LOCTITE®

Technical Process Bulletin

LOCTITE EF 9899CF AERO
Expanding Syntactic Film
(KNOWN AS SynSpand® EA X9899CF)

INTRODUCTION
LOCTITE EF 9899CF AERO is a medium density low exotherm expanding syntactic film suitable for core filling applications. The typical cured density range for LOCTITE 9899CF AERO is 18 - 35 pcf (0.29 - 0.56 g/cc). The low exotherm chemistry makes this product ideal for deep core fill. High compressive strength provides the potential for some structural applications.

FEATURES
- Unique Closed Cell Expanding Film Technology
- Capable of Expanding Over 300%
- Homogeneous Cell Structure
- Co-curable
- 250°F to 350°F (121°C to 177°C) Cure
- Density/Strength May Be Tailored to Meet Specific Design Needs
- Supplied as a 1' x 2' (0.30 m x 0.61 m) Sheet of Controlled Areal Weight and Thickness
- Wide Processing Window

Applications
- Core Stabilization
- Edge Close Out
- RTM Core Applications
- Filling Core in Closed Mold Operations
- Stiffening of Composite Structure
- Low Exotherm for Deep Core Fill

Handling
This product is supplied in 1' x 2' (0.30 m x 0.61 m) sheets in a thickness of approximately 100 mils/2.5 mm and 50 mils/1.25 mm or in roll stock 18 inches wide by 25 lineal feet (45.7 centimeters wide by 7.6 lineal meters), and is ready to use as received. Material should be removed from cold storage and allowed to warm to room temperature before removing the protective packaging. This material has protective liners on it, which must be removed prior to part assembly. The liners will always be a contrasting color from the material to allow the user easy confirmation of removal.

Application
Storage - LOCTITE EF 9899CF AERO requires refrigerated storage. Store @ 0°F/-18°C or below for maximum storage life. Shelf life @ 0°F/-18°C or below is 12 months. Store in sealed bag. Allow adequate time for the container to warm to room temperature before opening for use. Ambient temperature shipment of samples will be sufficient for durations of less than 7 days.

Applying - LOCTITE EF 9899CF AERO is a pliable film with tack and drape. It can be cut to any desired shape using ordinary razor knives or scissors. Razor knives using templates as guides work best. After cutting the material, the user can remove the product liners by peeling them back from a corner.

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Open Assembly Time - 15 day working life @ 77°F/25°C.

Curing - LOCTITE EF 9899CF AERO may be cured for one hour @ 250°F/121°C and, if desired, post cured for one hour at 350°F/177°C. See Processing Guidelines for detailed instructions on lay-up and cure.

Expansion - LOCTITE EF 9899CF AERO is capable of expanding in excess of 300%. The magnitude of expansion is controlled by applied cure pressure, heat up rate or the cavity volume of a closed mold. The recommended method of expansion uses a closed mold.

Cleanup - Little cleanup should be required. However, uncured material may be removed effectively with ketone solvents in well-ventilated areas. Saturate cloth or industrial wipers with solvent and only apply enough to do the job. Avoid contaminating uncured parts with spray or spillage. Wear respirators equipped with organic vapor cartridges, impervious rubber gloves, and mono goggles when handling solvents. Consult solvent container labels for skin and flame warnings.

Typical Uncured Properties

Density (ASTM D792),	41 pcf (0.66 g/cc)
Pliable and drapeable @ 77°F/25°C	
15 day working life @ 77°F/25°C	
Areal weight @ 50 mils/1.25 mm	0.16 - 0.19 psf
Areal weight @ 100 mils/2.5 mm	0.31 - 0.38 psf

Typical Cured Properties

Density range (ASTM D792)	18 - 35 pcf (0.29 to 0.56 g/cc)

Expansion Ratio

1°F/0.5°C heat rise per minute	2.4 : 1
5°F/3°C heat rise per minute	3.0 : 1

Typical Mechanical Properties

Block Compressive Strength

Block compressive strength was determined via ASTM D695 procedures using ultimate compression strength or strength at 2% load, whichever came first, on cured LOCTITE EF 9899CF AERO in the density range of 19-34 pcf. Cured expanding syntactic film panels were fabricated using process techniques described in the processing guideline section of this data sheet. Cure was accomplished in a hydraulic press under 65 psi/0.45 MPa cure pressure for 90 minutes @ 250°F/121°C. Post curing one hour @ 350°F/177°C will provide higher compressive strengths.

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Test Condition	Nominal Density 19 pcf psi	19 pcf MPa	26 pcf psi	26 pcf MPa	35 pcf psi	35 pcf MPa
-67°F/-55°C	1,250	8.6	3,000	20.7	9,000	62.1
77°F/25°C	1,000	6.9	2,500	17.2	6,500	44.8
180º/82ºC	400	2.8	1,000	6.9	4,000	27.6
250°F/121°C	200	1.4	500	3.5	1,200	8.2
350°F/177°C	100	0.7	300	2.1	1,000	6.9

Average compressive strength after environmental exposure:

Test Condition	Nominal Density 19 pcf psi	19 pcf MPa
Skydrol, 7 days @ 77°F/25°C	900	6.2
Jet fuel, 7 days @ 77°F/25°C	1,000	6.9
Degreasing fluid, 15 min @ 77°F/25°C	1,000	6.9

Processing Guidelines
LOCTITE EF 9899CF AERO may be cured into any closed cavity or mold. A typical example is curing into honeycomb core. The following details lay-up and cure parameters for the successful use of LOCTITE EF 9899CF AERO.

Quantity Calculation
The formula described herein provides the number of plies of LOCTITE EF 9899CF AERO 100 mil/2.5 mm film required to fill a mold of specified height to achieve a targeted average cured density.

For example, a 1 inch high (25.4 mm) cavity will require six plies of 100 mil/2.5 mm LOCTITE EF 9899CF AERO to achieve a 1 inch (25.4 mm) cured foam with an average cured density of 27 pcf.

The following calculation yields the same information for any cavity height:

$$\textit{Number of plies required} = \frac{\textit{Cavity height (ft) x Target cured density (pcf)*}}{\textit{areal weight}}$$

*Target cured density must be within 18 to 35 pounds per cubic foot for formula to be valid. Round up to nearest whole number.

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Lay-up Procedure
Closed Mold Lay-up
Expanding syntactic film is cut to fit the X and Y dimensions of the mold or cavity. Molds may be constructed of metal or any stiff material, which retains its shape under pressure. The plies are stacked together and placed inside the mold. Air paths connecting the interior and exterior of the mold, such as those afforded from glass cloth or strings or porous armalon are recommended to ensure complete expansion of the expanding syntactic film within the cavity. If the expanding syntactic film is not intended to bond to the mold, pre-treat the mold with an appropriate release agent.

Honeycomb Core Filling
Honeycomb sandwich structures reinforced with expanding syntactic film are processed by either one-step (co-cure) or two step processes described below:

General Co-cure Lay-up Procedure
1. Lay down initial plies of prepreg and adhesive (if applicable).
2. Place lightweight glass cloth as a bleed path for evacuation of air in the core.
3. Place honeycomb core down.
4. Lay down the appropriate plies of expanding syntactic film on top of the core.
5. Place top prepreg plies and adhesive (if applicable) on top of the expanding syntactic film.
6. Place caul plate on top of assembly.
7. Bag the part and pull vacuum, and cure.

Co-cured structures use the skins of the sandwich structure to confine the expanding syntactic film to the honeycomb cavity during cure. The expanding syntactic film plies are either placed between the honeycomb and adhesive layers of the assembly, or are imbedded into the core using a debulking, or pressing, step. Slight heat (<150°F/66°C) facilitates impregnation. For very thick cores, imbedding is recommended, as this aids the filling operation. For solid skin structures, an air path, such as a lightweight glass cloth, is highly recommended between the honeycomb and adhesive layers to aid air evacuation from the core during cure.

Alternatively, expanding syntactic film may be expanded and cured into a honeycomb core prior to skin bonding or other operations. This process is similar to co-curing, except that the honeycomb face sheets are non-bondable pressure plates which confine the expanding syntactic film expansion to the honeycomb cells. After expansion, the face sheets can be bonded to the expanding syntactic film-filled honeycomb using standard processes.

Curing
Assemblies containing expanding syntactic film may be cured via autoclave, oven or press techniques. Heat-up rate, cure temperature and pressure are all factors, which influence the expansion of expanding syntactic film.

Vacuum bag processing provides the most effective means for curing expanding syntactic film assemblies. Parts containing expanding syntactic film are vacuum bagged and cured via standard techniques. Bleeder plies connect mold interiors to the vacuum source.

Vacuum bagging provides external force to restrain expansion, and is most effective when combined with autoclave curing. Pressure from the autoclave ensures part configuration is retained. Vacuum pressure during autoclave cure is not necessary. Oven processing is a viable alternative when an autoclave is not available. Vacuum pressure must be maintained during an oven cure.

Heat-up and Cure Temperature
Heat-up rates of between 2°F to 8°F (1°C to 4°C) on the leading and lagging part thermocouples are recommended for curing expanding syntactic film. *It is important that the heat-up rate is controlled by measuring the part temperature and not the oven temperature*. Cure may be accomplished between the temperature range of 250°F to 350°F (121°C to 177°C). For vacuum bag and autoclave cures, comparing heat-up rates, faster heat-up rates will yield lower cured density parts. Care should be taken when curing thick structures containing expanding syntactic film to avoid potential exothermic conditions. Generally, slow heat rates and lower cure temperatures (250°F/121°C) will minimize excessive heat build-up in parts. Low temperature step curing (250°F/121°C)prior to cure at 350°F/177°C is recommended with thick structures >1.5 inch/4 cm and/or when more than eight 100 mil plies of expanding syntactic film are used.

Pressure Guidelines
Cured expanding syntactic film densities of 20 pcf can be accomplished with vacuum bag pressure. Cured densities, however, are best controlled by autoclave or press processes. Cured expanding syntactic film structures exceeding 25 pcf usually require cure pressures of 45 psi or greater. Tailoring both the heat rise and cure pressure is often successful in producing cured expanding syntactic film parts with the desired features.

Handling Precautions
Do not handle or use until the Material Safety Data Sheet has been read and understood. For industrial use only.

DISPOSAL INFORMATION
Dispose of spent remover and paint residue per local, state and regional regulations. Refer to HENKEL TECHNOLOGIES MATERIAL SAFETY DATA SHEET for additional disposal information.

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PRECAUTIONARY INFORMATION

General:

As with most epoxy based systems, use this product with adequate ventilation. Do not get in eyes or on skin. Avoid breathing the vapors. Wash thoroughly with soap and water after handling.

Before using this product refer to container label and HENKEL TECHNOLOGIES MATERIAL SAFETY DATA SHEET for additional precautionary, handling and first aid information.

Note

The data contained herein are furnished for information only and are believed to be reliable. We cannot assume responsibility for the results obtained by others over whose methods we have no control. It is the user's responsibility to determine suitability for the user's purpose of any production methods mentioned herein and to adopt such precautions as may be advisable for the protection of property and of persons against any hazards that may be involved in the handling and use thereof. In light of the foregoing, **Henkel Corporation specifically disclaims all warranties expressed or implied, including warranties of merchantability or fitness for a particular purpose, arising from sale or use of Henkel Corporation's products. Henkel Corporation specifically disclaims any liability for consequential or incidental damages of any kind, including lost profits.** The discussion herein of various processes or compositions is not to be interpreted as representation that they are free from domination of patents owned by others or as a license under any Henkel Corporation patents that may cover such processes or compositions. We recommend that each prospective user test his proposed application before repetitive use, using this data as a guide. This product may be covered by one or more United States or foreign patents or patent applications.

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