ZOTEFOAMS

Technical Information Sheet TIS28

MECHANICAL PROPERTIES AT ELEVATED TEMPERATURES

The ability of a foam to perform at elevated temperatures is application dependent.

If used at elevated temperatures, three main impacts on the material should be considered:

1. Dimension changes can occur, both temporary and permanent. Temporary dimension changes can occur when the temperature of a foam is increased below the softening point, due to thermal expansion of the polymer and the gas in its cells. Permanent shrinkage can occur when foam materials are exposed to temperatures above the softening point for long periods, then cooled back to ambient.
2. Mechanical properties will change with temperature, and for thermoplastic polymers usually results in softening with increasing temperature. Changes to mechanical properties can be both a gradual and a step change (a transition temperature).
3. Chemical degradation of polymer - the amount of degradation for a polymer is dependent on the temperature and environment to which it is exposed, and the length of time in those conditions. One effect of this is a reduction in strength.

This document focuses on the mechanical property changes that can occur when foams are used at elevated temperatures.

IMPACT OF POLYMER TYPE

The stiffness (modulus) of polymer foams will decrease as the temperature is increased. This means that the foam will take less force to stretch or compress it when used at elevated temperatures. Foams based on different polymers will change properties at different rates as the temperature is changed.

Material family	Relative change in stiffness with increased temperature
Plastazote® LD	High
Plastazote HD	Very High
Plastazote EV	High
ZOTEK® F	Medium
ZOTEK F HT	Medium
ZOTEK T	Low

At elevated temperatures, changes to the mechanical response will be significant for materials that have high crystallinity - often materials that have relatively high stiffness at room temperature, such as the Plastazote® HD range. Softer, elastomeric materials, such as the Evazote® or ZOTEK T ranges will show less significant changes in their mechanical response at elevated temperatures.

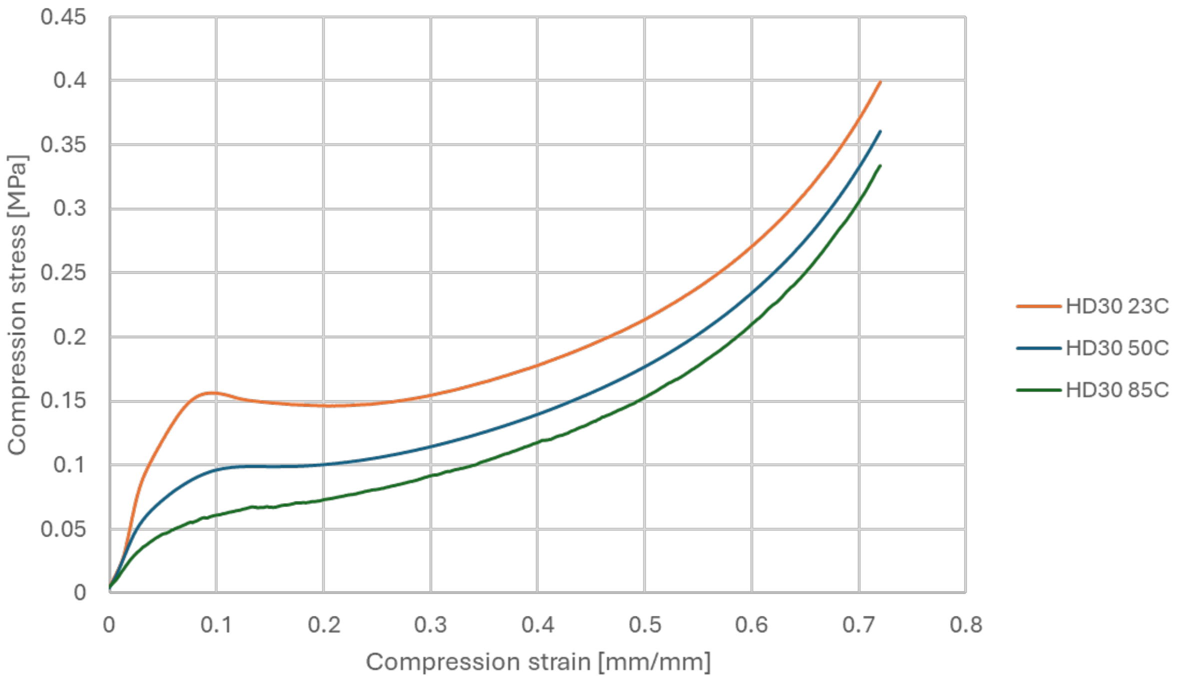


Figure 1: Graph showing the change in compression response for Plastazote HD30 material tested at 23, 50, and 85°C. Tested on a sample size 100 x 100 x 25 mm compressed to 70% of its original thickness at a rate of 12.5 mm/min.

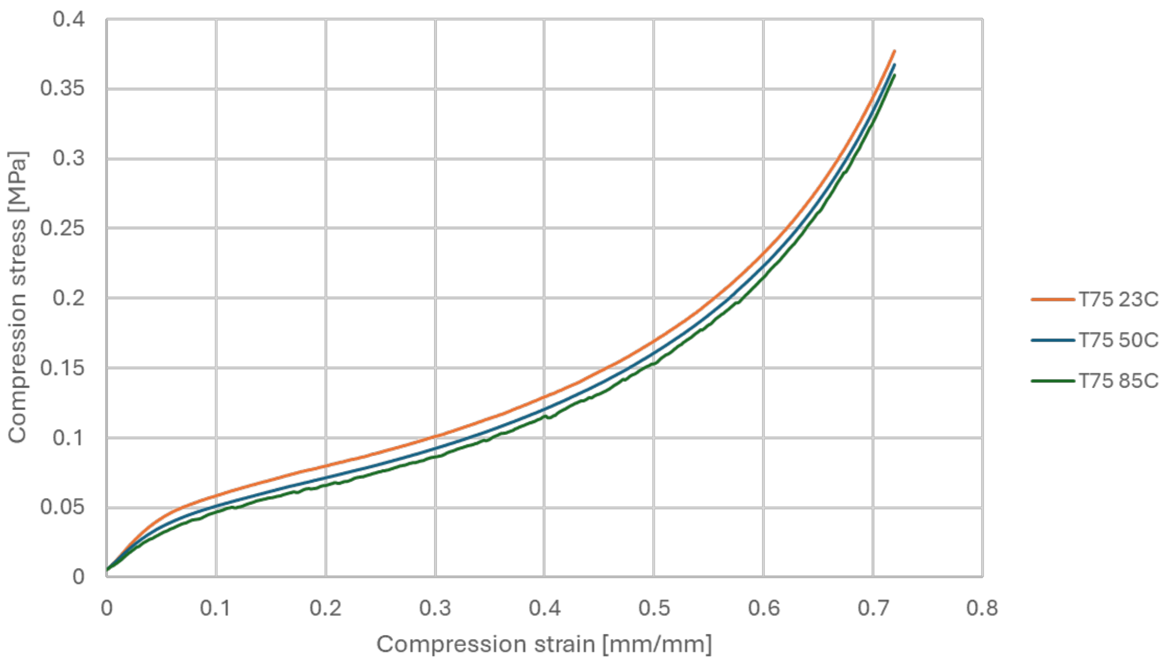


Figure 2: Graph showing the change in compression response for ZOTEK T75 material tested at 23, 50, and 85°C. Tested on a sample size 100 x 100 x 25 mm compressed to 70% of its original thickness at a rate of 12.5 mm/min.

For guidance on how mechanical properties will change over a wide temperature range, we can look at the response of different foams to dynamic mechanical analysis – a technique where a temperature and frequency properties of polymer materials can be studied. The following graphs show the expected change in stiffness of Zotefoams materials typically used in Aviation and Sports and Leisure markets. The percentage change in stiffness is driven by polymer type and will be similar for foams of different density made from the same polymer. For information about materials not shown below, please contact our Technical Support team for more information.

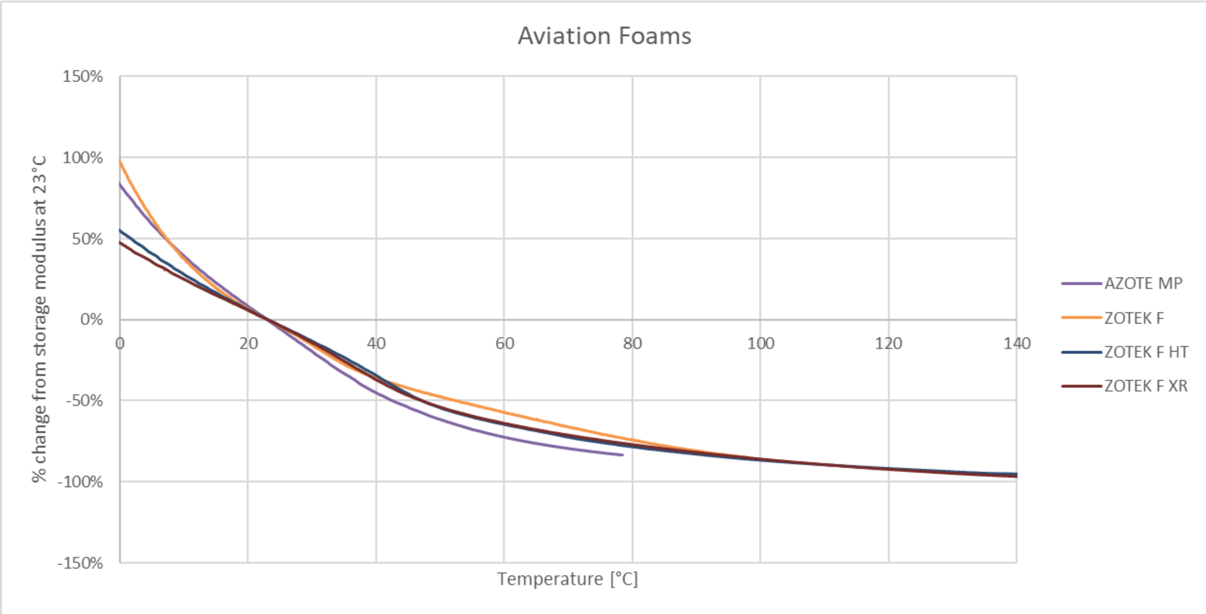


Figure 3: Percentage change in modulus with temperature compared to modulus measured at 23°C for foam materials typically used in aviation. Measured using 5 mm single cantilever bending clamps at a frequency of 1 Hz.

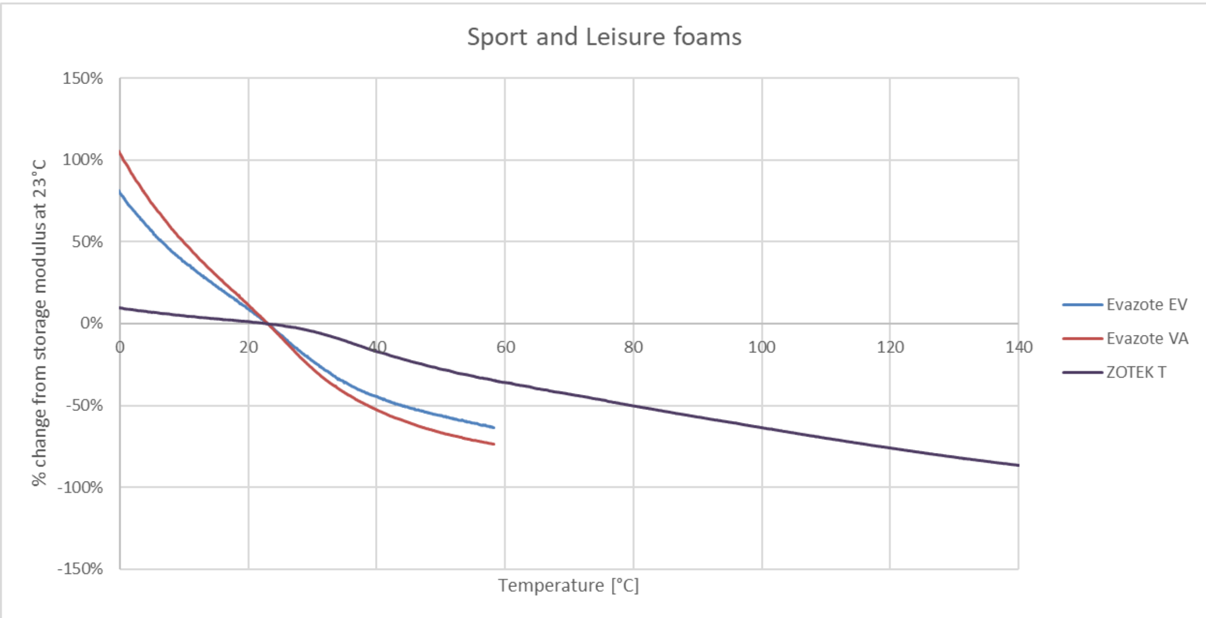
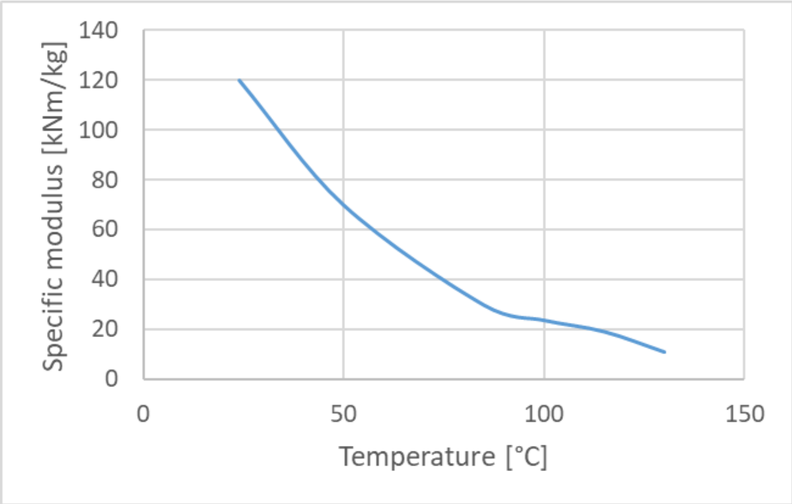


Figure 4: Percentage change in modulus with temperature compared to modulus measured at 23°C for foam materials typically used in sports and leisure. Measured using 5 mm single cantilever bending clamps at a frequency of 1 Hz.

As a further example, focusing in closer on higher temperature applications, the compression strength and modulus of any density of ZOTEK F HT foam will decrease as the temperature is increased. The graph below shows a typical relationship between specific modulus (absolute modulus divided by the density of the material) and temperature.



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