

IN•TOUCH

The Importance of Density

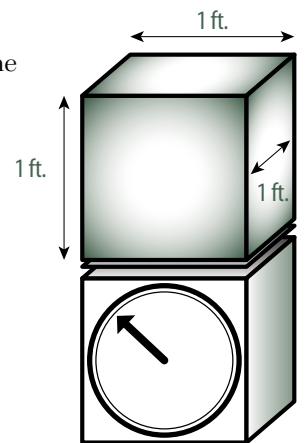
Density is a key flexible polyurethane foam specification. It is an important indicator of foam performance with regard to comfort, support and durability. It is also an indicator of the relative economics of the foam.

The Definition of Density

Foam density is not weight. It's actually a measurement of mass per unit volume. Density is a function of the chemistry used to produce the foam including any additives or fillers that may be used to impart specific performance features or to increase foam density. Flexible polyurethane foam is available in a broad range of densities, ranging from as low as 0.5 pcf to as high as 6 pcf. Polymer density is a function of the density of the virgin, or unfilled foam without factoring in possible additive content.

Flexible polyurethane foam density is measured in pounds per cubic foot (pcf), or in metric terms, kilograms per cubic meter (kg/m³).

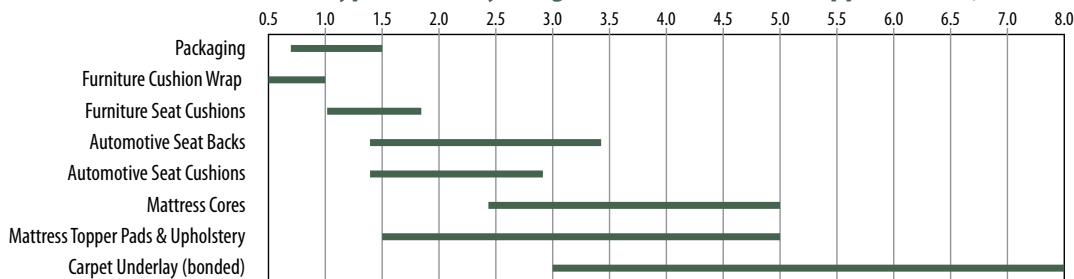
If the foam contains no additives or fillers, the polymer density is the same as the overall foam density. When additives or fillers are used in producing the foam, the foam density will be higher than the polymer density.



$$\text{Density} = \frac{\text{Weight}}{\text{Length} \times \text{width} \times \text{height}}$$

Generally speaking, the higher the polymer density of the foam, the greater the cost of the foam. Higher density foams typically offer better physical properties including support and durability than lower density formulations. It is always important to determine whether the foam contains additives or fillers, so that a clear understanding can be established as to the polymer density compared to the foam density.

Typical Density Ranges for Different Foam Applications (pcf)



How Density Affects Foam Performance

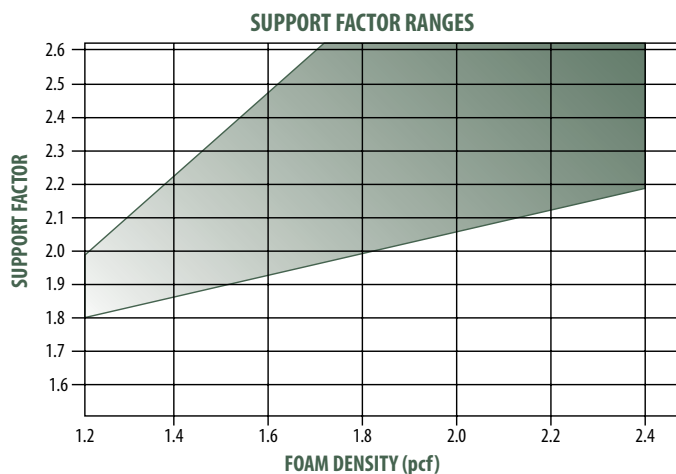
The denser the foam, the more material used to produce it, and the more material there is in the cushion to provide weight support.

It is important to remember, though, that foam surface firmness is independent of foam density. High density foams can be produced to be very soft. Low density foams can be made to be very firm. Therefore, there is no such thing as “hard” or “firm” density. High density foam products generally offer great deal of support, but they can be manufactured to be fairly soft foams.

What’s the difference between firmness and support? Firmness, 25% Indentation Force Deflection (IFD), is a measurement of the surface feel of the foam. Support is the foam’s ability to “push back” against weight and prevent the foam from “bottoming out.” Higher density foam helps prevent the feeling of having the foam collapse beneath body weight in an end use application. Both firmness and support affect foam comfort.

There is even a measurement to determine the foam’s ability to provide support. This measurement, support factor (also known as compression modulus or SAC factor), is determined by measuring the surface firmness (25% IFD) of the foam by compressing a 4” thick foam sample 25 percent of its original

As a general rule, the higher the density (polymer or overall foams), the greater the support.

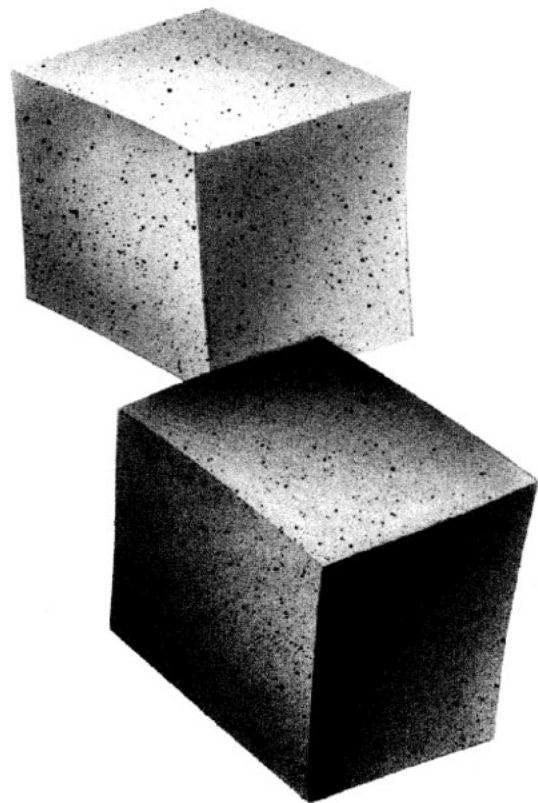


Support factors can vary in different types of foams. Some “high performance” foam grades are formulated to have higher support factors even at lower densities.

height (e.g., a 4” thick sample to 3”) and then measuring the deeper firmness (65% IFD) when compressing the same 4” thick foam sample to 65 percent indentation. The ratio of the 65 % IFD divided by the 25% IFD is the foam’s support factor.

The higher the support factor, the greater the ability of the foam to support weight. Foams with support factors of 2.0 or above are better suited for load bearing applications, like furniture seat cushions.

Density also can affect foam durability. Again, the more polymer material used to produce the foam, the better foam tends to retain its original properties over time.



Foam density is independent of foam firmness.



Research into foam durability by measuring flex fatigue, or the loss of foam firmness after flexing the foam a predetermined number of cycles, shows that as polymer density increases, firmness loss is usually lessened. Less firmness loss means that, for example, seat cushions and mattresses can much

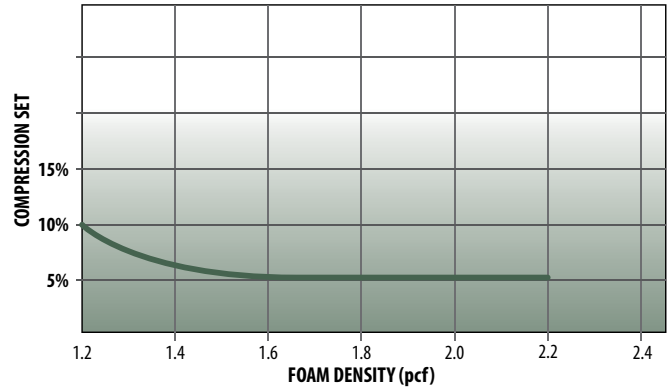
of their original “feel” over extended periods of normal use. Higher density foams also tend to retain their ability to provide support. Other factors used to gauge foam durability can also improve as density increases. One of these is compression set, or the tendency of foam to lose thickness or height as it is used. As density increases, height loss decreases dramatically, which means that the fabric on furniture cushions can remain taut longer and that mattresses body impressions may be less noticeable. In fact, some mattress manufacturers use higher density quilting foam to reduce instances of body impressions in innerspring as well as foam mattresses.

The Role of Foam Additives and Fillers

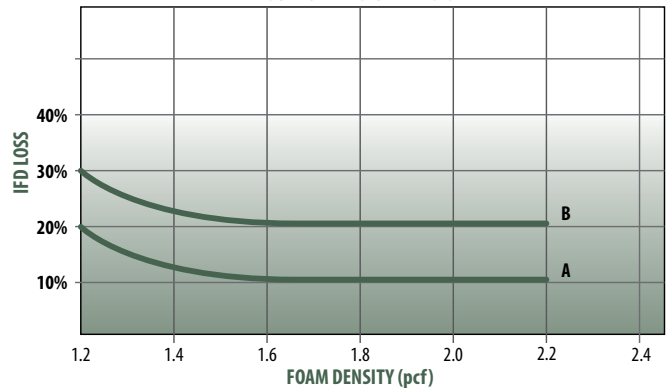
As noted before, overall foam density can be affected by additives and filling materials used to manufacture different foams. In some cases, additives are used to improve the combustion performance of foams. For example, substantial amounts of combustion-modifying additives may be needed to formulate foam products for application in California Technical Bulletin 133 (CA TB 113) complaint furnishings. This full-scale flammability test for finished items used in certain public occupancies calls for components that work together to resist a very hot open-flame ignition source. Combustion modification additives for

Foam compression set decreases as density goes up.

COMPRESSION SET TRENDS



SUPPORT FACTOR RANGES



this application may increase the foam’s density by more a pound per cubic foot. Additives also may be used to increase foam support characteristics and to resist compression from weight loading. Heavier weight foam can also give a seating cushion a more luxurious feel. However, it is important to note that while additives may increase density, and in some cases improve support, they may not improve other properties of the foam. Large amounts of additives can make foams more likely to tear and can reduce foam durability. This is because additives, since they are not part of the actual foam polymer, can act as abrasives that break down foam cell walls. So, high concentrations of additives can cause foam to lose more of its original properties through use. Therefore it is important that when you select foams for different applications, you look at the polymer, or unfilled, density of the foam being used.

Summary

- Density, measured in pounds per cubic foot, is a key property for determining flexible polyurethane foam performance.
- Foam density is independent of foam firmness.
- Density relates to the comfort, support and durability properties of the foam.
- Density can be affected by foam additives or fillers. To truly gauge foam performance, the unfilled, or polymer density of the foam must be evaluated. Polymer density takes into account only the weight of the basic fully-reacted raw materials.
- Foam fillers and additives can be used to make the cushion feel heavier and more luxurious, improve support, provide antistatic performance, reduce photosensitive color change, or improve the combustion performance of the foam, but large concentrations of fillers or additives may have a negative effect on other foam properties.

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This information is provided as a service of the Polyurethane Foam Association to improve the understanding of key issues that affect flexible polyurethane foam cushioning. To learn more about specific foams, contact your foam supplier.

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