DIVINYCELL®

-the quality core!

THERMOFORMING

Scope

Thermoforming is done by heating Divinycell to it's softening point and forcing it against the contour of a female or male mold. There are at least a dozen thermoforming methods: vacuum assisted, pressure, drape, sweep, match mold and free forming, to mention some. We will cover only three of them in this section. All figures in this section are derived from previous production experience and testing. Adjustments might have to be considered depending on individual production conditions.

Molds

Thermoforming molds can be made of most common materials.

If a series is small, or if you are working on a prototype, a wooden mold is acceptable. The problem with wood is the accumulation of heat in the mold. The cooling time will be long and the productivity low in a continuous production.

Steel or aluminum molds are preferable due to their high thermal conductivity and their stability. Plastic molds could be used but they also accumulate heat.

Single curved products with a radius bigger than 400 mm (1 .5 ft) are best formed on a male mold. This could either be sweep forming with a thin steel foil or vacuum bagging.

Vacuum bagging is a simple operation with low tooling costs, but is has some disadvantages. It takes time to apply the vacuum bag, and the sheet might cool down too much.

This can be avoided if the vacuum bag is assembled on a cold sheet and mold. The mold is then placed in a hot air oven. The temperature inside the sheet is registered with a thermal gauge. When the right temperature is reached the vacuum is applied. The mould is then taken out of the oven and allowed to cool down with the vacuum on. Consideration has to be given to time, temperature and vacuum to avoid creep effects.

If the radius is below 400 mm (1.5 ft), a female mold should be used. It could either be vacuum bagged or match mold formed.

The latter should be used if the radius is small, the thickness or density is high and a high load is required. Fixed stops must be used to avoid compression of the core.

Heating

The best way to heat the Divinycell is in a heated platen press with fixed stops or in a circulating hot air oven.

Infrared heaters could also be used up to 10-15 mm (25/64-19/32 in) thickness. The IR-waves will not penetrate deep enough on thicknesses above that.

If the temperature is too high the dimension stability will be affected and if it is too low the spring back will be too big. An uneven temperature distribution will make the Divinycell twist.

For further information contact:
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Temperatures and times

The following temperatures should be used for the different qualities, independent of radius and thickness:

Quality	H45	H60	H80	H100-200	HT	HCP
Temperature °C	+80	+85	+100	+110	+120	+120
°F	+126	+185	+212	+230	+248	+248

The following times should be used for different thicknesses, independent of radius and quantity.

Quality	H45	H60	H80	H100-200	HT	HCP
Thickness mm	10	20	30	40	50	60
In	25/64	25/38	1 3/16	1 37/64	2	2 3/8
Time min	5	7	10	12	15	20

The following temperatures in the center of the core should be used for the different qualities when a cold sheet is vacuum bagged in a hot air oven.

Quality	H45	H60	H80	H100-200	HT	HCP
Temperature °C	+70	+70	+80	+85	+100	+100
°F	+158	+158	+176	+185	+212	+212

The time from removal from the heating unit until the pressure is applied must not exceed 0.5 minutes to avoid cooling down of the Divinycell.

Dimensional stability

The heating of the Divinycell will change it's dimensions slightly. The following dimension stability figures in percent of the original dimension are valid when the Divinycell is heated in accordance with temperatures and times as mentioned above.

Length/width = 2 %
Thickness = -2 - 0 %

To compensate for the spring back of the Divinycell the mold radius should be 5-10 % smaller than the final radius.

It should also be noted that the edges of the thermoformed pieces have a tendency to be straightened out.

Care must also be taken to avoid spring back during storage. Specially designed boxes or pallets often need to be used.

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Effect on physical properties

The Divinycell is affected in two ways during thermoforming.

1) Decrease in density during heating.
2) Stretching of the outer radius.

Both will decrease the physical properties slightly. Typical decrease is 0-5 %. From design standpoint 10 % should be used.

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