27 pli
Tear Resistance (Sprit Tear)	5 pli
Surface Hardness (Shore Durometer)	(Top Skin): 35 - 40A
Bashore Rebound	(Top Skin) 22%

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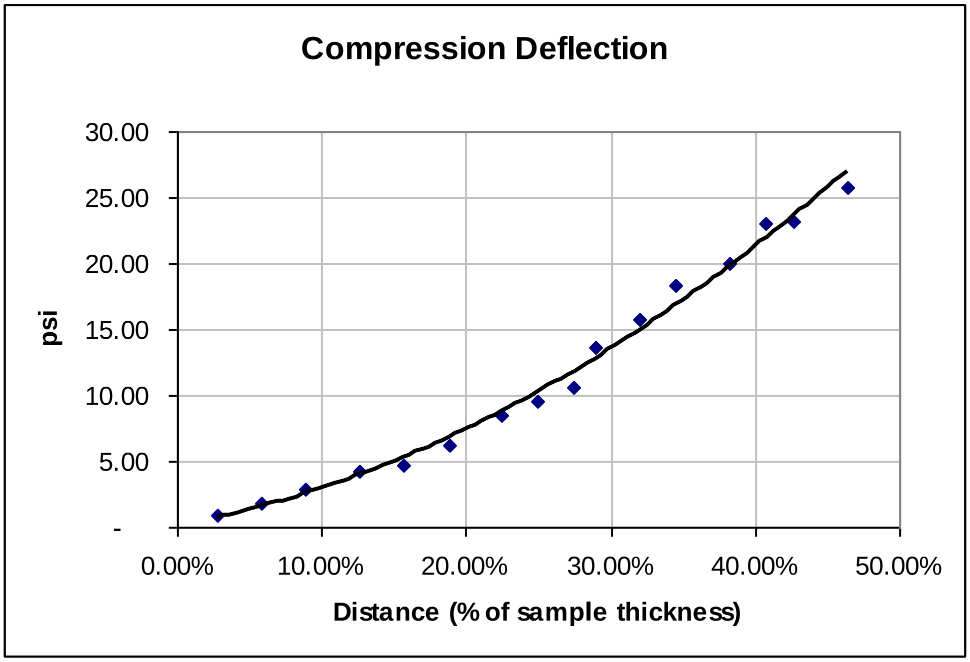

- The above data is typical properties of the free-risen foam tested in our generic test method. Compression-molded foam will have different deflection property.

Component Properties

	Prepolymer (Part-A)	Curing Agent (Part-B)
Code Number:	MSA-018	PLE-018
Specific Gravity:	1.183	1.048
Equivalent Weight:	183	184
%NCO	23 %	n/a

Mixing Ratio	(A)	(B)
Volume Ratio:	1.000	1.150
Weight Ratio:	1.000	1.000
NCO Index	1.008	

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Processing Temperature:

Part-A	Ambient
Part-B	Ambient
Mold/Substrate	100 - 110 ºF

* The ideal temperature for the mold and substrate is 100 - 110 ºF. However, if you are using plastic mold, this may not be necessary. For all metal molds, the temperature needs to be between 100 to 110 ºF.

Cure Pattern:

Mixing time	20 - 25 seconds (for manual hand-mix)
Pot life (pour within)	40 seconds
Demolding time	30 - 40 minutes
Complete Cure Cycle:	24 hours at room temperature

Note: The part-A component, MSA-018 is sensitive to low temperature. It can freeze just below the room temperature range, and keeping the material at the frozen state can permanently damage the material. During the cold seasons, the material may arrive frozen while in transit. The material must be inspected immediately after receiving, and if it has signs of freeze, it must be thawed immediately following our thawing instructions. After the material is thawed, it must be stored at a warm indoor storage with temperature range between 72 ˚F and 100 ˚F. The ideal storage temperature is 90 ˚F. Since we do not have any control over the environments during the shipping, we cannot guaranty the material to be arriving without being frozen. Northstar Polymers will not be replacing or refunding for the material damaged by the cold temperature or mishandling by the customer. This disclaimer must be accepted at the time of ordering the material.

Recommended Processing:

We recommend testing small amounts to see how the material behaves, then develop your processing method accordingly. When you process/test, please be sure to operate in a well-ventilated area or large open area, wear rubber gloves, long sleeves, and protective eyeglasses to avoid skin/eye contact. Read the Material Safety Data Sheets for details on the safety and handling of the component materials.

- Before you start your test, there is a chance the part-A material being frozen during the transportation or storage in cold seasons. Freezing may cause phase separation within the components. Indication of frozen material includes cloudy color, high-viscosity, gel-consistency, or complete solid. In such case, you need to heat the part-A component to 140 – 160 °F to thaw and agitate the content by rolling the container(s). Do not open the container for part-A (MSA-018) until you are ready to use as it is a moisture sensitive material. Use metal or plastic spatula to agitate. Do not use a wooden paint stick as it contains moisture which contaminates the material. After agitating the component, remove from the heat and keep it at a room temperature between 70 and 90 ºF. Storing the components at a higher temperature accelerate deterioration of the quality.

- Pre-heat the mold and substrate to between 100 and 110 ºF if necessary.

- Apply mold release into the mold. Do not use silicone-base mold release as it destroys the foam surface.

- Calculate the total inside volume inside the mold (or the finished part volume) in cubic feet. Multiply it by the density (8 in this case). This will give you the weight of the component mixture at the free-rise density in pounds. Multiply by 1.1 for 10 % compression rate. (See below for more detailed information on compression molding). This will give you the total weight for the two components.

- Take the correct ratio of part-A and part-B into a mixing cup. Mix well with a steel or plastic stir stick for 20 to 25 seconds. Agitate vigorously and thoroughly. Scrape the material off the side and bottom of the cup as you mix.

  The pot life is short, thus there is a limit to the quantity you can mix well by hands. Employing a meter mixing/casting machine may be best for your production if your part is large or your production quantity is high.

- Cast the mixture into the mold. The mold should be between 100 and 110 ºF. You may use ambient temperature if you are using plastic mold/substrate that does not absorb heat very much. If your mold is of metal or other heat-absorbing material, the foam may not cure properly under the room temperature. Excess heating also affects the foam quality, so do not over heat.
- Cure the foam in the mold for at least 35 - 40 minutes before demolding. Please check the strength of the foam surface before demolding. The surface of the foam may be fragile at this point. The open top surface may still be tacky, but this is normal.

- The foam should be open cell if you are simply open casting the foam. However, if you modify mixing ratio or molding it in a compression mold, the cells in the foam may not be sufficiently opened. If the cells in the foam are not opened, this will lead to substantial shrinkage after the foam is cooled. Compress the foam with hands to test to see if the foam has an open-cell structure. If it bounces back strongly like when you push a balloon as you press farther, the foam cells are not opened. In this case, you may need to adjust or tighten the control of your mixing ratio, compression rate, temperature, or other processing parameters.

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- Even with open-cell structure, this foam shrinks slightly. Design your mold accordingly if tighter dimensions are required.

- Store at room temperature for 24 hours to complete the cure cycle before evaluation.

Compression Molding

Foam needs to fill the mold space by putting a controlled amount of foam material into the mold. The controlled expansion pressure of the foam sends the foam material to fill the mold to the expected shape. The mold therefore needs to be close mold and has to have a capacity to retain the internal pressure. A simplest compression mold will be an open-top box with a lid. The lid needs to be clamped to hold the pressure. The air trapped in the mold could make large voids if it is not released. For this purpose, you need to have very small vent holes to let the trapped air escape from the mold.

The mold material can be metal, plastic, or elastomeric polymers. Mold surface needs to be slick as foam could stick to any porous surface. Metal molds tend to absorb the heat. The mold may need to be heat to 100 to 110 ºF in case of metal molds. If your mold is made of a plastic or elastomeric material, such as silicone rubber, epoxy, and urethane, this may not be necessary.

Compression rate is the rate in which how much more material you would put in to create the internal pressure. Typically, about 10 % compression should give enough pressure to distribute the foam within the mold. Using higher rate makes the foam denser and stronger. However, it will increase the chance of closed-cell/shrinkage problem described below.

Trouble Shooting

- Shrinking Problem from Closed-Cell Structure

This material uses a chemical reaction within the formulation to create CO2 (carbon dioxide) gas as a source of foaming. This reaction happens when the material is hot, so this gas is hot when foam is made. As the foam cools after curing, CO2 gas also cools; as it cools, the volume of gas contracts. If the cells in the foam are closed, this CO2 gas take the whole foam down and shrink the foam significantly. It would look like a prune.

To alleviate this, you need to make an open-cell foam structure. At the specified mixing ratio, the foam should have open-cell structure when it is free-risen. However, by compression-molding, it increases the wall strength of the foam cells, and this may prevent the cell from opening. This often happens when the compression rate is too high. When this happens, the foam quality becomes “balloon-like” when you push the foam by hands soon after cured (40 to 60 minutes after pouring). If possible, you can crush this foam soon after it is cured, but while the foam is still worm. You may hear popping sounds from the foam as you crush. You can keep crushing until you hear no more popping sound. This will open the cell inside of foam and will prevent the large shrinking. If your parts are too thick, this may be difficult. You may need to adjust your processing parameters such as mixing ratio, compression rate, or mold temperature.

- Prevent Air Voids by Vent Holes

When you compression-mold a foam, you would trap the air inside of the mold in corners and it makes large voids. Sometimes, this is erroneously thought that there is not enough material in the mold. If you try to compensate this with increasing the compression rate, you may have the closed-cell-structure problem mentioned above.

You need to develop parameters for where in the mold the material should be placed, and how the mold should be positioned while foam is forming in the mold. This will determine where the air in the mold is pushed when the foam expands.

When you find the pattern for the air void(s), you would need to put very small holes to where the voids form so you can release the in-mold air. The vent holes should be small enough so that they will be closed when the air is pushed out by the expanding foam material and then the material closes the vent holds, so you will still have the internal pressure. After the part is demolded, you may need to machine off the small amount of material squeezing out from the vent holes.

- Inconsistent/Large Foam Cells

If you see many small voids in the foam, this may be because the material is cast in while the mixture is creaming and loosing its flow. You may be enclosing more air into the foam while the mixed liquid has a high viscosity. You may need to finish agitating sooner to avoid enclosing too much air.

Another possible cause is that the material may be touching the side wall before it is dropped to the proper position for the material to be placed in the mold. The material on the side wall starts to foam before the expanding foam from the bottom reaches there. The foam material stuck on the side wall blocks the passage, which can cause voids. Place the mold in such position that you can pour the material to the bottom without touching the side wall of the mold.

If you see inconsistent foam cells near the mold surface, your mold release may be affecting the quality. Try using different mold release. Silicone and a few other mold release constituents can affect the surface tension of foam material, which may destroy the cell structure. Also, if the mold temperature is too high, it would affect the cell structure near the mold surface. Try at lower mold temperature.

Other Information

Applications that requires fire-retardant property:

This foam is not fire-retardant foam, and it is not recommended for applications, which require or should be using fire-retardant grade materials. The applications such as automotive interior, building material, and components for some electronic parts often require fire-retardant grade materials by law. It is the user's responsibility to conform to the applicable regulations. We also do not recommend this foam to be used to the applications in which the foam can be exposed to high temperature or being near an ignition source.

By adding fire retardant additives, this foam may be modified to fire-retardant grade foam. The user must test the foam modified with the fire retardant additives for the fire-retardant property and the conformance to the applicable regulations.

Part-A (Isocyanate Prepolymer) Component

Part-A component (prepolymer) contains isocyanate component, which is highly sensitive to moisture. If it is left in air, part-A will react with atmospheric moisture and will be ruined. This reaction is non-reversible. Soon after opening the container to dispense the content, dry nitrogen gas or argon gas needs to be injected to the container to purge and blanket the top space. Please consult Northstar Polymers for nitrogen gas set-up information.

For gravity feeding system from a 55-gallon, silica gel or calcium chloride desiccant filter(s) should be installed to the vent-hole of the drum. A valve to inject dry nitrogen gas can be installed instead.

Store the containers a dry indoor storage within the temperature range between 72 and 100 °F. Avoid direct sunlight.

Note:

This isocyanate prepolymer (MSA-018) may freeze during the transportation and storage in the cold seasons. Frozen state of isocyanate prepolymer can be indicated by solid, gel, or high viscosity liquid state and cloudy color. This material may freeze just below room temperature. This product makes unwanted byproducts if it is kept frozen. It may ruin the material if it is store frozen for a long time. The frozen material must be thawed immediately. Please consult Northstar Polymers if isocyanate prepolymer is suspected to be frozen. Northstar Polymers will not refund or replace the material damaged from cold temperature and mishandling.

If a large amount of water mixes with a large amount of isocyanate base materials, the chemical reaction may produce a large amount of CO_2 gas and heat to create a hazardous condition. Keep the storage area free of water.

Under a certain combination of heat, catalyst (basic chemicals), amounts of reactive materials, and some other favorable conditions for the reaction, the water (or alcohol/glycol) to isocyanate reaction can reach a dangerous state of accelerated reaction. The accelerated reaction may create a very high temperature condition. The thermal decomposition of isocyanate based material by extremely high temperature or fire can produce toxic gasses and smokes. Please be sure that the containers are stored in dry indoor storage, away from source of large amount of water.

If a leak is found in a drum, please place the drum in such a position that the leaking part is at a higher part of drum so that the content no longer leaks out. Cover the leaking area with dry towel to prevent air from entering. If possible, transfer the material into new container(s) with nitrogen purge. If moisture enters into an isocyanate container from a small leakage, CO_2 gas may be produced to gradually pressurize the container. If pressure built up is suspected, open the bung (or cap) very slowly to release the pressure before you change the drum position.

Part-B component may be hygroscopic. If the material is exposed to ambient air, it may absorb moisture. Moisture contaminated part-B material may become source of degradation or excessive bubbles in the product. Avoid exposure of the material to air. Purging the empty space in the container with nitrogen gas or negative-40-degree-due-point dry air is also recommended to prevent moisture contamination of part-B as well. The storage temperature should be at a room temperature between 65 and 90 °F.

Safety:

The component materials are industrial-grade chemicals. Please keep them in a secure place and prevent access from any unauthorized individual. The personnel who handle these materials need to read the Material Safety Data Sheet (MSDS) for detail information on safety and handling of the material. The MSDS for each component is sent with the shipment of the material.

When using this material, be sure to operate in a wide-open area with good air movement, or in a well-ventilated area. Wear rubber gloves, long sleeves, and protective eyeglasses to prevent skin/eye contact of the material. When your operation involves heating or spraying of the material, and if you expect the isocyanate content level in the work place atmosphere may become above the threshold regulated by OSHA or by other appropriate working place safety standard, we recommend, in addition to the above, installation of a proper hooded dynamic ventilation system and/or using an appropriate type of respirator (such as a full-face respirator equipped with OSHA approved HEPA filters for particulate and organic vapor) to prevent inhalation of the fume.

Direct contact of polyurethane raw materials to skin/eye, as well as ingestion may lead to health problems. No eating or smoking should be permitted at the working area. The operator should wash hands well with soap and water after handling the materials and follow the other procedures of the Standard Industrial Hygiene Practices. Please refer to the MSDS for each component for the detailed health information.

For any questions, please contact Northstar Polymers.

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