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INFORMATION ON

FLEXIBLE POLYURETHANE FOAM

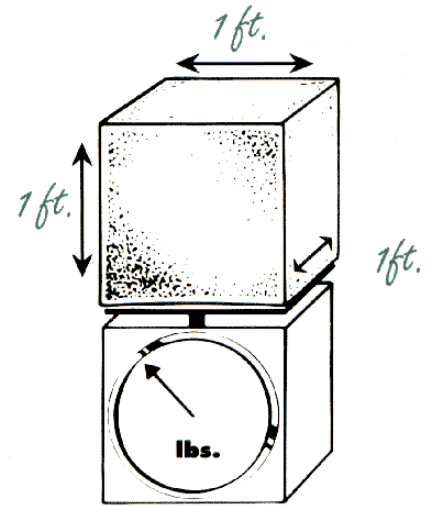
The Importance of Density

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, of additives used to increase density, and of any additives used to improve the combustion resistance properties of the foam. Flexible polyurethane foam is available in a broad range of densities, ranging from as low as 0.8 pcf to as high as 6 pcf. Most foam applications utilize foam in the 0.9 to 2.5 pcf density range. Foam density is a function of the density of the virgin, or unfilled foam. This is also called polymer density. 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.

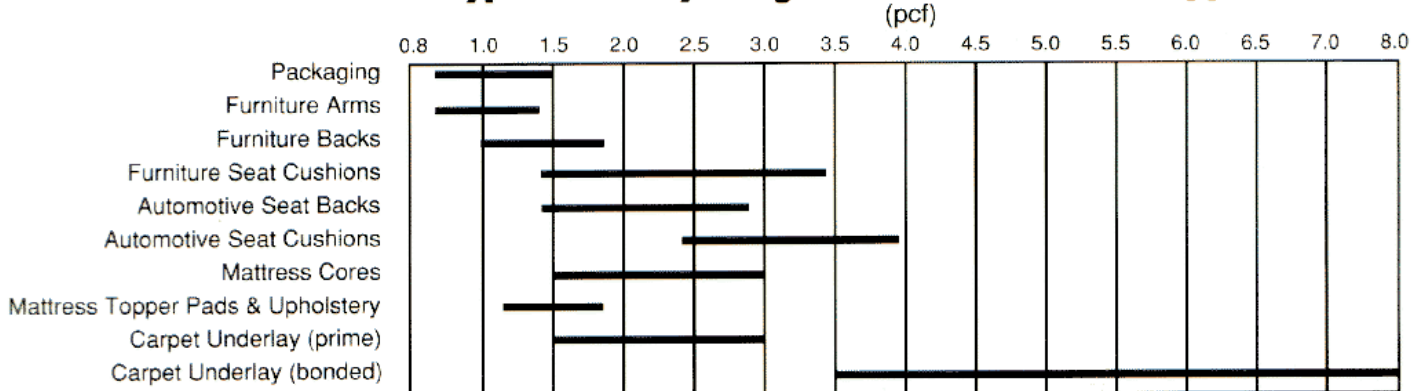
Flexible polyurethane foam density is measured in pounds per cubic foot (pcf), or in metric terms, kilograms per cubic meter (kg/m³).



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

Generally speaking, the higher the polymer density of the foam, the greater the cost of the foam. However, this foam will generally also have better physical properties including support and durability. If there is a concern for foam performance, it is always important to determine whether the foam contains any type of additives so that the clearest understanding can be established as to whether the foam density and the polymer density are one and the same.

Typical Density Ranges for Different Foam Applications (pcf)



How Density Affects Foam Performance

Obviously, the denser the foam, or the more material used to produce it, the more material there is in the cushion to provide support for weight.

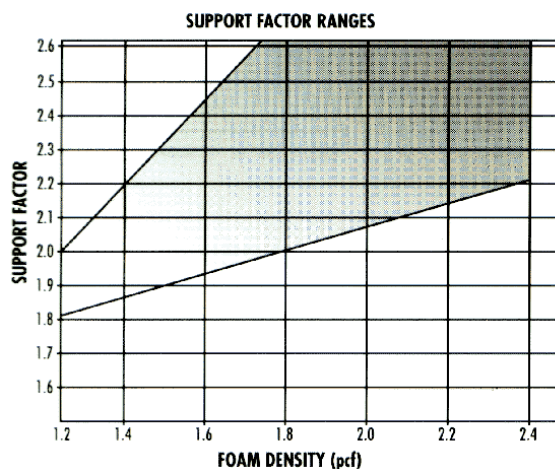
It is important to remember, though, that foam surface firmness is independent of foam density. High density foams can be produced to be very soft. Low density foams can be made to be very firm. Therefore, there is no such thing as "hard" or "firm" density. High density foam products generally offer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

What's the difference between firmness and support? Firmness (25% 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.

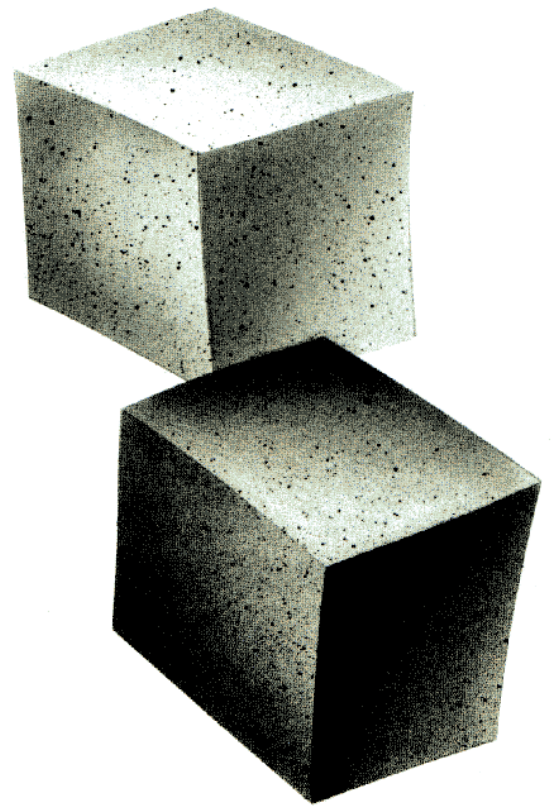
There is even a measurement to determine the foam's ability to provide support. This measurement, support factor, is determined by measuring the firmness (IFD) of the foam by compressing it 25 percent of its original height (e.g., a 4" block of foam to 3") and then measuring the firmness (IFD) when compressing the same foam sample 65 percent. The ratio of the 65 percent IFD divided by the 25 percent IFD is the foam's support factor.

The better 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 translates into foam durability. Again, the more polymer material used to produce the foam, the better foam tends to retain its original properties.

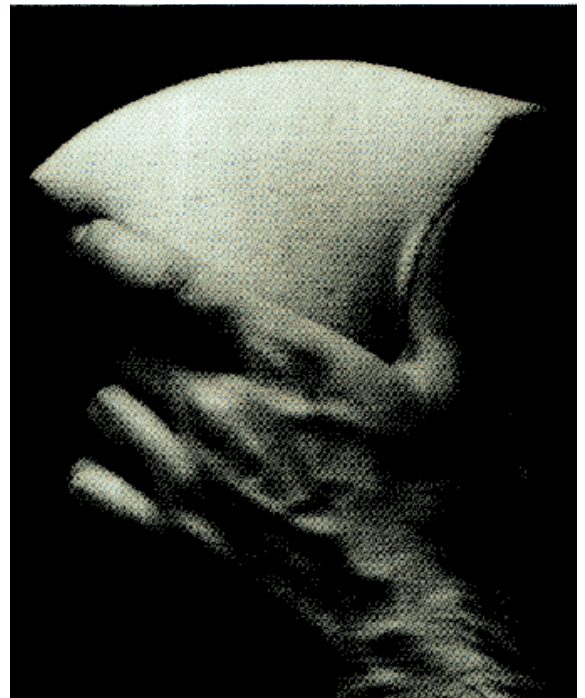
As a general rule, the higher the density (polymer or overall foams), the reater the support.



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.



Foam density is independent of foam firmness.

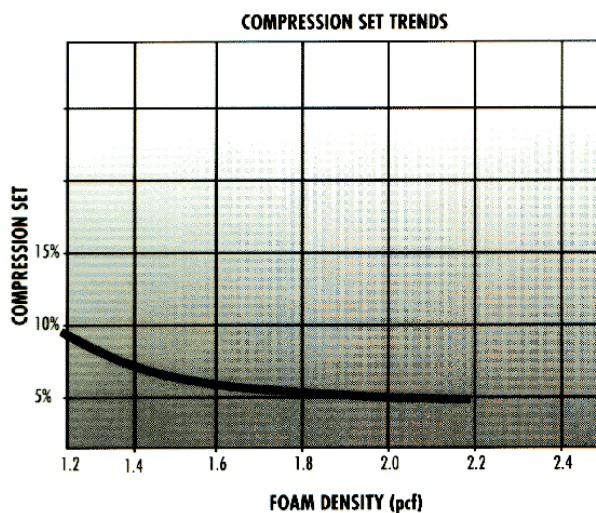


Research into foam durability by measuring flex fatigue, or the loss of foam firmness after flexing the foam a predetermined number of cycles, shows that as polymer density increases, firmness loss is lessened. Less firmness loss means that, for example, seat cushions still feel "new" and that mattresses retain their original "feel." Higher density foams also better retain their ability to provide support. Other factors used to gauge foam durability also improve as density increases. One of these is compression set, or the tendency of foam to lose height as it is used. As density increases, height loss decreases dramatically, which means that the fabric on furniture cushions stays taut and that mattresses don't get body impressions. In fact, many mattress manufacturers have increased the densities of their quilting foam during the past few years to reduce instances of body impressions in innerspring as well as foam mattresses.

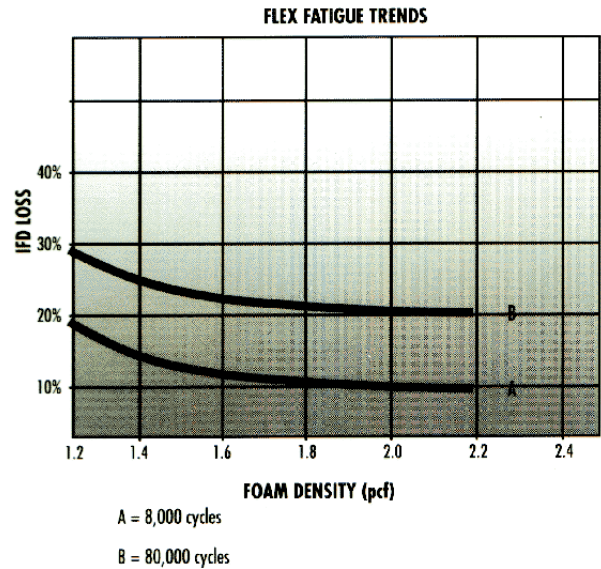
The Role of Foam Additives and Fillers

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. The most common occurrence of this is when additives are used to allow conventional

Foam compression set decreases as density goes up.



polyurethane foams to meet the combustibility requirements of California Technical Bulletin 117 for residential furniture. Additive requirements to meet this regulation are relatively minor, but they can affect overall foam density. To meet stringent combustibility requirements, greater amounts of additives or filling materials are needed. For example, foams that meet California Technical Bulletin 133, the Boston Fire Code, or similar stringent requirements have large amounts of additives that can increase the foam's density by



over a pound per cubic foot. Additives are used to increase foam density for other reasons. Additives may be used to increase the overall weight of the cushion, which gives the cushion a heavier, more luxurious feel, or additives and fillers can be used to simply increase the ability of the foam to provide support. Various materials are used as additives to increase density. 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. 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 cellular structure, can act as abrasives that break down foam cell walls, making foam 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

1. Density, measured in pounds per cubic foot, is a key property for determining flexible polyurethane foam performance.
2. Foam density is independent of foam firmness.
3. Density relates to the comfort, support and durability properties of the foam.
4. 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 only the weight of the basic foam materials into account.
5. Foam fillers and additives are used to improve the combustion performance of the foam, to make the cushion feel heavier and more luxurious, or to improve support, but may have a negative effect on other foam properties.

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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