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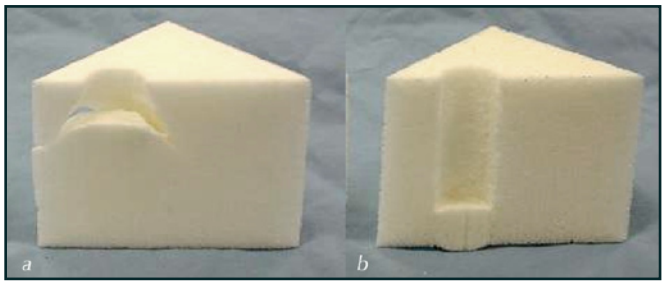
Sandia National Laboratories

Fact Sheet

TufFoam™ Rigid Polyurethane Foam:
Absorbs Energy, Worker Safe, and Environment Friendly

Product Description:

TufFoam™ is a toluene diisocyanate (TDI)-free, CFC-free water-blown, closed-cell, rigid polyurethane foam available in densities from 2 to 40 pounds per cubic foot. Initially formulated as an electronics encapsulant to mitigate the effects of harsh mechanical environments, TufFoam can also be used as a structural material as well as a thermal and electrical insulating material.



Samples of TufFoam™ (a) and a TDI based foam (b) after being impacted with a plunger showing how TufFoam™ is much more effective in spreading a penetrating load immediately after impact.

Absorbs Energy: TufFoam does not fracture or spall upon compression testing even to high strains, where other foams fail at relatively low strains. Other mechanical properties of TufFoam™ have been found to be comparable or superior to conventional TDI-based foams.

Worker Safe: Because TufFoam contains no carcinogenic toluene diisocyanate (TDI), the handling hazards and chemical sensitization associated with exposure during processing of common, polyurethane foams are greatly reduced. TDI is both a chemical sensitizer and carcinogen with a permissible exposure limit of 0.02 ppm. This low limit requires engineering controls to minimize worker exposure and respirators are recommended. With ever tightening Occupational Safety & Health Administration regulations, it is important to choose wisely in the selection of chemicals for manufacturing processes.

Environment Friendly: Water was chosen as the blowing agent for TufFoam instead of CFC's, hydrochlorofluorocarbons, fluorocarbons or hydrocarbons. These other blowing agents are either bad for the environment or are flammable. Water reacts with excess isocyanate to generate carbon dioxide gas that ultimately expands the foam. Intelligent selection of blowing agents will help when dealing with ever tightening EPA regulations.

Resists Water Absorption: TufFoam's closed-cell structure resists water absorption, and it will not swell, crack or split on exposure to water.

Ease of Use: TufFoam can be supplied either as a two-part kit for foaming in place or molded parts, or as board stock. TufFoam™, like most polyurethane foams, is stable, inert and resistant to most chemical and solvents. It is easily worked with common tools.

Applications:

- Impact energy mitigation
- Thermal insulation
- Floatation device core

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

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TufFoam™ Rigid Polyurethane Foam PRODUCT PROPERTIES		
GENERAL		
Density	2 to 40 lbs/ft^3	
Closed Cell Content	> 95% estimated (no test data)	
Aging	No Change after 21 months at 176°F	
Water Absorption		
2.5 Hours	TBD %	
24 Hours	TBD %	
Chemical Resistance	Excellent	
THERMAL		
Service Temperature Range	-65 to 176 °F	
Coefficient of Thermal Expansion	4 x 10^{-5} /°F	@ 6 lbs/ft^3
Thermal Conductivity	0.019 W/m•K (0.132 BTU/hour-ft^2-°F/inch)	@ 2.5 lbs/ft^3
Glass Transition Temperature (Tg)	306°F (152°C)	@ 6 lbs/ft^3
Fire Resistant	No	
ELECTRICAL		
Volume Resistivity	3 x 10^{17} ohm•cm	@ 6 lbs/ft^3
MECHANICAL		
Compressive Strength (psi)	Modulus (psi)	Density (lbs/ft^3)
10	290	2
25	580	2.5
44	1,450	3
160	9,570	6
319	15,950	10
392	20,300	12
479	26,100	14
972	46,400	20
4,060	159,500	40
Tensile Strength	232 lbs/in^2	@ 6 lbs/ft^3
Impact Energy Absorption*	> 0.048 BTU/in^2	@ 12 lbs/ft^3
High g environments (-65 to 165°F)		
Random Vibration (45 sec)	47 G-rms	@ 14 lbs/ft^3
Swept Sine (10 Hz-2kHz)	30 G	@ 14 lbs/ft^3
Mechanical Shock (0.45 ms)	5000 G	@ 14 lbs/ft^3
Crack Growth	TBD	
Hardness (Shore-D)	20	@ 3 lbs/ft^3
	55	@ 6 lbs/ft^3
*at 60% compression strain (100 in/in/sec with 1.6 in diameter x 2 in tall sample)		

TufFoam patent applications have been filed, and Sandia National Laboratories invites companies interested in making and selling liquid kits to contact Jim Wilhelm in Sandia's Business Development & Partnerships Office.

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