NOVA Chemicals
Polyethylene

Considerations for Light-Weighting Rotomolded Parts

For the Association of Rotational Molders 2016 Annual Meeting

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Sept 24-27, 2016

New Orleans, LA

Agenda

- Benefits and risks of light-weighting/down-gauging
- Experimental design
- Risk assessment
  - a. ARM impact strength
  - b. Side wall stiffness
- Benefit assessment
  - a. Processing speed
  - b. Process window
  - c. Thickness distribution
- Summary
- Appendix- real world example
- Last Word

Light-Weighting

Benefits and risks

Benefits
Lower material cost
Environmental gain (reduce)
Faster processing
Easier transport/handling

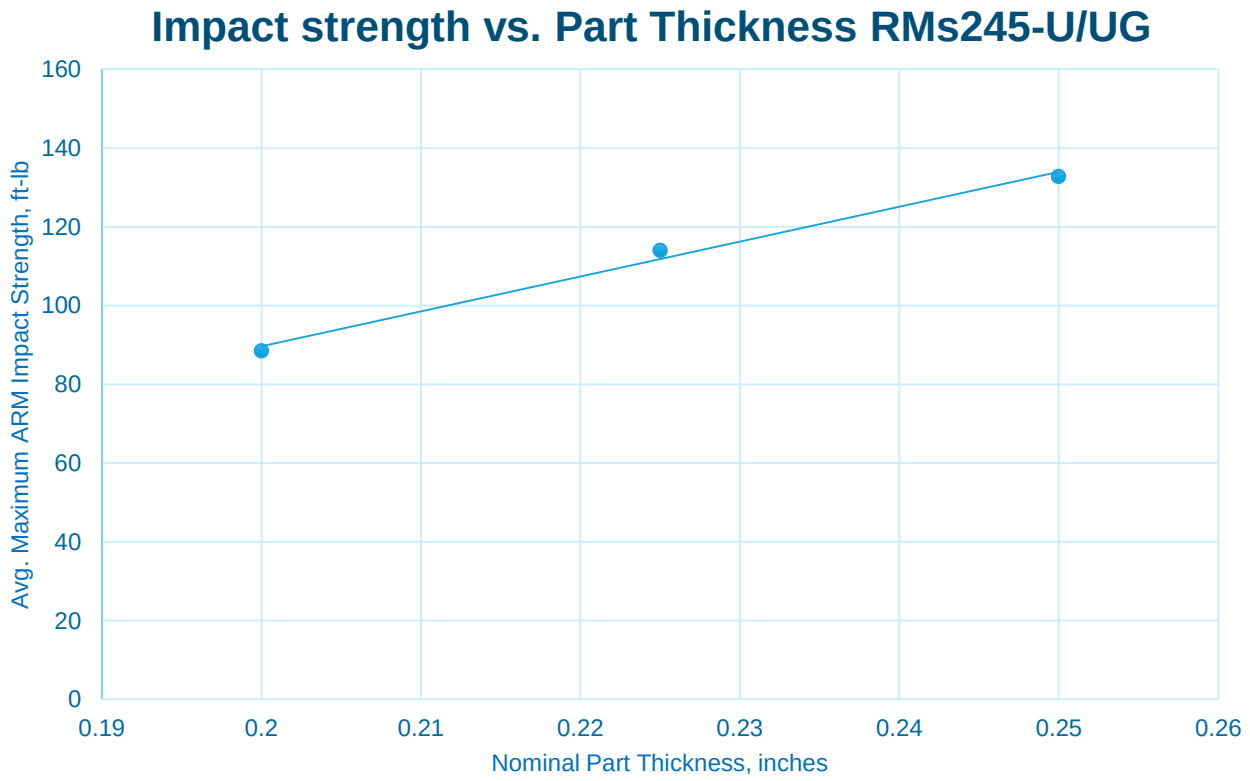
Risks
Reduced impact strength
Reduced side-wall stiffness
Narrow processing window?
May exceed HDB stress recommendation (tank-specific)

Light-Weighting

Study parameters

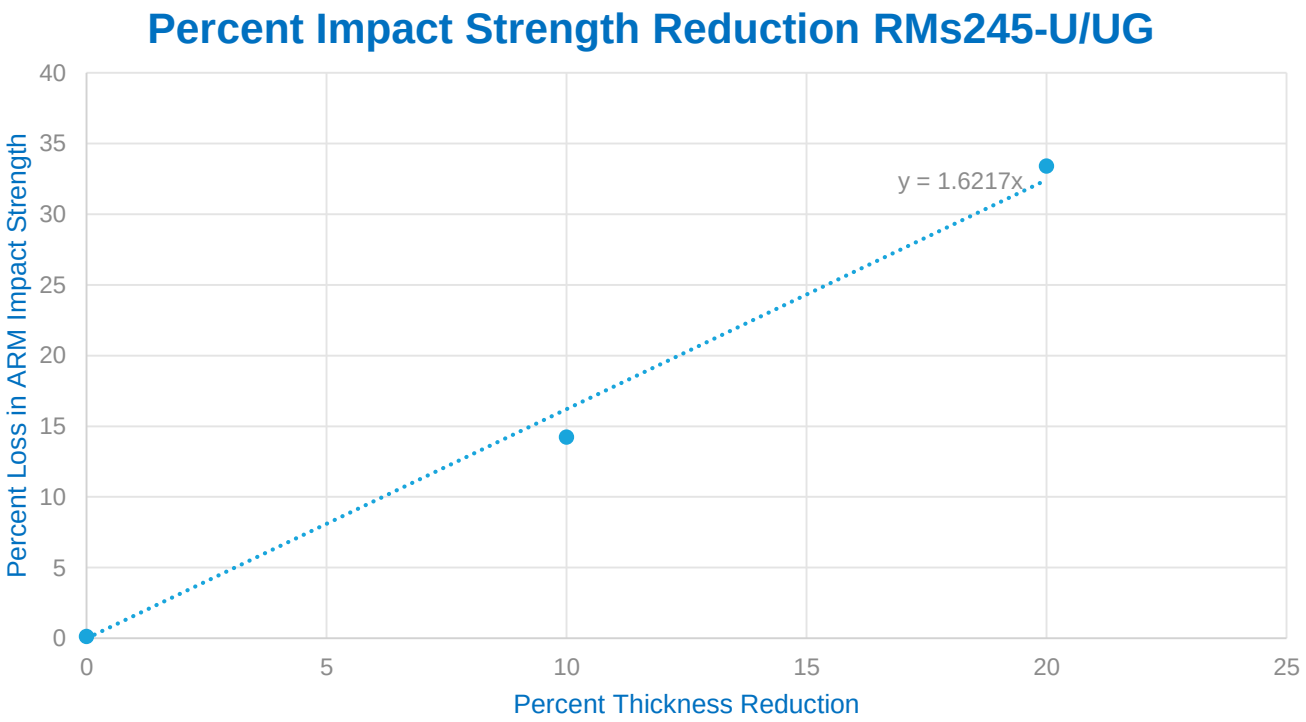
- Conducted in 2016
- 81 parts made and tested on a Ferry RS160
- All tests conducted with RMs245-UG
- 18” cubes; 0.200″, 0.225″, 0.250″ nominal thickness
- 480F, 520 F, 560 F oven temperatures
- Measured LW effects on:
  - ARM impact strength
  - Side-wall stiffness
  - Cycle time
  - Process window
  - Thickness distribution

1. ARM Impact Strength



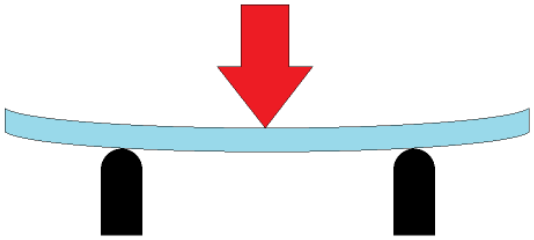
Not surprisingly, impact strength decreases with decreasing part weight

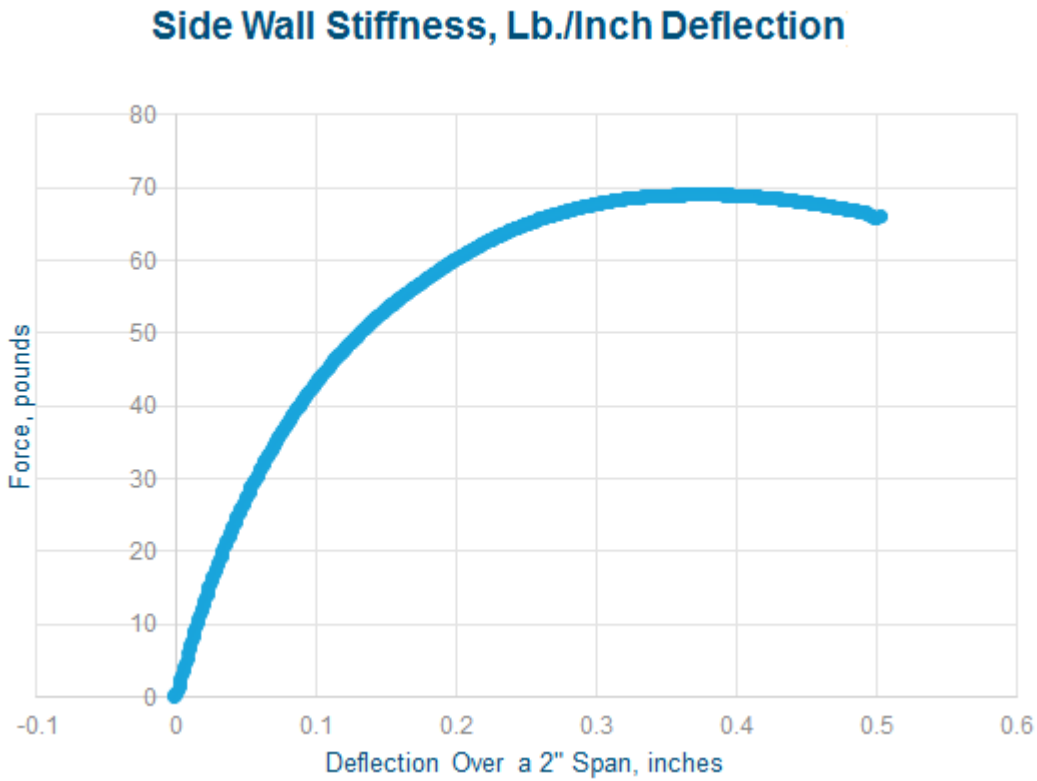
1. ARM Impact Strength



Expressed in percentage terms, a 10% reduction in weight/ thickness costs about 16% in peak impact strength over the thickness range tested.

2. Side Wall Stiffness





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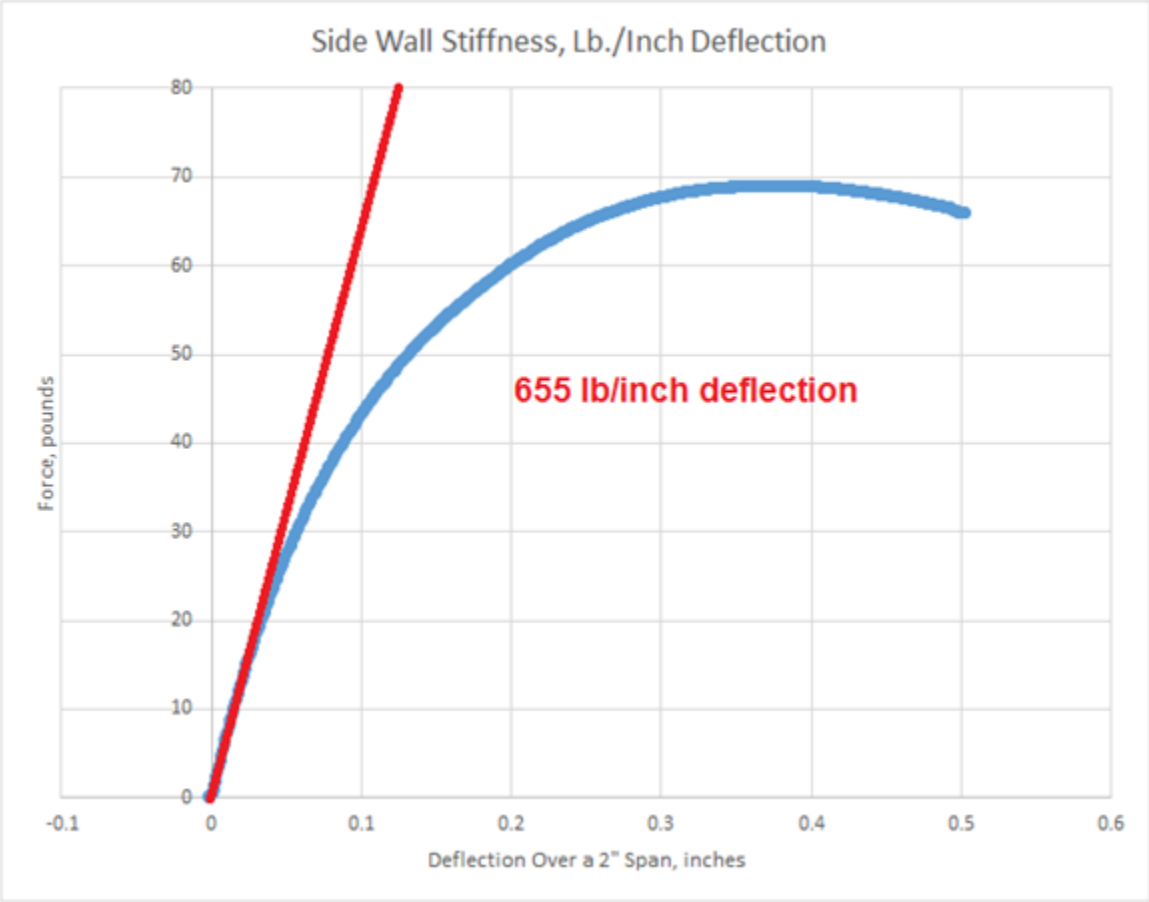
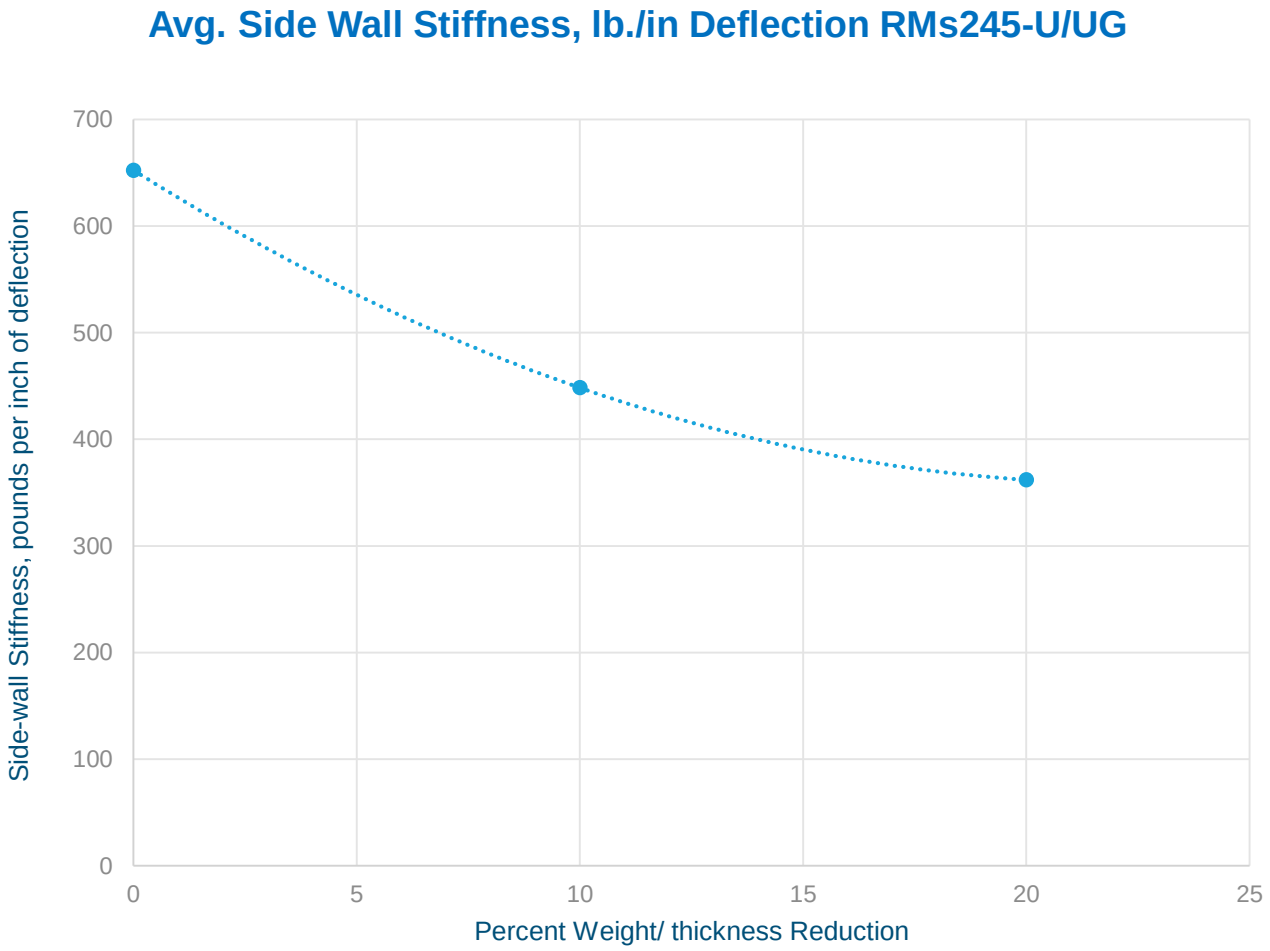
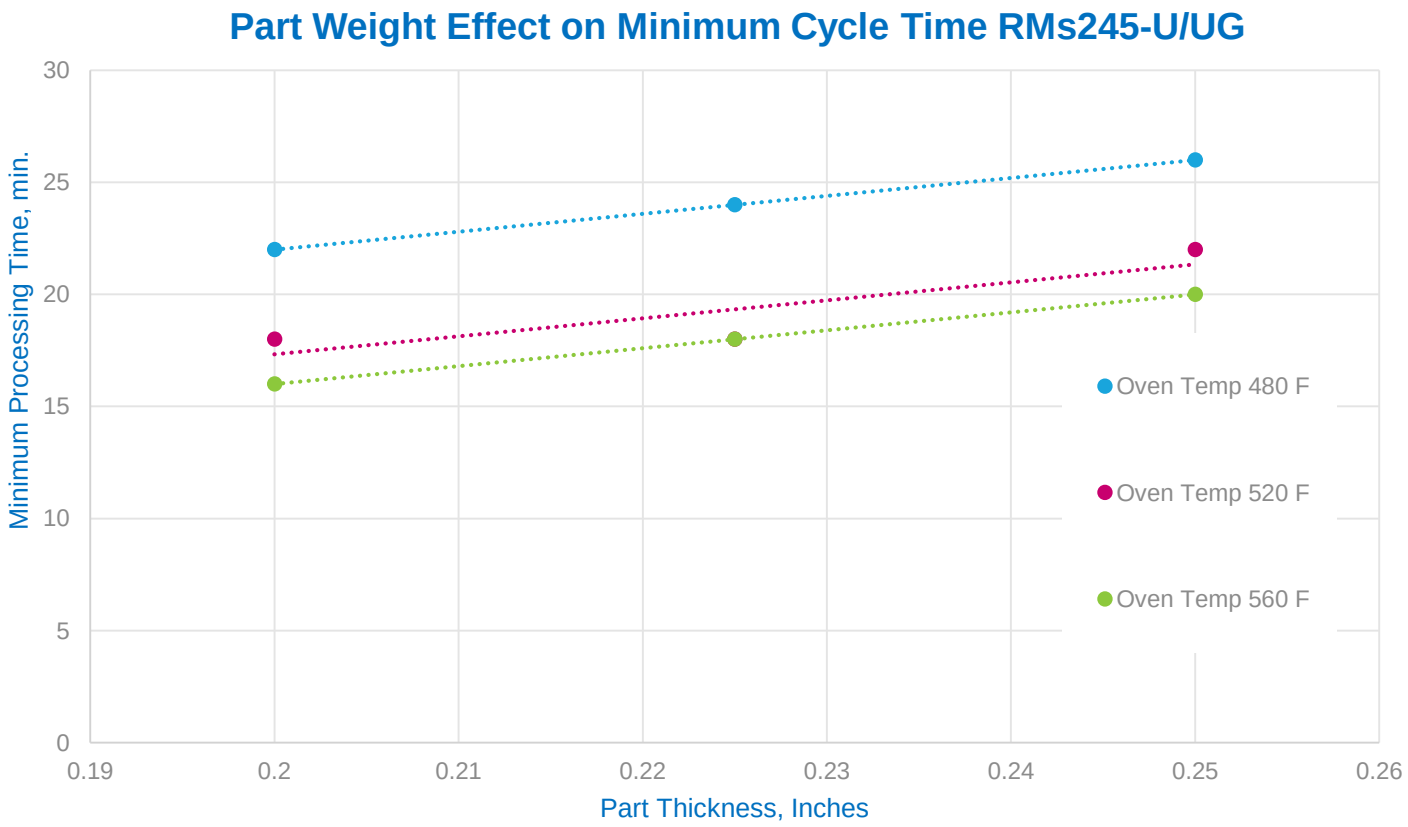


2. Side Wall Stiffness

- First 10% weight reduction= 31% loss of apparent stiffness
- First 20% weight reduction= 44% loss of stiffness



3. Process Speed (minimum cycle time)



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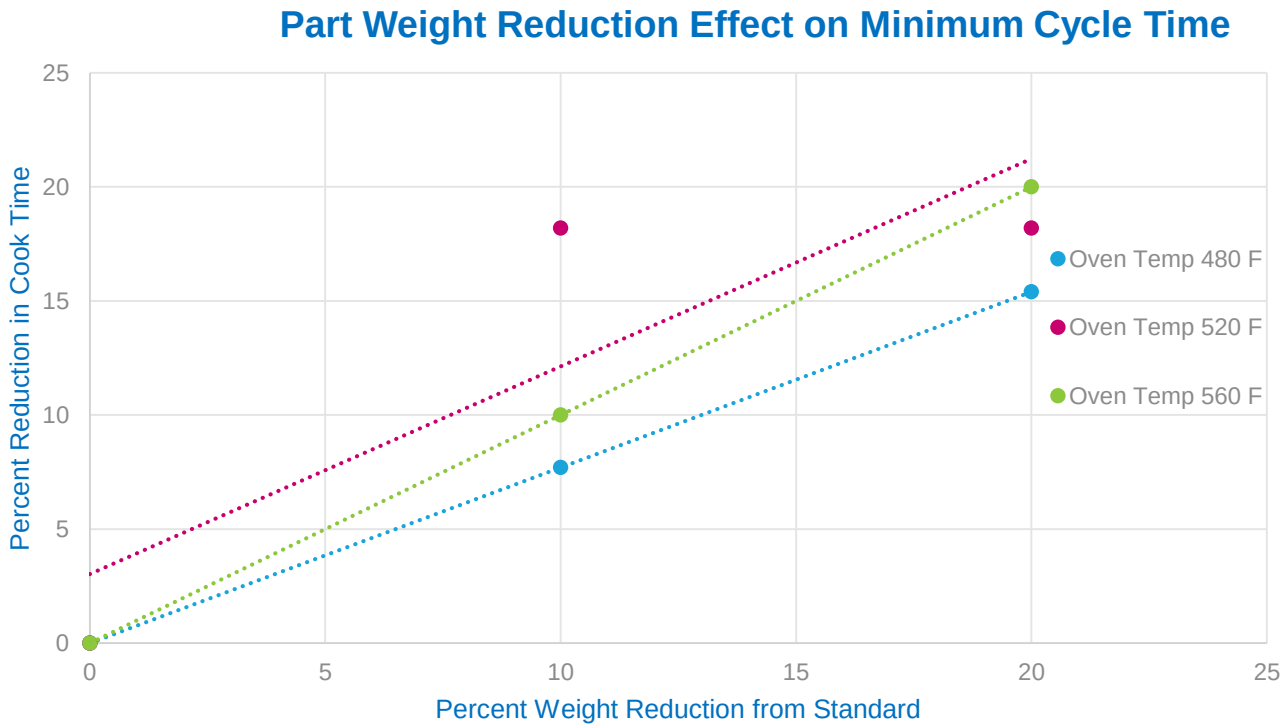
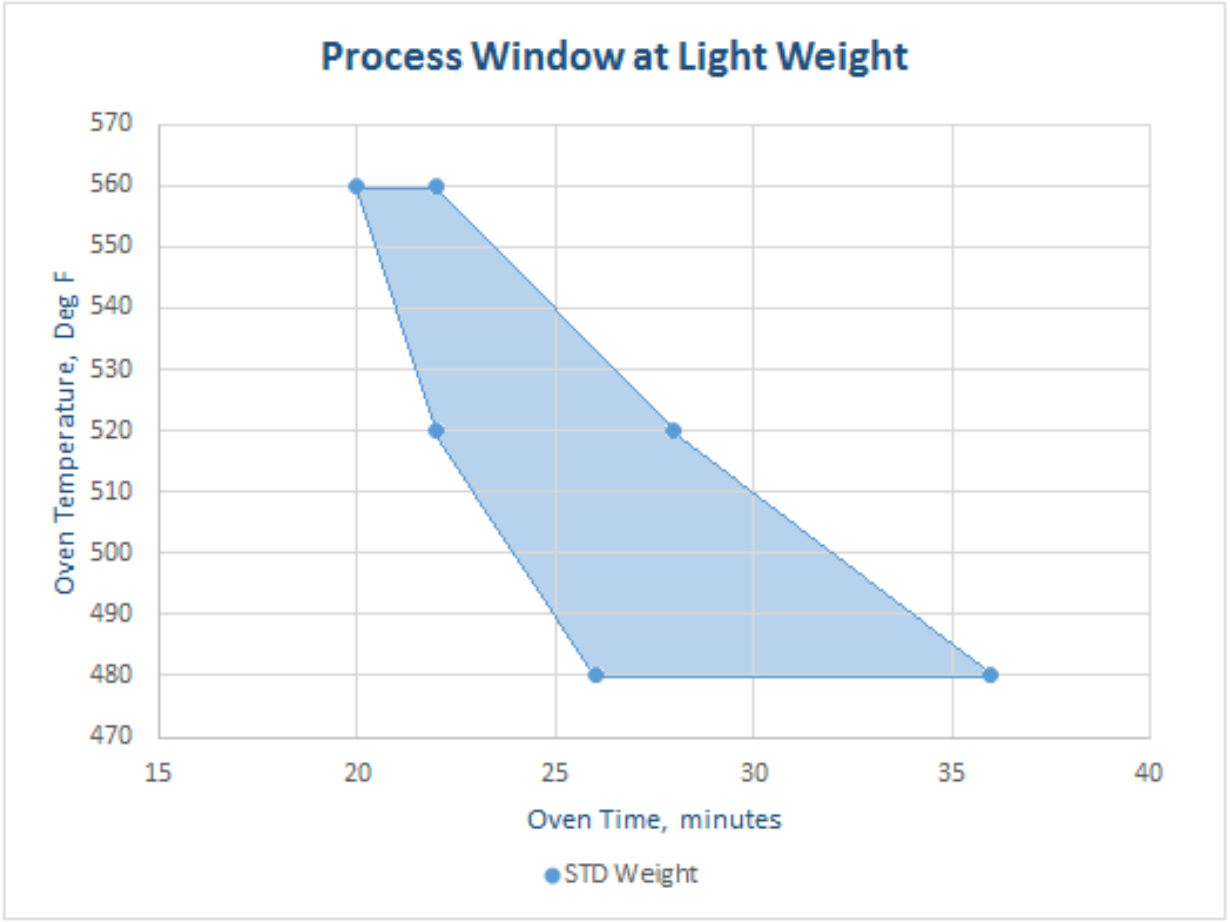
3. Process Speed (minimum cycle time)



7-12% cook time reduction seen per 10% weight/ thickness reduction

4. Process Window

- Fin diagram
- Shaded area is process envelope at a given weight
- >50% ductility, >50% max impact strength
- All data RMs245-U/UG, 18” cubes



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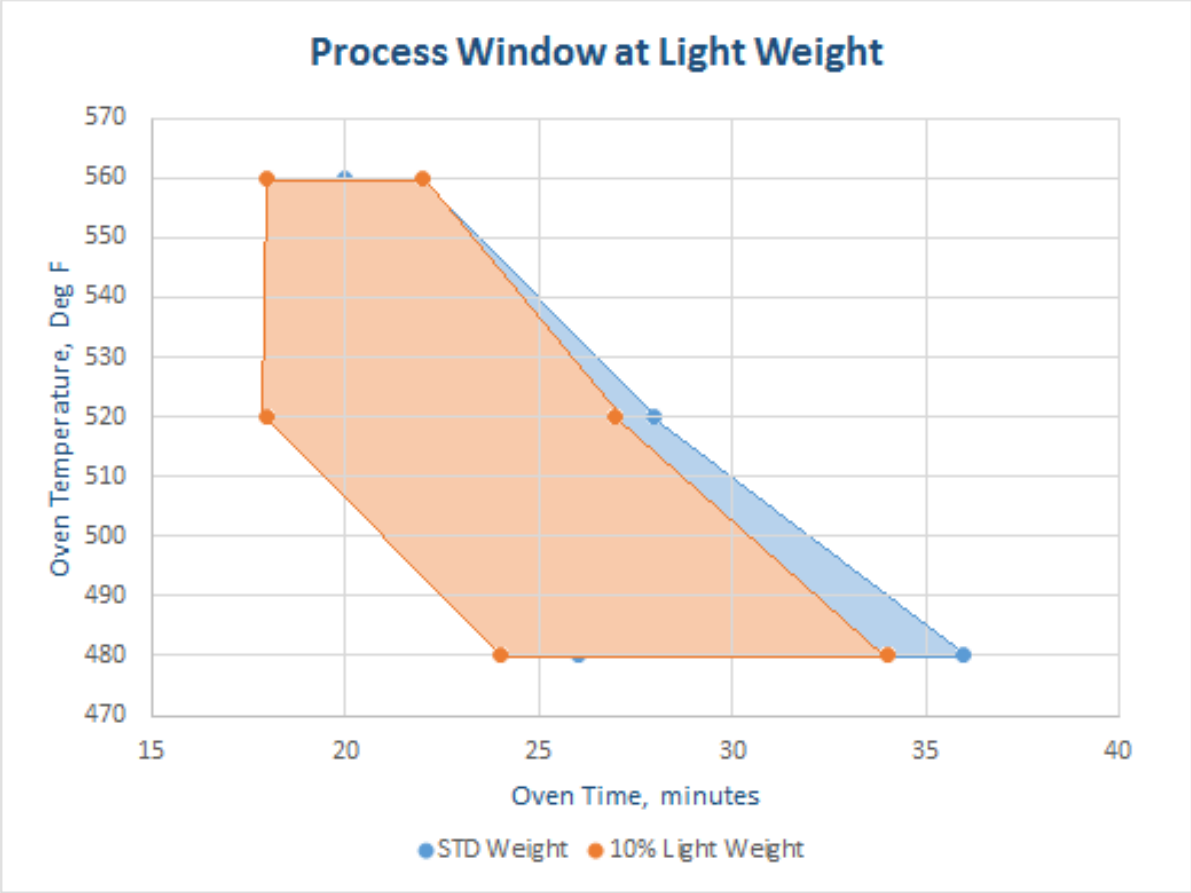
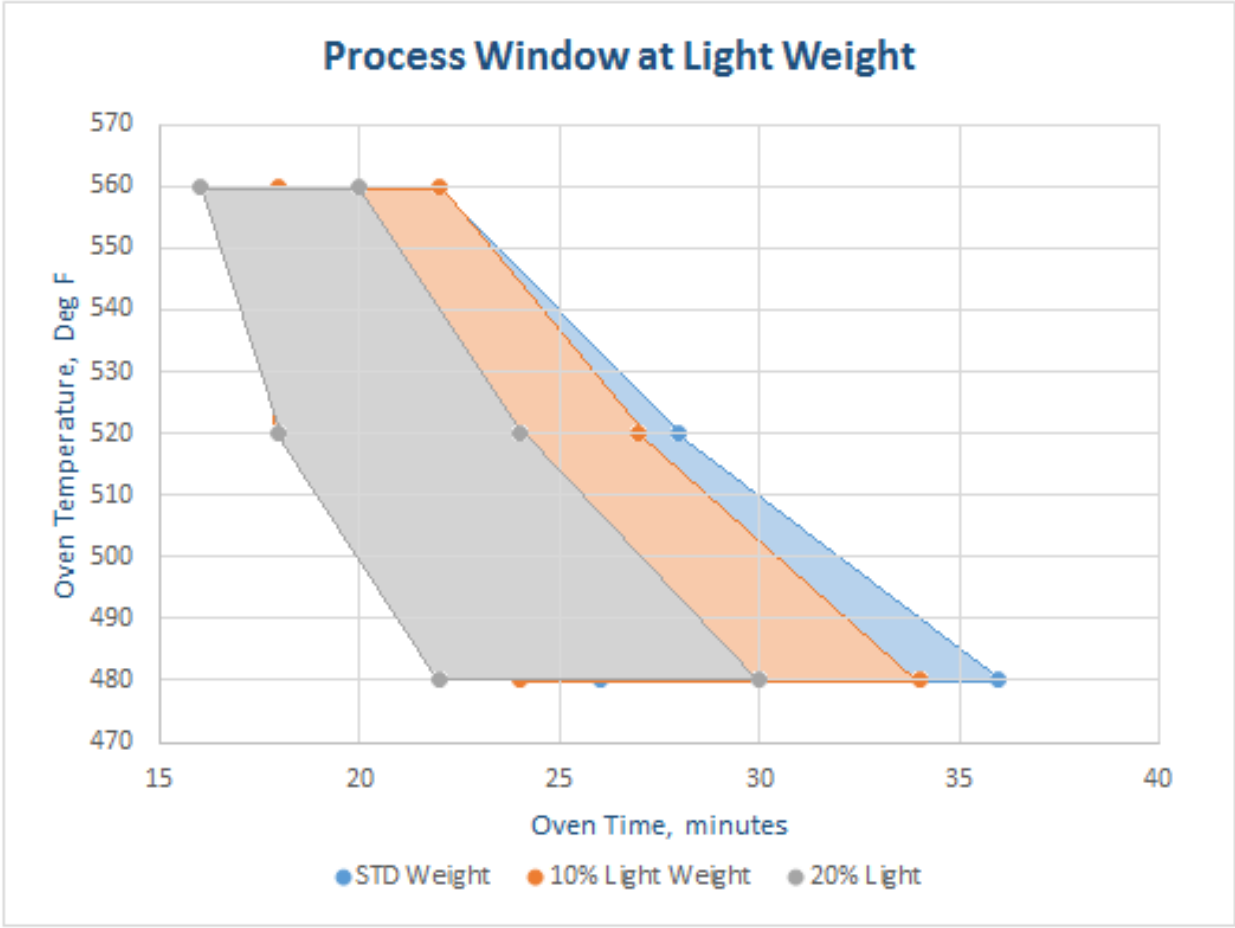


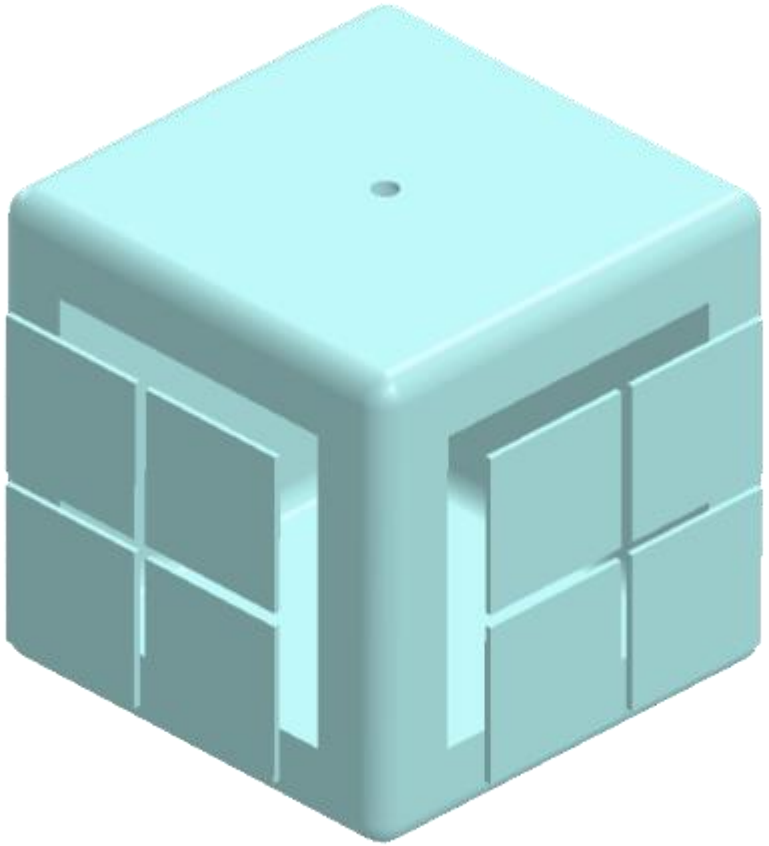
4. Process Window

- Lighter weight move to left (shorter times), but window stays wide.
- Broad rule of thumb: 10% light weight saves about 7% (2 minutes in our case) from cycle time.



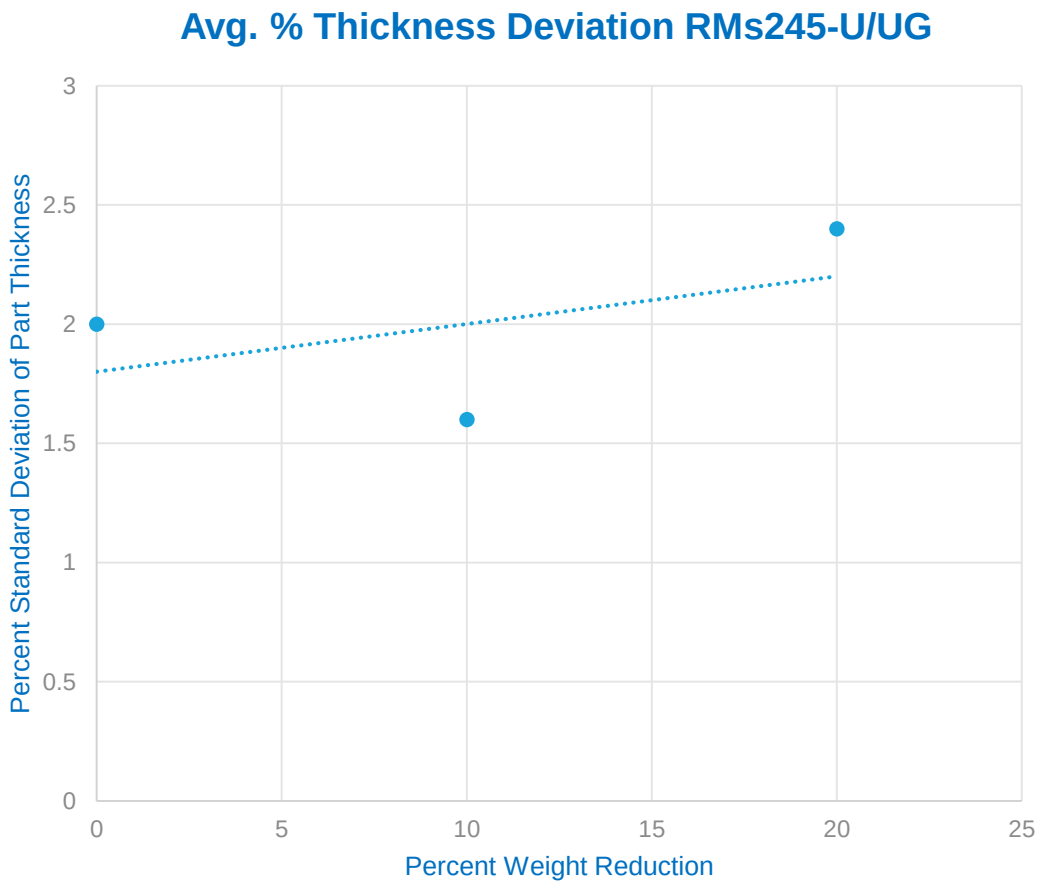
5. Thickness Distribution

- Impact samples measured, four per face.
- Standard deviations expressed as % of nominal thickness.
- Corners not measured.



5. Thickness Distribution

- No significant correlation seen.
- Note: side walls measured, not corners.



Summary-Consequences of Light-Weighting

Benefits
Lower material cost, environmental gain, easier transport/handling
Faster processing, 7-12% shorter oven time/ 10% weight reduction
No process window reduction
No detriment seen to wall thickness distribution

Risks
Lower impact strength, 1.5 X % weight reduction
Significant loss of side-wall stiffness, 2-3 X weight reduction
May exceed HDB stress recommendation (tank-specific)

Mitigation
Impact: Define impact needs. Reduce sharp corners and stress risers. If maintaining toughness is important, use high-toughness resin
Stiffness: Design stiffeners (ribs, creases, kiss offs etc.). Use higher-stiffness resins to offset losses
HDB (Tanks): Use high HDB (e.g. 1600 psi rated) resin

Real World Example
Thanks to Dura-Cast Ltd.

275 Gallon Bio-Diesel Tank
Dura-Cast, Ltd.
Lake Wales, Florida

OLD

- 110 pound shot weight
- 20 minute cook at 615º F
- 5-MI MDPE

NEW

- 99-pound shot weight
- 10% (11 pound) weight reduction
- 20 minute cook at 615º F
- RMs245-UG SURPASS® resin

Real World Example

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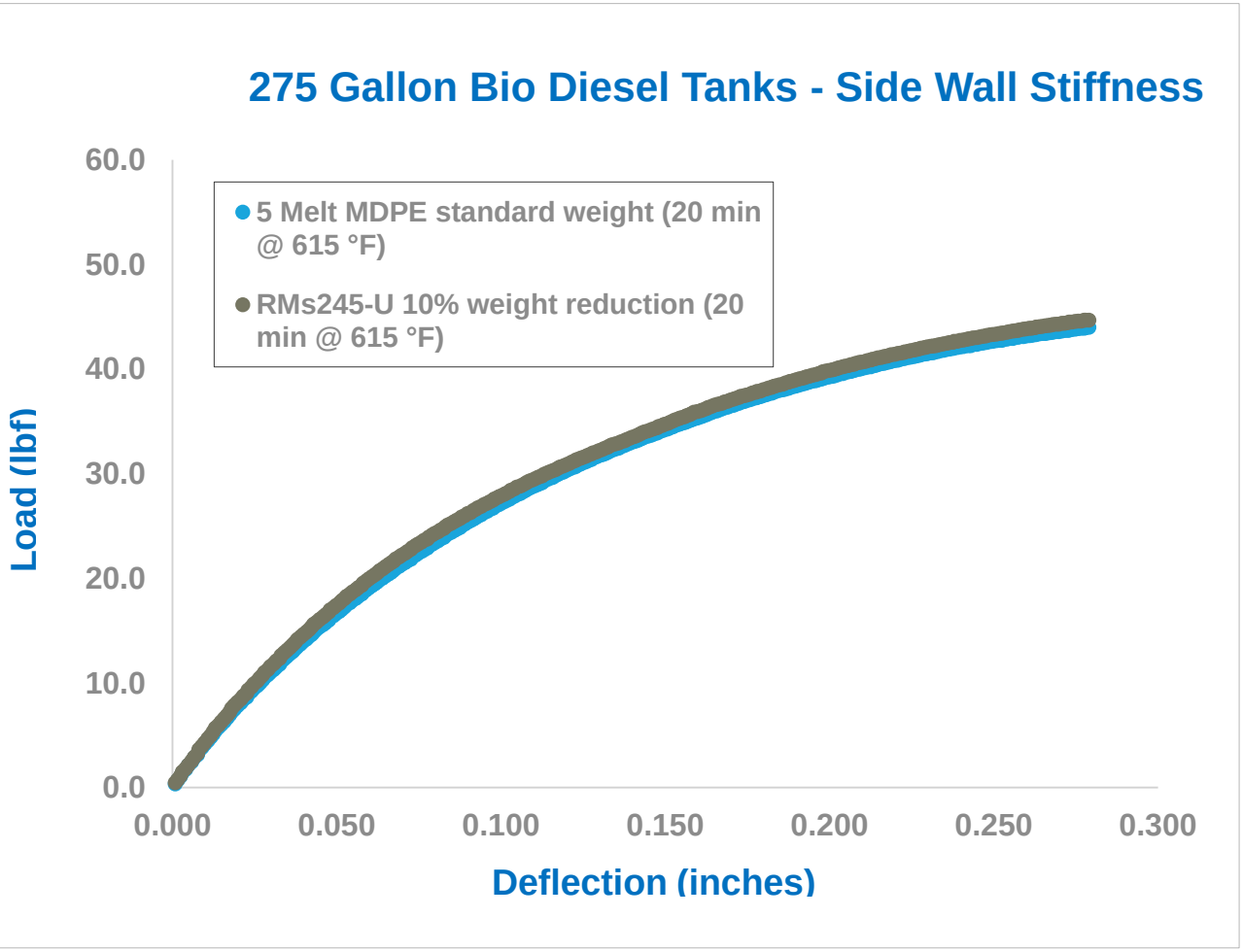

- 10% (11lb.) lighter
- No change in wall stiffness
- No loss in cycle time
- Fully cured, high quality part

Last Words on Light-Weighting

1. **Know the advantages and risks (eyes open).**

2. **Know true part requirements. (what, if anything can you give up, what qualities MUST be retained.)**

3. **Maintain quality by intelligent material substitution.**
   - High stiffness
   - High toughness
   - Lower MI can be offset by processing gains
   - Check HDB ratings (tanks)

4. **One word: Collaborate.**

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