Multilayer Rotational Molding

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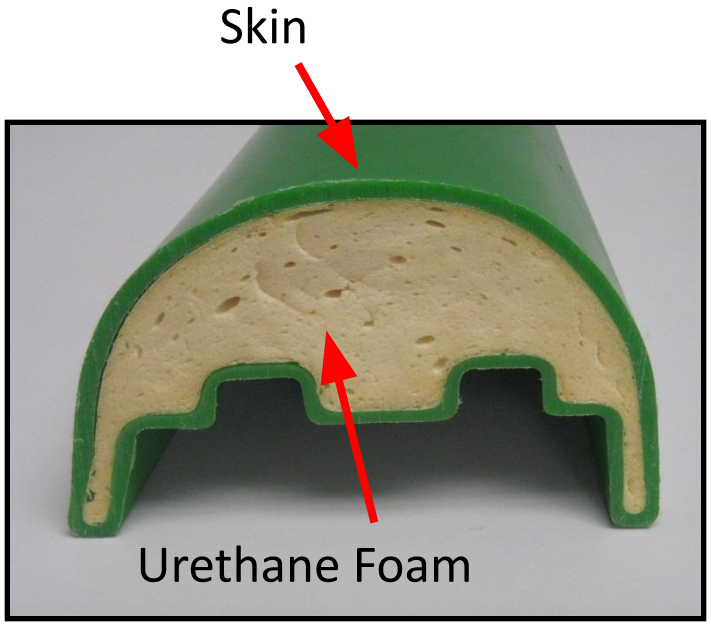
Centro
INCORPORATED
CUSTOM ROTATIONAL MOLDERS

Multilayer Rotational Molding

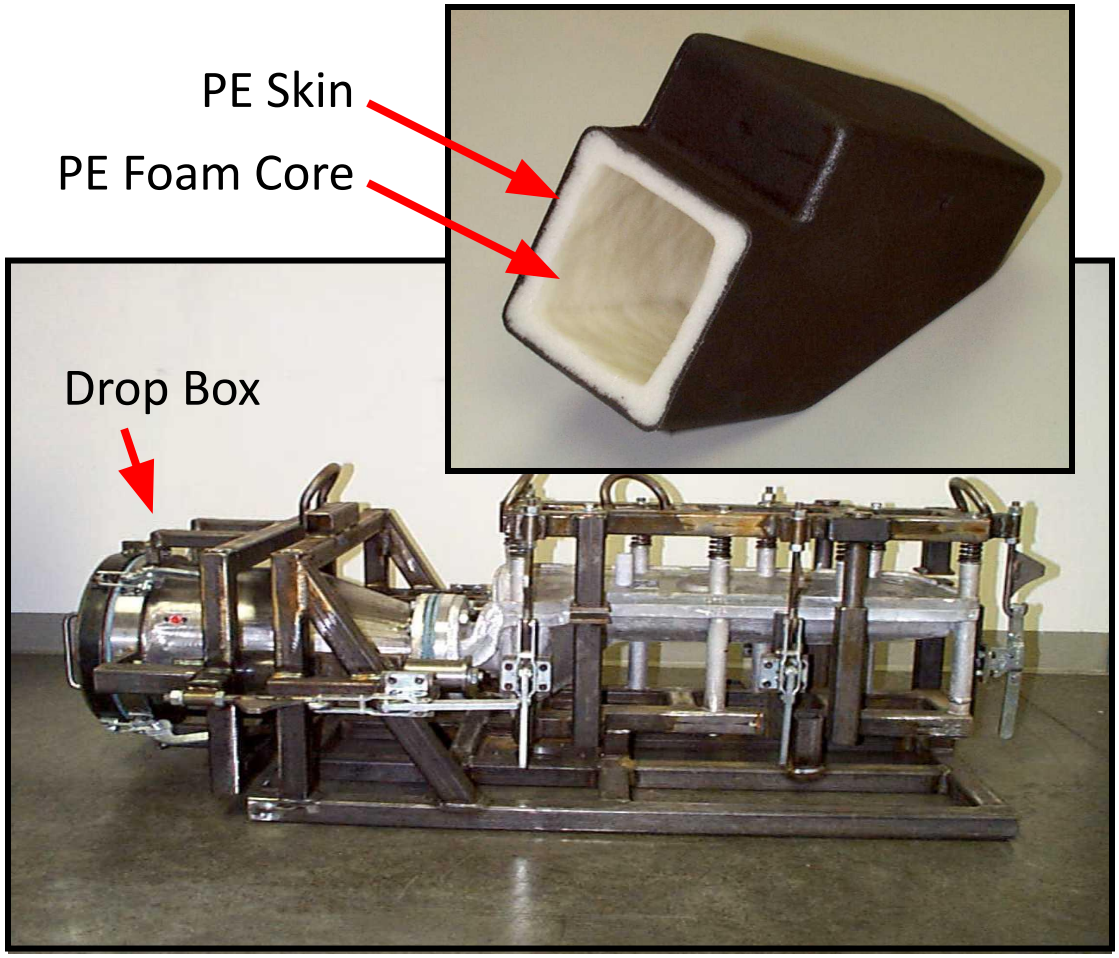
- Skin-foam Polyethylene – 2 layer
  - Insulation
  - Stiffness (even though it reduces modulus!)
  - Floatation
- Skin-foam-skin Polyethylene – 3 layer
  - All of the above, with greater strength/stiffness
- RotoLoPerm® XLPE/Barrier/XLPE – 3 layer
  - Gasoline fuel tanks requiring low emissions
  - High impact strength
- Crosslink/PA11 – 2 layer
  - Hydraulic fuel tanks for temps exceeding XLPE capabilities
  - Gasoline fuel tanks requiring low emissions (high cost)
- Crosslink/PA6 – 2 layer
  - Hydraulic fuel tanks for temps exceeding XLPE capabilities
  - Gasoline fuel tanks requiring low emissions

Foam Processing – PE & PU

Post-Mold PU Foam

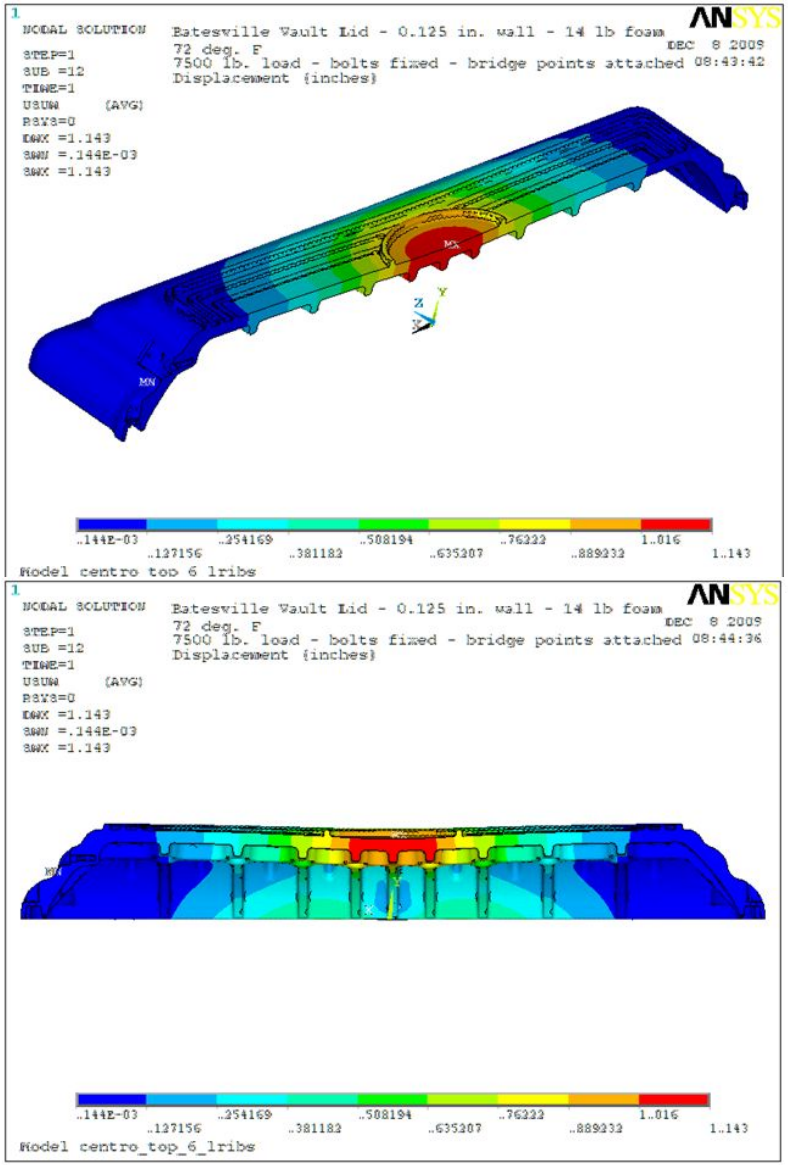


In-Mold PE Foam



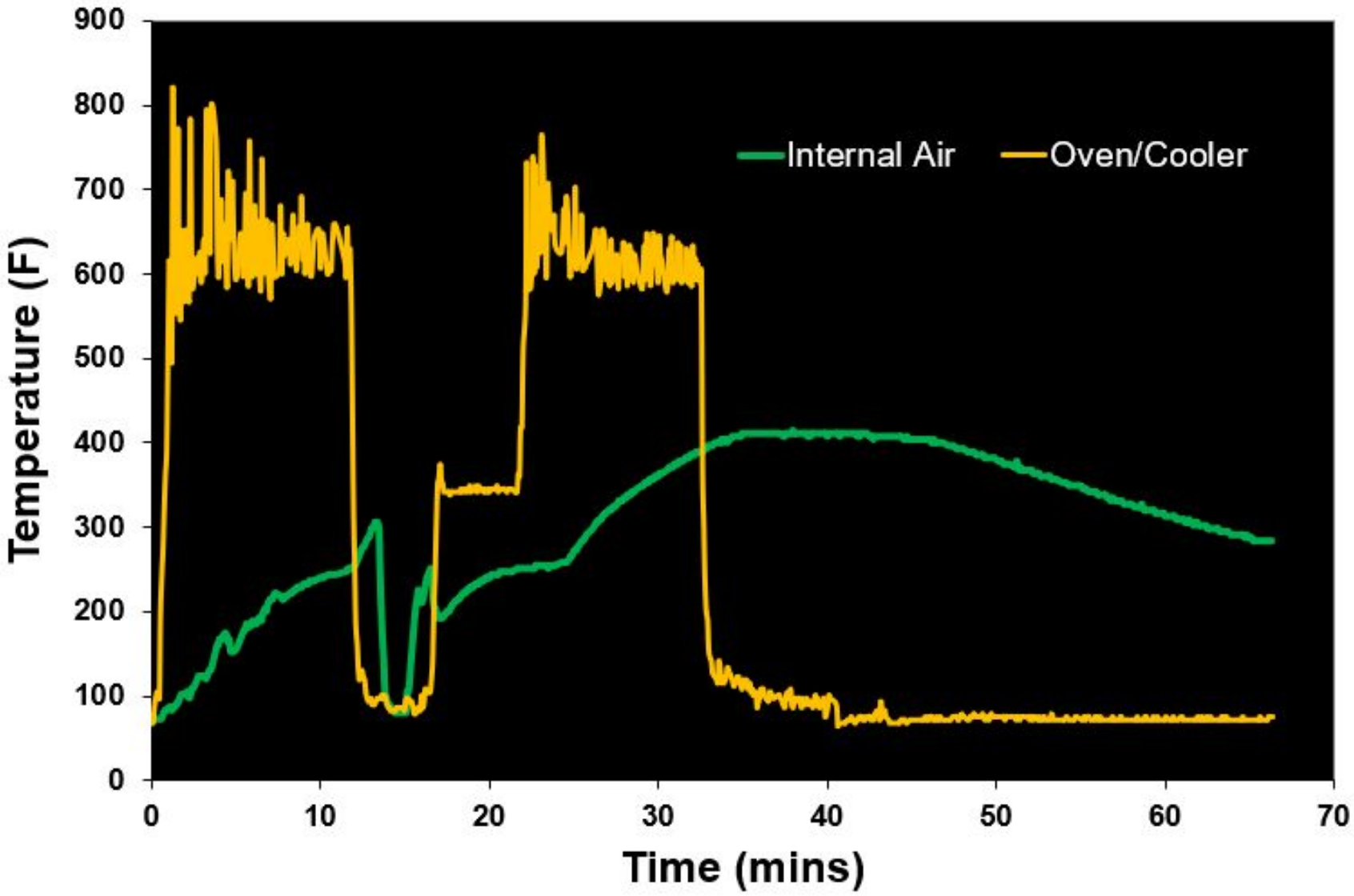
PE In-Mold Foam Examples

Burial Vault PE Foaming Cycle



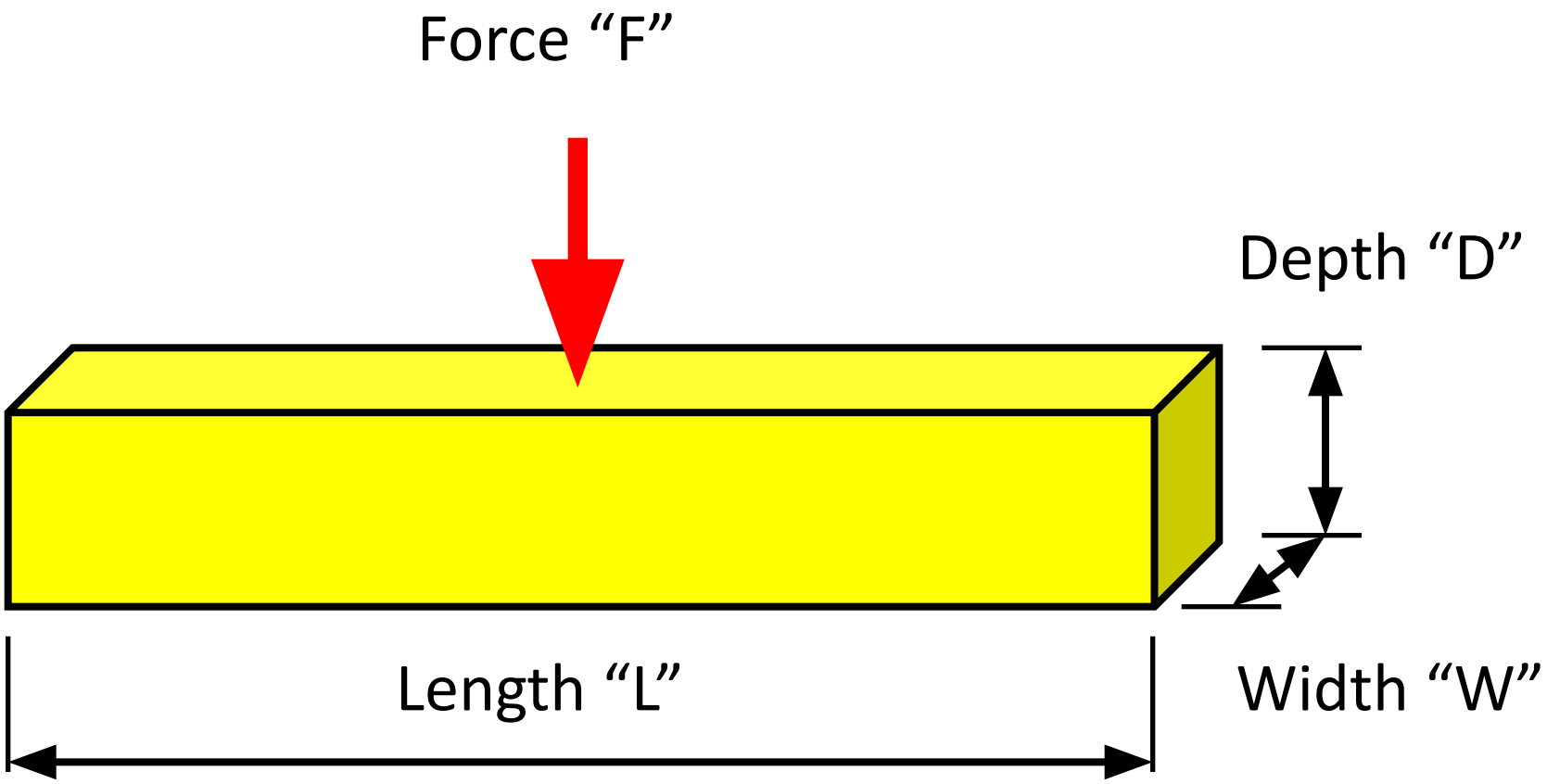
- Vault lid was foamed solid
- Lid was load bearing
- 5,000lbs (2267kg) concentrated at 12” center
- 22,000lbs (10,000kg) spread over entire lid
- FEA used to determine if minimum deflection could be met
- Lid was ribbed on underside

Burial Vault PE Foaming Cycle



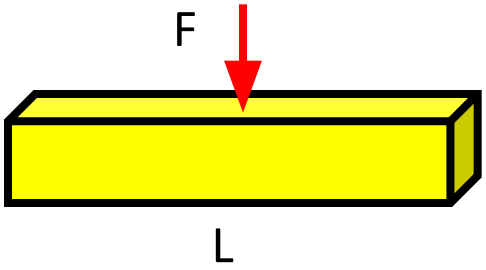
How PE Foam Improves Stiffness

Laws of Deflection



How PE Foam Improves Stiffness

Laws of Deflection



Deflection: “б” $= \alpha (FL^3 / EI)$

where : E = modulus of the material

I = second moment of area $(WD^3/12)$

α = constant

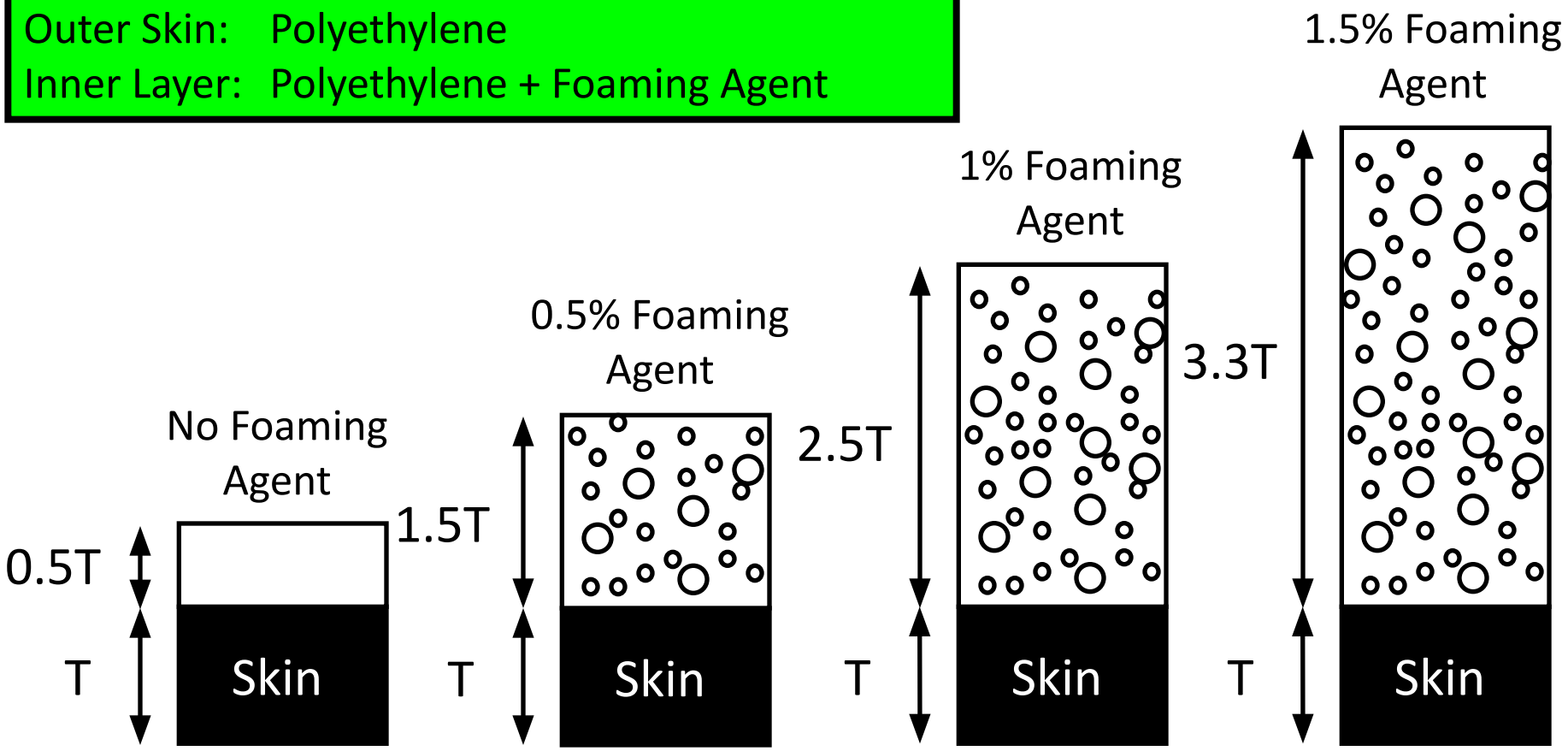
Stiffness: $F/б = \alpha (EI / L^3)$

$= \alpha (EWD^3 / 12L^3)$

How PE Foam Improves Stiffness

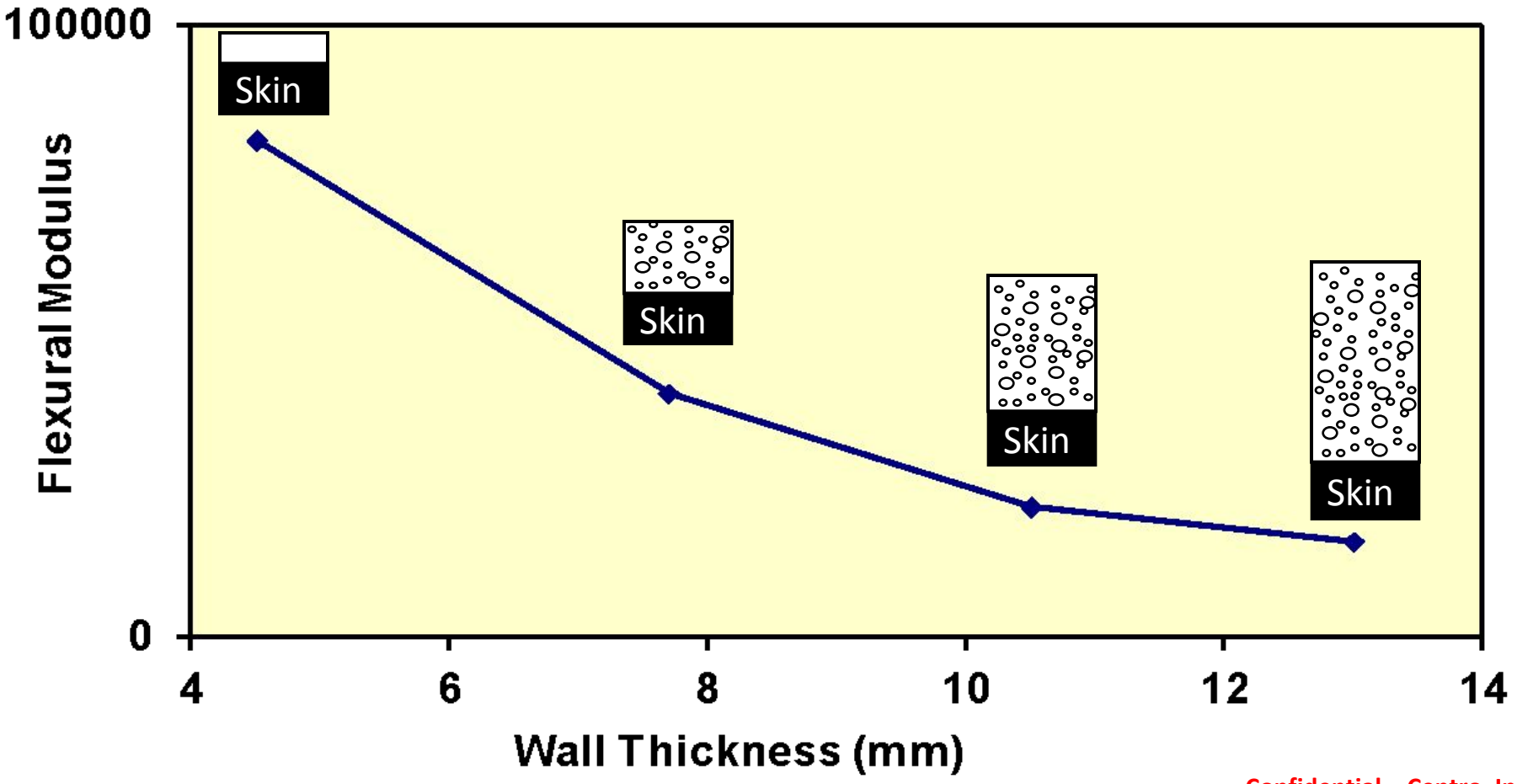
Foam Expansion

Outer Skin: Polyethylene
Inner Layer: Polyethylene + Foaming Agent



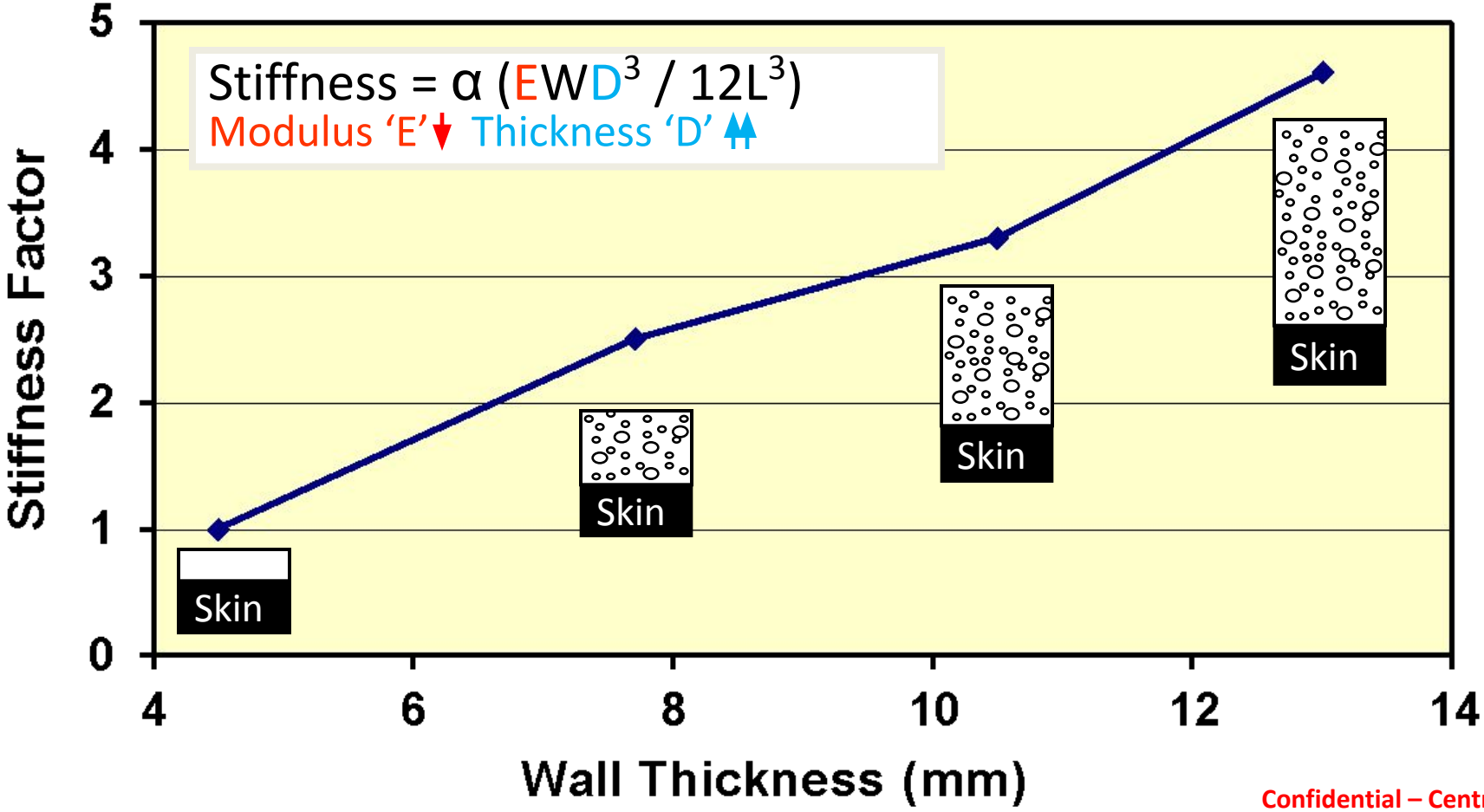
How PE Foam Improves Stiffness

Effect of Foam on Modulus



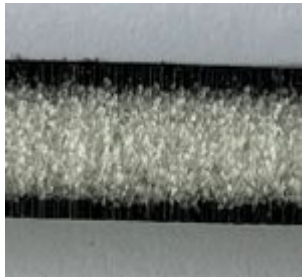
How PE Foam Improves Stiffness

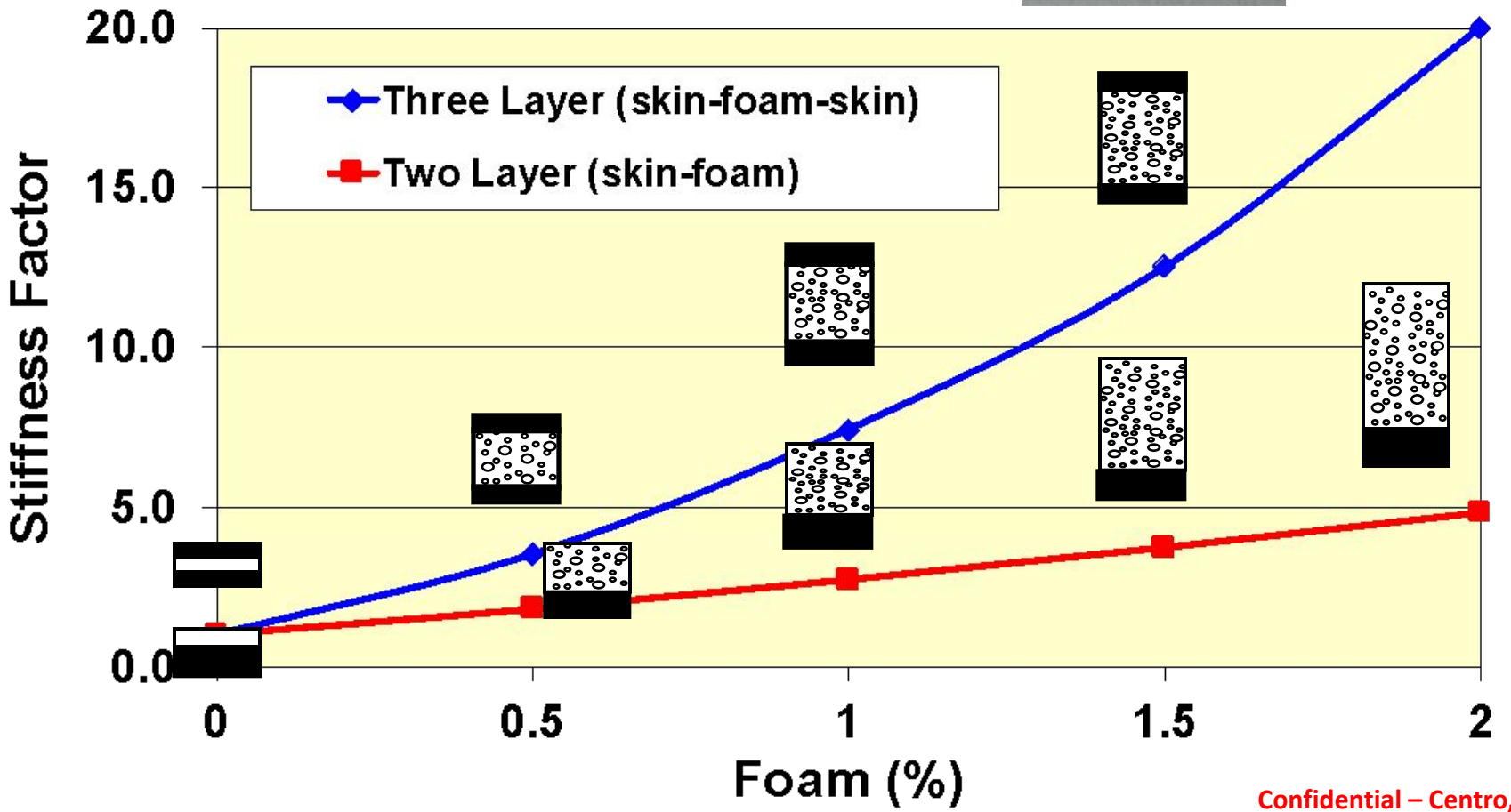
Effect of Foam on Stiffness



How PE Foam Improves Stiffness

Effect of Skin/Foam/Skin on Stiffness

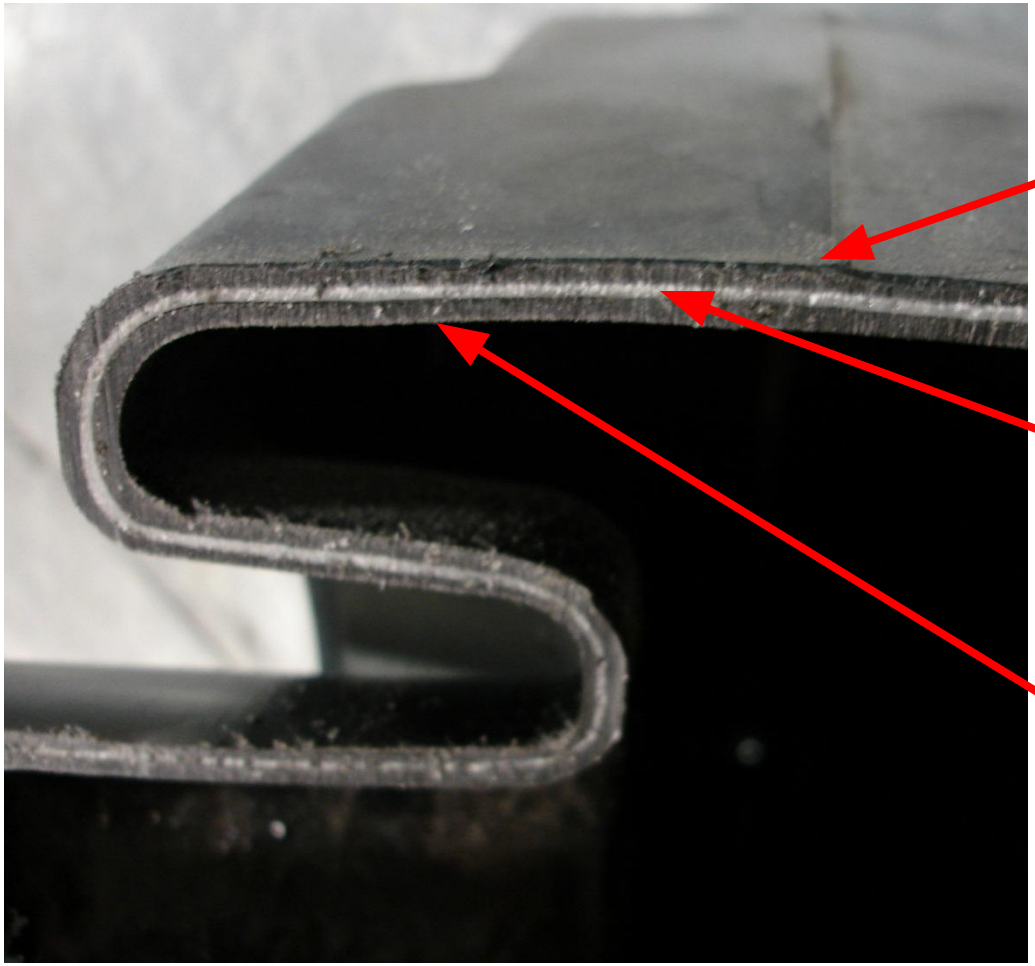




RotoLoPerm® 3-Layer Gasoline Tank

- Developed by Centro
- XLPE/Hydrocarbon Barrier/XLPE combination (3 shot)
- RotoLoPerm trademark
- 3 Patents
- Passed SAE J288 & J1241 impact tests, ANSI B71.10
- CARB and EPA compliant
- Offers excellent mechanical properties – cold impact, burst resistance, abrasion resistance etc.
- Licensed to 4 molders
- See RotoWorld Volume XX, Issue 2, 2024

Cross-section of RotoLoPerm® Layers



Outer Layer –
UV/Abrasion Resistance
typically 2mm

Middle Layer –
Permeation Resistance
typically 1mm

Inner Layer –
Impact/Fuel contact
*typically 2mm**

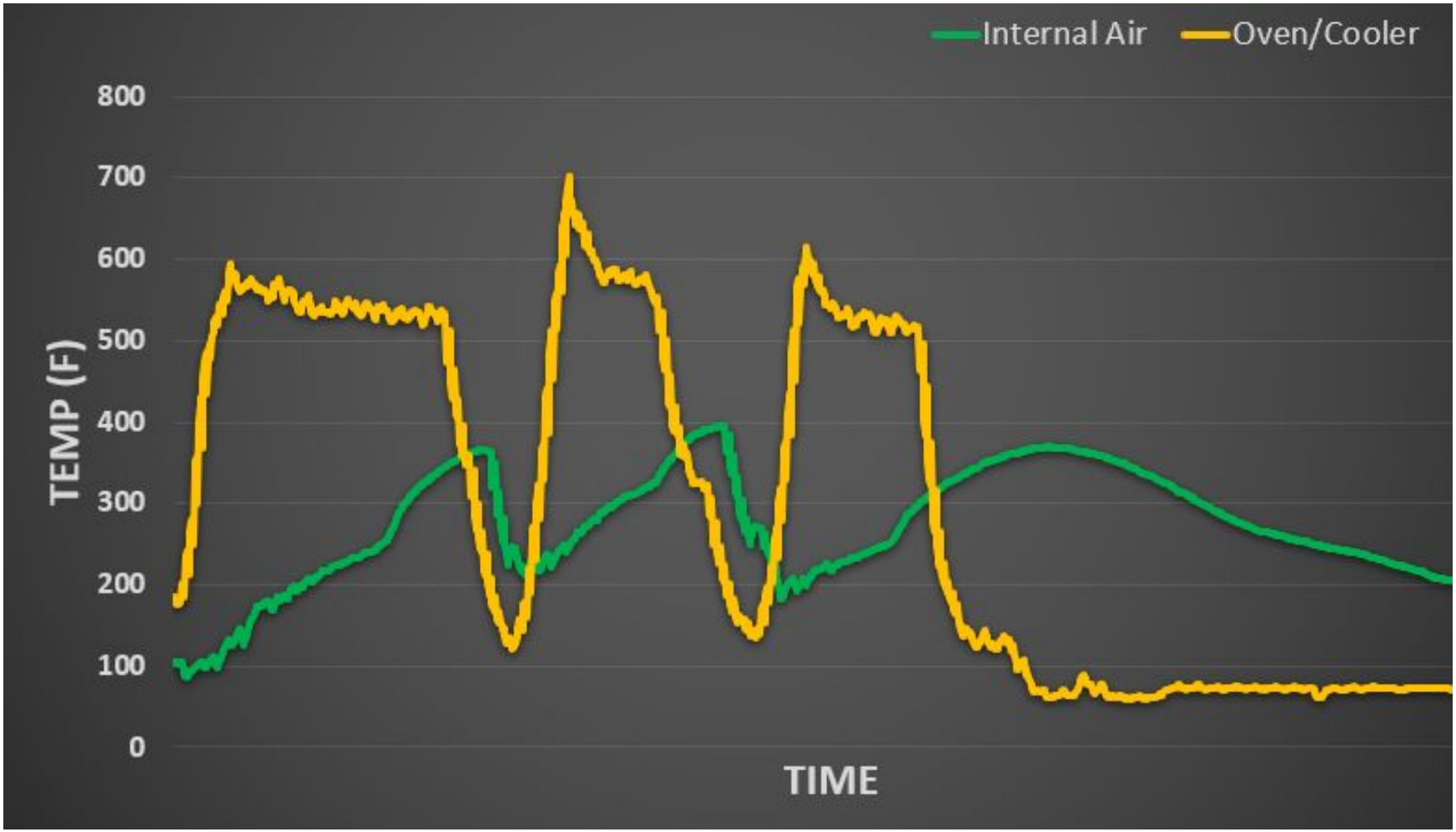
* Inner layer thickness can be increased to improve impact strength if required

Cross-section of RotoLoPerm® Layers

RotoLoPerm® Applications

- Mowers
- Generators
- Boats
- Portable Gas Tanks
- Motorcycle Gas Tanks

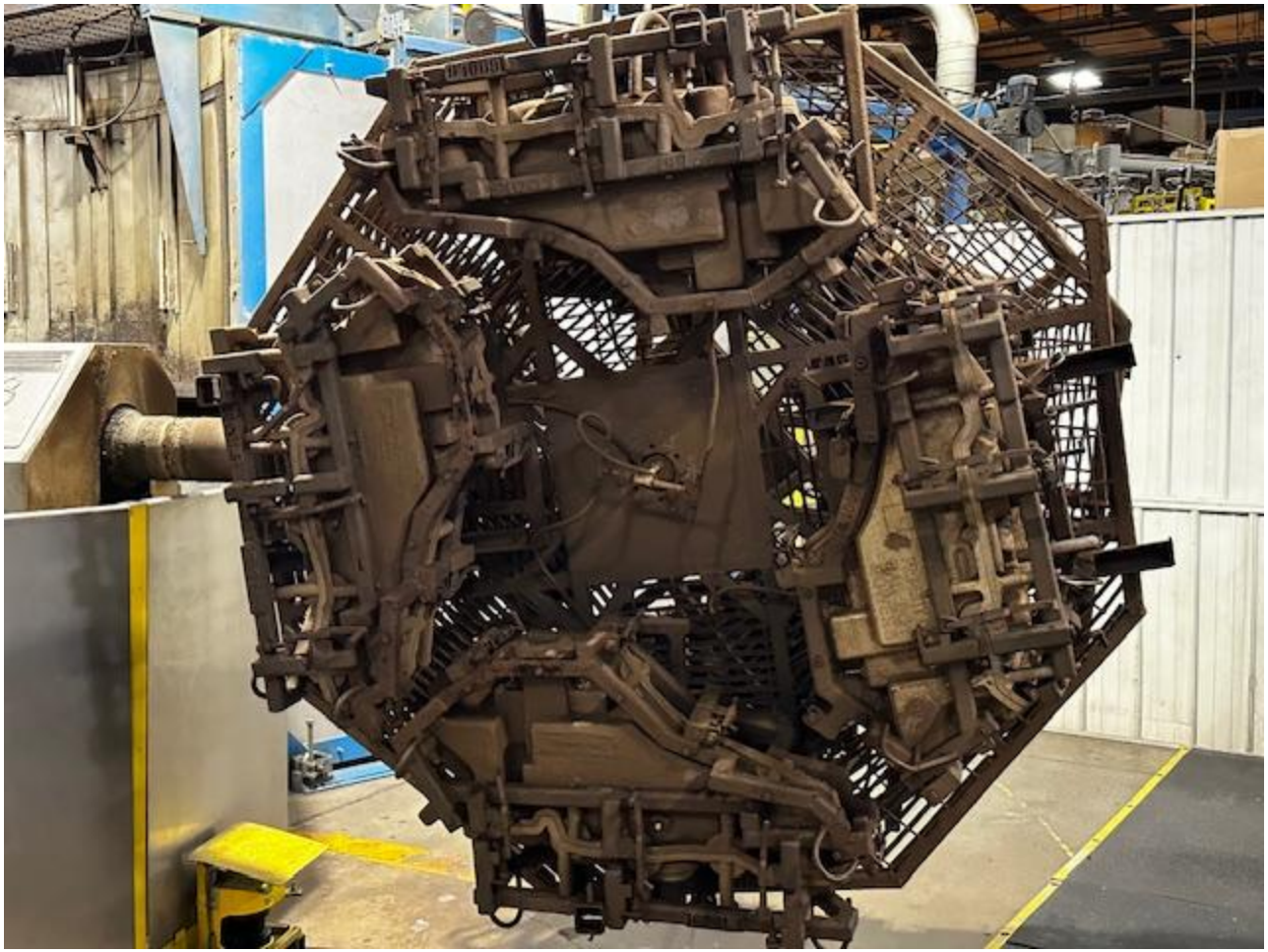
RotoLoPerm® Cycle



RotoLoPerm® Processing

- A little more challenging that single layer!
- The benefit of have XLPE as the skin layer is that you can stop rotation to add 2nd layer
- There are critical temperatures at which to introduces 2nd/3rd layers for best performance
- The middle layer is a mixture of 2 materials, one for permeation resistance, the other for adhesion
- We use proprietary resin transfer devices to add the 2nd/3rd shots
- We can run up to 8 molds on one arm
- Having a 2nd oven can increase the rounds per day

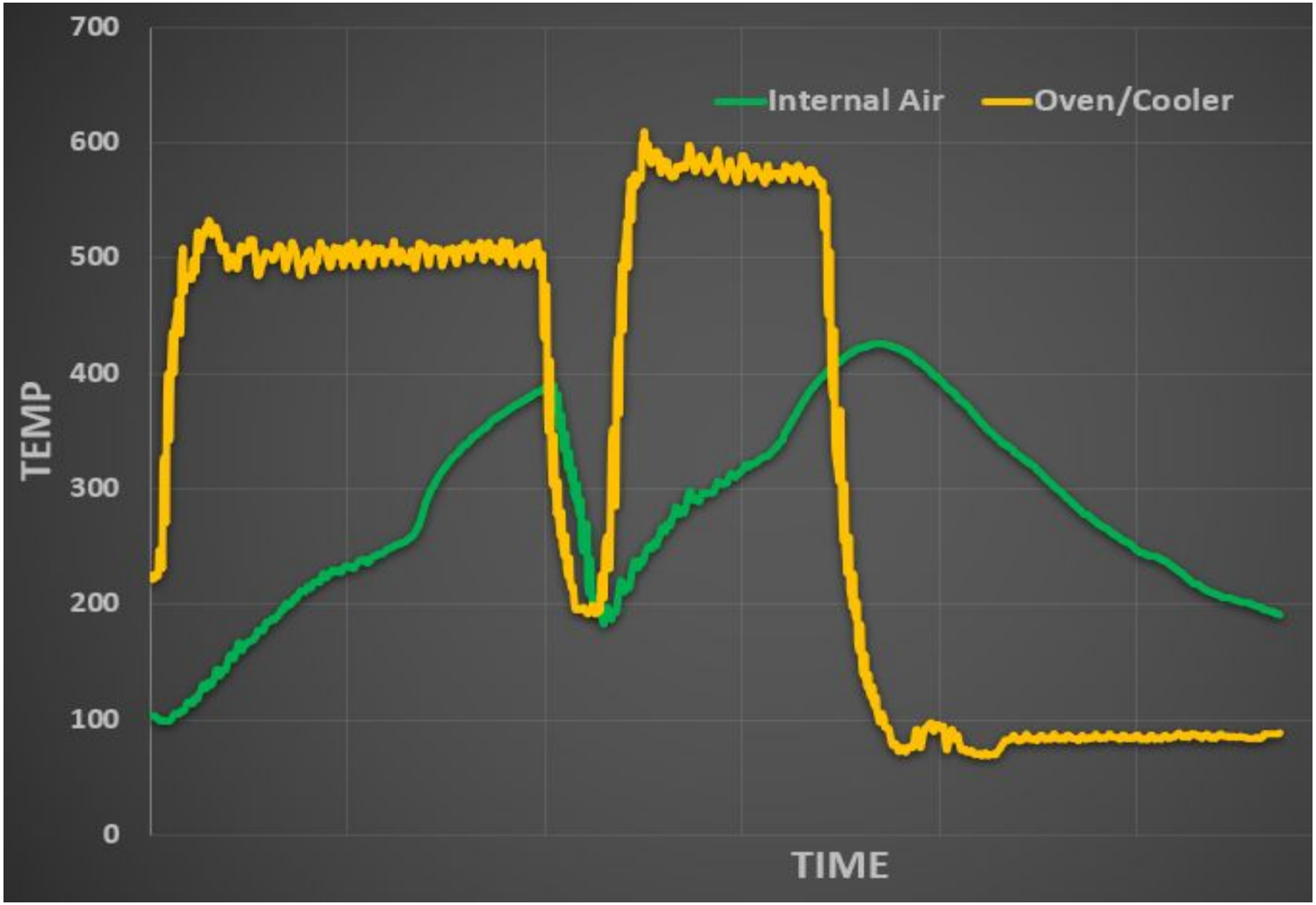
RotoLoPerm® Processing



Crosslink/PA11 Processing

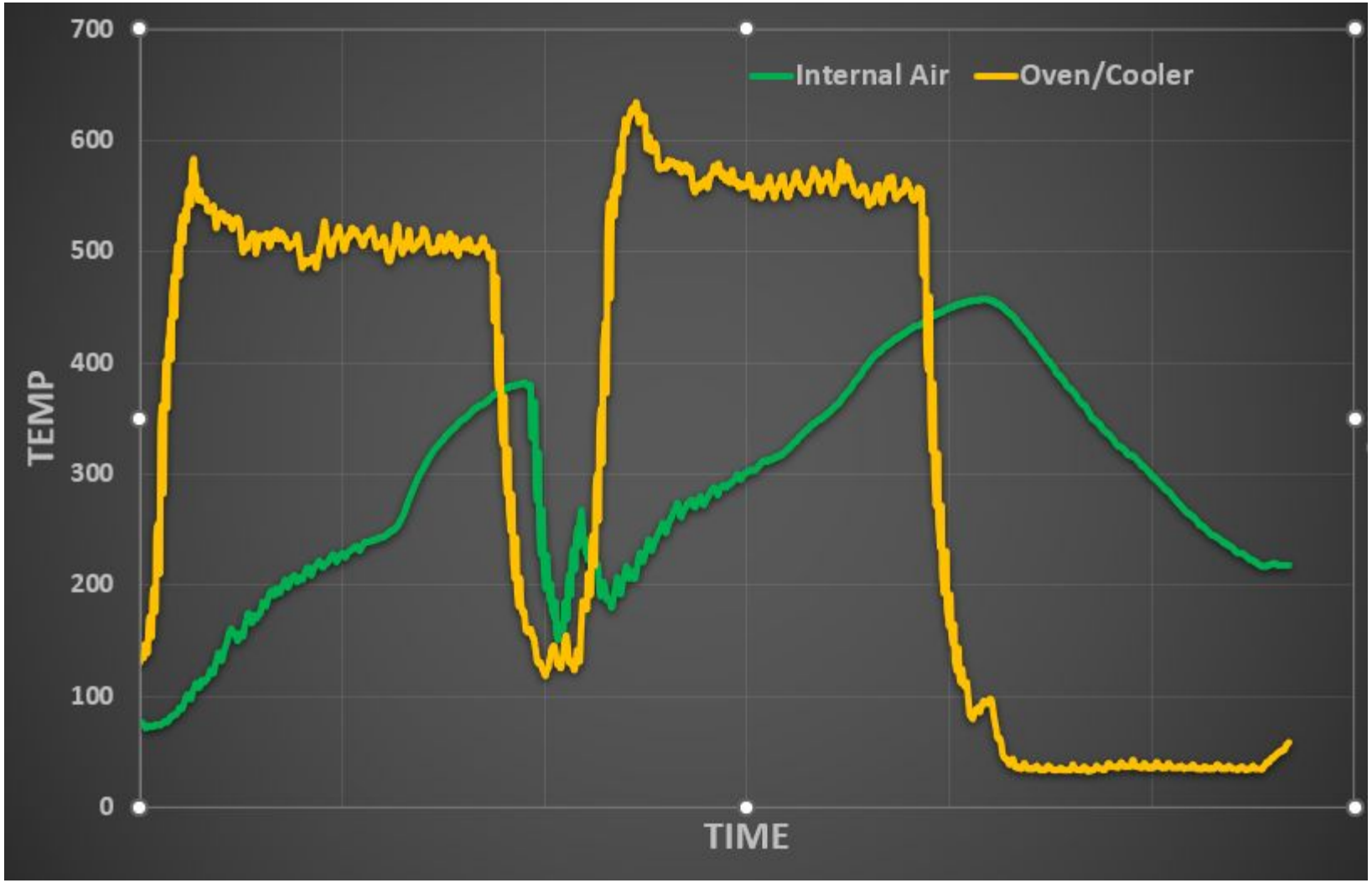
- For hydraulic tanks (to prevent XLPE delamination)
- Reasonably straight forward to mold
- Different heating rates to for each material
- Different shrinkage rates (3 v 2.25)
- Bigger radii helps
- Faster cooling is desirable
- Inter layer of PA11 1.5 – 2mm
- Having different colors for each layer helps
  - Natural/black or black/natural

Crosslink/PA11 – XL11 Cycle



Crosslink/PA11 – Coverage

Crosslink/PA6 – XL6 Cycle



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Thank You!