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Innovative Tooling Materials for Thermoforming

Syntactic Foam Plug Assists: PP Material Distribution Study
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Plug assists made from syntactic foams have been found to provide improved material distribution in thermoformed parts versus plug assists made from solid polymers. This improvement has been attributed to the syntactic foams low heat transfer properties. The majority of the syntactic foam structure is made up of hollow glass microspheres. This "reinforced air-filled" structure creates the low thermal conductivity, lower density and low specific heat on a volume basis that characterizes syntactic foams.

A study performed jointly by CMT Materials and Aristech Chemical Corp. confirmed that syntactic foams dramatically outperform often-used solid polymers when comparing the material distribution of the thermoformed polypropylene part. The study shows a greater than 40% reduction in relative deviation of the part thickness. This could translate into a similar materials thickness savings on starting sheet.

The study centered on the evaluation of the six plug materials listed below:

Plug Type	Description
HYTAC-W	Standard 350°F Epoxy Syntactic
HYTAC-B1X	350°F Thermoplastic Syntactic
HYTAC-WF	High Strength and Clarity 350°F Epoxy Syntactic
Formplast® 2000	Solid Urethane Material from Cadillac Plastics
HYTAC-B	350°F Solid Engineered Polymer
Polysulfone	Solid Transparent Thermoplastic

Each plug was machined to an identical geometry to produce a 32 ounce clear cup. The study was run on an OMV Inline machine at the Aristech Pittsburgh facility using FT-021-N polypropylene. The overall tool was a 4-up cavity, cups made on only the two center cavities were utilized to minimize edge effects. The machine was allowed to run until the plugs had come to an equilibrium temperature prior to measurements. Figure One shows the plug configuration and resultant cups.

Following the trials, 10 cups produced from each plug were chosen at random. Thickness measurements were made along the cup length and bottom at seven locations. The cup was then rotated 90° and the measurements were repeated. The relative deviation from the standard as a percentage was calculated for each plug material and plotted. The results are shown in Figure Two. Measurement of haze and reflectance was also performed. The high scatter in the results of these measurements made the data inconclusive.

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Figure One: Plug Configuration and PP Cups

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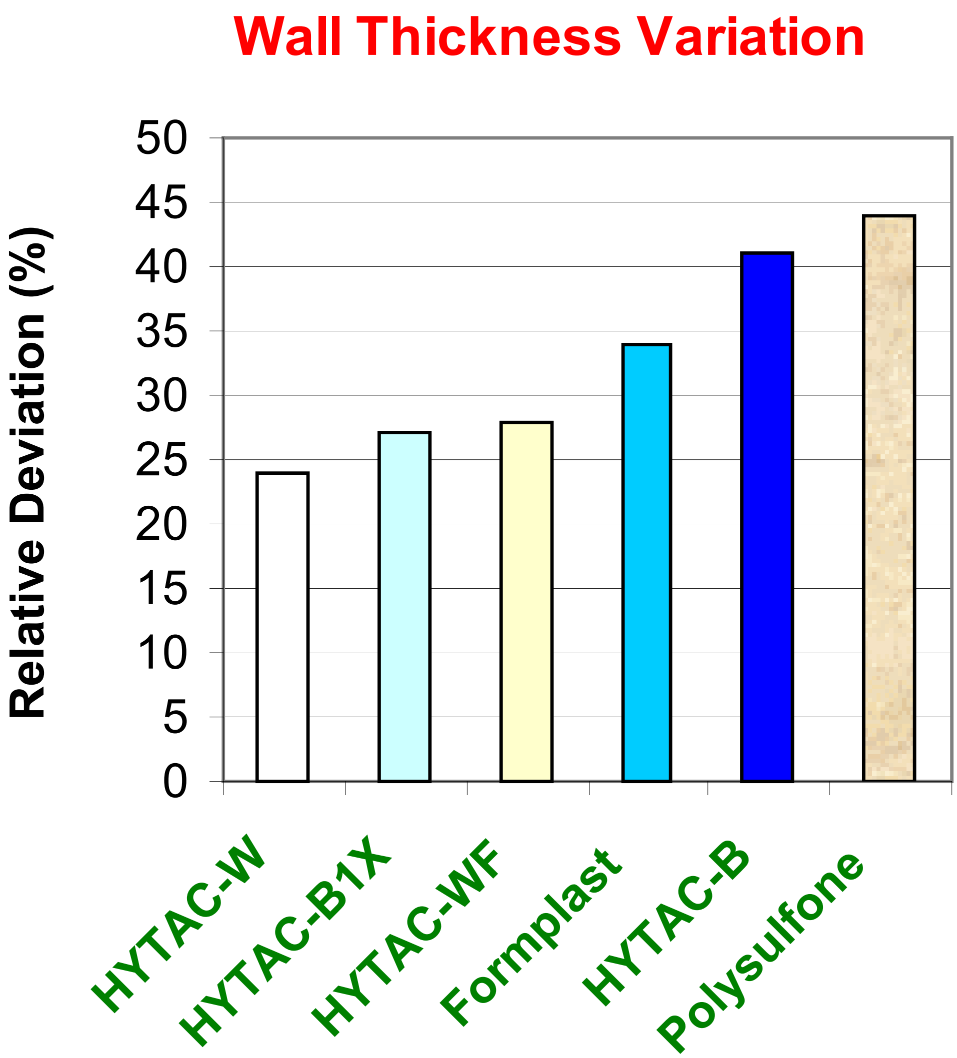

Trials run on OMV Inline Courtesy of Aristech Chemical Corp.
using FT-021-N Polypropylene

Figure Two: Material Distribution Chart

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Conclusions & Recommendations

- Due to the heat transfer characteristics of the materials, all syntactics outperformed the solid polymers in minimizing thickness variation in this test.
- Based on the differences measured, it may be possible to minimize starting thickness of the polymer up to approximately 40%.
- No measurable difference in clarity of the resultant cups was found by haze or reflectance tests.
- The results are based on a single geometry. Improvements for any of the materials may be obtained by altering/optimizing the geometry of the plug.
- The surface finish of the plugs not optimized. All materials were finished to roughly the same surface condition.
- Wear and deterioration issues were not addressed in this study. Great differences are known to exist in the manner in which each plug material degrades due to high temperature and/or abuse.