QWIK GUIDE: POLYISOCYANURATE VS. POLYURETHANE IN COMPOSITE FOAM CORES

BACKGROUND:

Dyplast manufactures polyisocyanurate foam cores for use as substrates within composites, particularly *sandwich* applications. Polyisocyanurate (polyiso or PIR) is a *modified* polyurethane with chemistry that enables considerable advantages in composite applications, discussed below. Dyplast's polyisocyanurate brands include a complete line of rigid polyiso foam bunstock, fabricated into highly customizable dimensions and shapes, available in a range of densities between 2.0 to 6.0 lb/ft^3 - - each with its own rigidities and strengths. Dyplast's ISO-CF® and ISO-CF/HT offer superior temperature range flexibilities from -297 to +350°F (-183 to 177°C), and ISO-CF/HT is suitable for intermittent temperatures up to 375°F (191°C) intermittent.

POLYURETHANE vs. POLYISOCYANURATE CHEMISTRY

Rigid foam cores under the general category "polyurethane" can be made with quite different formulations and therefore quite different physical properties and performance characteristics. The chemistry of ISO-CF and ISO-CF/HT polyisocyanurate, on the other hand, is based on a modification of traditional polyurethane formulations. The starting materials are similar to those used in polyurethane, yet the proportion of methylene diphenyl diisocyanate (MDI) is higher and a polyester-derived polyol is used instead of a polyether polyol.

The main difference between polyurethane and polyiso foams is that in the latter, the excess MDI, which remains after the initial urethane reaction between the polyol and MDI, reacts with itself to form the isocyanurate or a trimer ring structure. This reaction is boosted by heat from the urethane reaction and the use of specific trimerization catalysts. The resulting isocyanurate molecular structure is chemically more stable than urethane alone, and combined with the aromatic ring structure and the higher cross link density, provides increased mechanical performance and a rigid foam which is thermally more stable. The breakdown of isocyanurate bonds is reported to start above 482°F (250°C), compared with urethane at 302 to 356°F (150 to 180°C). Most polyiso foams typically have an MDI/polyol ratio, also called its "index", equal to or greater than 250, whereas rigid polyurethane foams are normally around 110.

- Service Temperature: the isocyanurate structure of polyiso plays a major role in improving most key physical properties such as *service temperature* - - making it more stable at high temperatures, and allowing Dyplast to develop ISO-CF/HT having a service temperature of up to 350°F (177°C) continuous and 375°F (190°C) intermittent.
- Flame Resistance: polyiso when compared to a urethane has improved flame resistance due to the presence of the aromatic ring structure of polyiso foams, which during a fire promote char formation.
- Resistance to Water and Chemicals: ISO-CF has superior closed cell content (nominally 97%), enabling low permeability to moisture and very low water absorption characteristics; the cross-linked structure also helps it resist chemical exposure.
- Dimensional Stability: Perhaps the biggest improvement polyiso offers over urethanes is in dimensional stability. Because of its highly cross-linked structure, polyiso is very stable at a wider range of climatic conditions. This structure is rigid enough to resist movement by the fabricated foam, making the "growth" and "warp" which has been associated with urethane type foams very negligible with polyiso. This factor also proves advantageous during the handling and incorporation of polyiso into or combination with other composite materials.

CONCLUSION

Dyplast's ISO-CF and ISO-CF/HT polyiso rigid foams have considerable advantages over polyurethanes and indeed the majority of composite substrates. Considering the following additional benefits, Dyplast's products offer a competitive alternative:

- highly customizable dimensions, shapes, and tolerances utilizing Dyplast's CAD and CNC equipment
- multiple densities - - each with its own rigidities and strengths
- high volume production capacity, plus just-in-time delivery options.

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