TECHNICAL BULLETIN 0218

POLYISOCYANURATE VS. POLYURETHANE FOAM CORE FOR COMPOSITE APPLICATIONS

PURPOSE

This Technical Bulletin is one in a series of white papers aimed at providing our clients, engineers, contractors, fabricators, and friends with objective information on our products and those of our competitors. A surprisingly large number of potential buyers of polyurethane (PUR) foam cores for composite applications are unaware of the advantages or even the existence of polyisocyanurate (polyiso or PIR). Some may even think they're the same thing. The fact is that the differences are considerable.

This Bulletin should help end-users better understand their alternatives. Note that while this Bulletin is focused on generic differences between PUR and PIR rigid foam cores for structural composite applications, there are indeed differences between the physical properties and performance characteristics of competing polyiso foam cores. We recommend end-users view other Technical Bulletins from Dyplast that address these differences.

POLYURETHANE AND 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 the traditional polyurethane formulations. The starting materials are similar to those used in polyurethane except that 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 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, provide increased mechanical performance and a 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 polyisocyanurate foams typically have an MDI/polyol ratio, also called its "index", equal to or greater than 250. By comparison the indices of rigid polyurethane foams are normally around 110. While the majority of structural composite applications benefit from higher rigidity foam cores, Dyplast can manufacture different polyiso densities - - each with its own rigidities and strengths.

POLYISOCYANURATE VS. POLYURETHANE PROPERTIES

A. Service Temperature

While incorporating the isocyanurate structure into polyiso does not affect thermal conductivity, it plays a major role in improving most other key properties. One such property is the service temperature. The cyclical aromatic ring structure that is unique to polyiso makes it more stable at high temperatures when compared to urethanes to the extent that Dyplast has developed ISO-CF/HT which has a service temperature of up to 350°F (177°C).

B. Flame Resistance

Another important improvement which is seen with polyiso when compared to a urethane is in the flame resistance. This is due to the presence of the aromatic ring structure of polyiso foams which during a fire promote char formation.

C. Resistance to Water and Solvents

Since ISO-CF two-pound density foam core is 97% closed cell, it has a low permeance to water (2.5 perm-in) and very low water absorption characteristics (0.5% by volume). The cross-linked structure also helps it to resist chemicals and solvents. Incidental contact between many solvents and polyiso will cause little or no damage to the foam.

D. 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 installation of polyiso.

SUMMARY: DYPLAST'S ISO-CF AND ISO-CF/HT

Dyplast's polyisocyanurate brands include a complete line of rigid polyisocyanurate foam bunstock available in a range of densities between 2.0 to 6.0 lb/ft^3. Dyplast's ISO-CF polyiso is ideal for composite foam core temperatures between -297 and +300°F (-183 to 149°C). ISO-CF/HT is suitable for higher temperatures up to 350°F (177°C) continuous and 375°F (191°C) intermittent. Dyplast's ISO products can be fabricated into sheets of various thicknesses and or highly customizable shapes utilizing Dyplast's CAD and CNC equipment. Very precise dimensions can be achieved to satisfy a variety of specialized or general composite foam core needs.

Thus, Dyplast's ISO line of products is highly differentiated from historical urethane foams. Hopefully, in the future, polyiso brand foams such as ISO-CF will not be confused with the urethanes and will be recognized as a distinctly different and superior foam core for structural composite applications.