Introduction

A panel of industry experts selected specific material properties for their polyurethane seating specification. The properties and requirements were chosen because they are identified as key foam characteristics, which relate to the functional application of polyurethane foam in an automotive seat. It was also recognized that, while these properties characterize the foam, they do not address its application from a seat engineering perspective. These guidelines are provided to help fill that gap and to highlight some of the most common misconceptions about foam.

Temperature and Humidity Effects

The temperature and relative humidity level, in the atmosphere where the foam is conditioned prior to and during testing, affects the hardness of the foam. This is the reason that all foam labs are maintained at standard conditions of 23 ± 2°C and 50 ± 5% RH. Seating foams will soften as temperature or humidity rises and become harder as they decrease. An instrumented foam hardness tester can measure hardness changes at relatively small shifts in temperature or humidity. However any increase or decrease in hardness would have to be fairly significant for a person to feel the difference. Foam hardness change is related to the transient environmental condition in the test lab and it is not permanent.

Foam Hardness

This specification uses Indentation Force Deflection (IFD), the current industry standard method, for measuring the hardness of foam blocks and seat pads. IFD is a repeatable and reliable test method for monitoring the hardness of foam from a quality standpoint, but it has its drawbacks as a design/engineering measurement. IFD measures foam hardness by indenting the test sample, with a 200 mm diameter compression plate, a specific percentage of its overall thickness, typically 50%. This means the IFD value is relative, because it is thickness dependent. To demonstrate this thickness effect, it is estimated that the 50% IFD value of a foam test block will decrease by approximately 12% for every 25 mm reduction in thickness. Pad geometry or components may also effect the IFD value.

Compression Force Deflection (CFD) on the other hand provides an absolute hardness measurement since the same size specimens, typically 50 x 50 x 25 mm, are cut from the interior or core of the foam block or part. This eliminates the influence of thickness, pad geometry and components. The hardness of a CFD specimen is measured very similarly to the IFD, except the compression plate is larger than the sample surface area. Unfortunately CFD also has its drawbacks. Since it is a
destructive test and more time consuming than IFD testing, it is not suited for monitoring production process harnesses. It is only recommended as a design/engineering or benchmark test to compare the absolute hardness level of foam samples at dissimilar thickness. (See ASTM D3574, Test B₁ and C for test method details)

Balancing Hardness and Density

Typically a seating pad will have a defined thickness based on the vehicle type and available interior space. Because of this, foam density and hardness become the remaining two variables, which is why the balance between these two properties is essential to achieve the desired level of performance from the part design. This specification segments polyurethane foam into four types and for each type there is a minimum core density requirement. It is important to understand that at the minimum density or at any other density foam can be produced over a fairly wide hardness range. If hardness is increased at a constant density the physical property values will become increasingly closer to the maximum allowable performance level for each foam type and eventually exceed the requirement limits. This is particularly true for the three properties that are associated with durability and comfort: Hysteresis Loss, Wet Set, and Constant Force Pounding.

Property Types

As noted in section 1.2 and 3.2 of this specification, the seat engineer needs to consider several factors concerning seat design, occupant expectations, vehicle type, and usage level when specifying the foam type for the pad under consideration. Depending on the design, vehicle class, and performance expectations, the same seating location in different vehicles, may not use the same foam type. This is also true for pad location within a vehicle. Higher demands will certainly be placed on a driver cushion than one located in the third row of an SUV, so the appropriate foam type selection is important for both performance and economical reasons. The table below gives a general guideline of how the foam types in this specification would be applied in an automotive vehicle.

<table>
<thead>
<tr>
<th>Seat Location</th>
<th>Foam Type</th>
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<tr>
<td></td>
<td>I</td>
</tr>
<tr>
<td>1st Row Cushion (Driver or Passenger)</td>
<td></td>
</tr>
<tr>
<td>2nd Row Cushion (SUV &amp; Sedan)</td>
<td></td>
</tr>
<tr>
<td>1st Row Back</td>
<td></td>
</tr>
<tr>
<td>2nd Row Back (SUV &amp; Sedan)</td>
<td></td>
</tr>
<tr>
<td>3rd Row Cushion</td>
<td></td>
</tr>
<tr>
<td>3rd Row Back</td>
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</table>
General Best Practices

- Design the seat system to ensure that the foam is in Compression.
- Support the pad properly to minimize bridging gaps and to prevent putting the foam in tension. Polyurethane foam cushion is not a structural component.
- Foam pads should be designed at a realistic foam thickness to avoid over compression of the foam.
- If foam pad thickness is decreased, the density of the pad should be proportionately increased. In general, this will maintain the pad performance level, because the polymer content of the pad will remain the same.
- A gap should not exist between the B-surface of the foam pad and the seat pan or suspension.
- Coring is allowed in non-load bearing areas, and it should be reviewed on a design basis.
- Avoid foam overhang around the structural seat pan b-surface foam bolster support. An unsupported bolster causes the foam to hinge, in tension, instead of compressing during occupant ingress/egress.
- Ensure there are no sharp edges (metal) adjacent to a foam surface.
- When using suspensions, a treatment (such as cloth) on the B-side of the foam, is recommended to distribute point loading and avoid penetration of suspension into foam.
- Ensure the package space is realistic in relation to foam thickness and specified H-Point. This will avoid over or under compression of the foam cushion.