Polyurethane with HCFC 22 vs. Polyisocyanurate with HCFC 141b
"R-Value Makes the Difference"

What is the difference between polyurethane and polyisocyanurate foam panels and how are they manufactured?

Polyurethanes are produced by an exothermic chemical reaction between liquid polyol and polymeric isocyanate. The foam recipe for polyol contains polyol, blowing agent, catalysts and surfactants, which are premixed in temperature controlled tanks and then mixed with isocyanate to initiate the chemical reaction. It is then injected between metal faces and bonds to the surfaces to form a continuous panel.

Commercially available polyisocyanurates are made from isocyanate, catalysts, blowing agent and surfactants, modified with polyurethane. The resulting mixture is poured as a liquid between metal faces. The liquid expands to form solid cellular foam that bonds to metal faces to form a continuous panel.

If the two foams appear similar in their components and method of manufacture, they are, but there are also some important differences. Rigid polyurethane and polyisocyanurate foams have the highest insulating value per inch of all commercially available foam insulation products today. Metl-Span's polyurethane core with HCFC 22, though, is recognized as having superior insulating qualities compared to all polyisocyanurate foams with HCFC 141b made in North America.

Growth in the use of polyurethane foam for panel products increased significantly in the 1970's because of their high R-value. Many of the early formulations, however, exhibited a high Btu content when they were tested for heat of combustion, and had difficulty passing the Factory Mutual Calorimeter test and the ASTM E84 test for flame spread and smoke development. Nevertheless, many manufacturers over time were successful in developing polyurethane foams that met Factory Mutual's Class I requirements.

When polyisocyanurate foams were originally developed as an alternative to polyurethanes they exhibited better fire performance properties. Flame spread and smoke developed ratings for polyisocyanurates, when measured in accordance with Factory Mutual criteria, ranged from 15 to 20 and 105 to 150 respectively, while polyurethane's ratings were typically higher.

Factory Mutual requirements for Class I approval, the best available in the US, specify a maximum flame spread rating of 25 and a smoke developed maximum of 450. Through advancements in polyurethane formulation using a HCFC 22 blowing agent Metl-Span is able to achieve comparable flame and smoke ratings to those historically obtained with polyisocyanurate. Metl-Span's average ratings are 20 for flame spread and 145 for smoke development.

Other data should be considered when determining whether to use polyurethane with HCFC 22 or polyisocyanurate with 141b as the blowing agent.

First, polyisocyanurate foam is characteristically more brittle or less flexible than Metl-Span's polyurethane, which can adversely affect the adhesion properties of the foam to the panel skins.

Metl-Span's polyurethane core density of 2.1 to 2.3 pounds per cubic foot provides just the right structural characteristics, flexibility and foam cell size. The foam cells contain the blowing agent that provides the high insulating value for the panel. Foam core density of polyisocyanurate combined with 141b blowing agent equivalent to polyurethane's density can cause numerous problems such as shrinkage of the core, and poor compressive, tensile and shear values are the result.

Increasing the density for polyisocyanurate foam cores in the range of 2.6 to 2.8 pounds per cubic foot is necessary for acceptable structural properties, but this increased density shrinks the size of the foam cells that contain the blowing agent and increases the amount of solid non-cellular polyisocyanurate. It is this blowing agent that gives the panel its insulating value. Less blowing agent mixed into the foam will reduce the panel's thermal performance.

Another primary difference between HCFC 22 used in Metl-Span panels and HCFC 141b used in polisocyanurate foam panels is the distinction between a gas versus liquid system. HCFC 22 is a gas system that has a very low boiling point of -40°F and is always trapped in the cells of the foam as a gas. HCFC 141b, conversely, is a liquid system with a boiling point of 90°F. Whenever the temperature of the core containing HCFC 141b drops below its boiling point it condenses in the cells of the foam, thereby causing the 141b foam to decrease in insulation value.

This decline in insulating value for the 141b foam occurs because the condensing gas becomes a better conductor for heat transfer through the core of the panel. As the mean core temperature continues to drop to 10°F, so does the R-value of the panel. What this means to the building owner is significantly improved insulating value of the wall system of 10% to 18% using Metl-Span panels with HCFC 22 versus a product with a HCFC 141b blowing agent.

Achieving superior thermal performance with insulated metal panels is still possible despite new federal government regulations. So when you think about your next project, stop and consider the thermal efficiency of Metl-Span wall and roof panels because changes taking place in manufacturing processes today can make a difference.