

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?

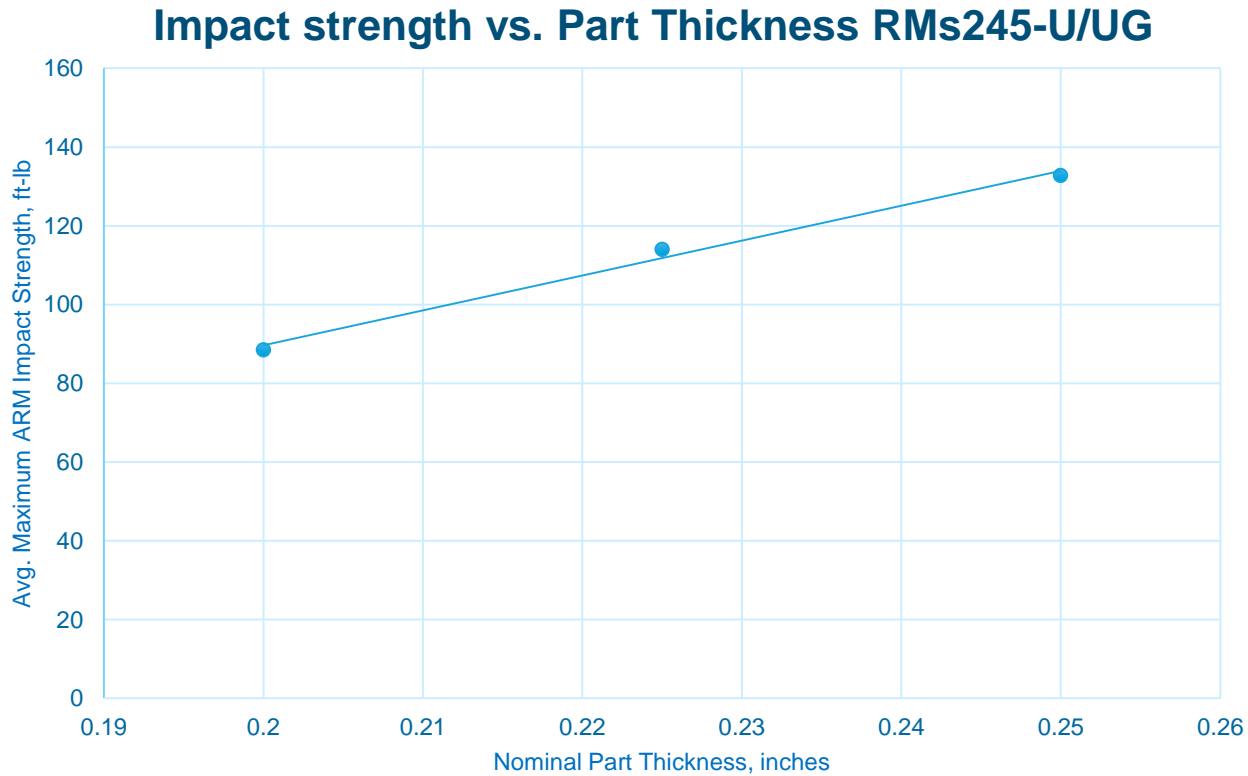
May exceed HDB stress recommendation (tank-specific)

Light-Weighting

Study parameters

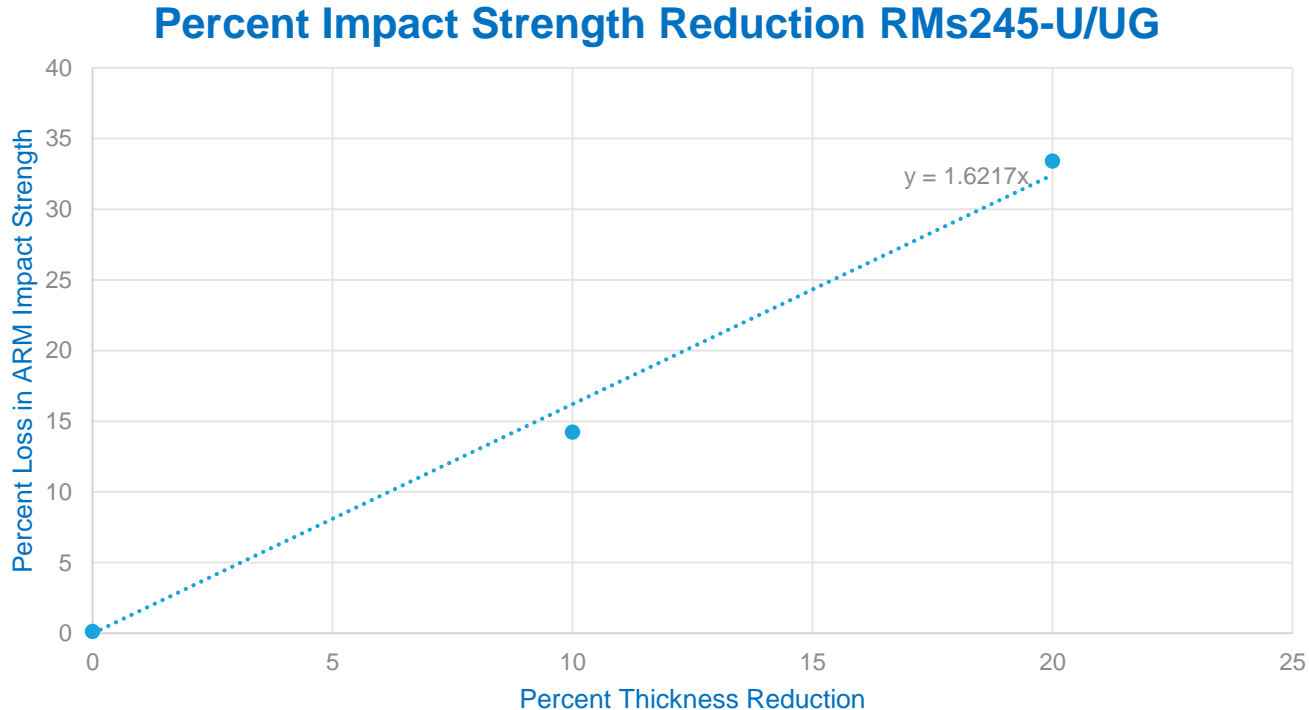
- Conducted in 2016
- 81 parts made and tested on a Ferry RS160
- All tests conducted with RMs245-UG
- 18" cubes; 0.200", 0.225", 0.250" nominal thickness
- 480F, 520 F, 560 F oven temperatures
- Measured LW effects on:
 - ARM impact strength
 - Side-wall stiffness
 - Cycle time
 - Process window
 -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

1. ARM Impact Strength



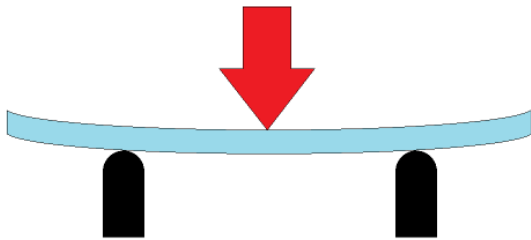
Not surprisingly, impact strength decreases with decreasing part weight

1. ARM Impact Strength

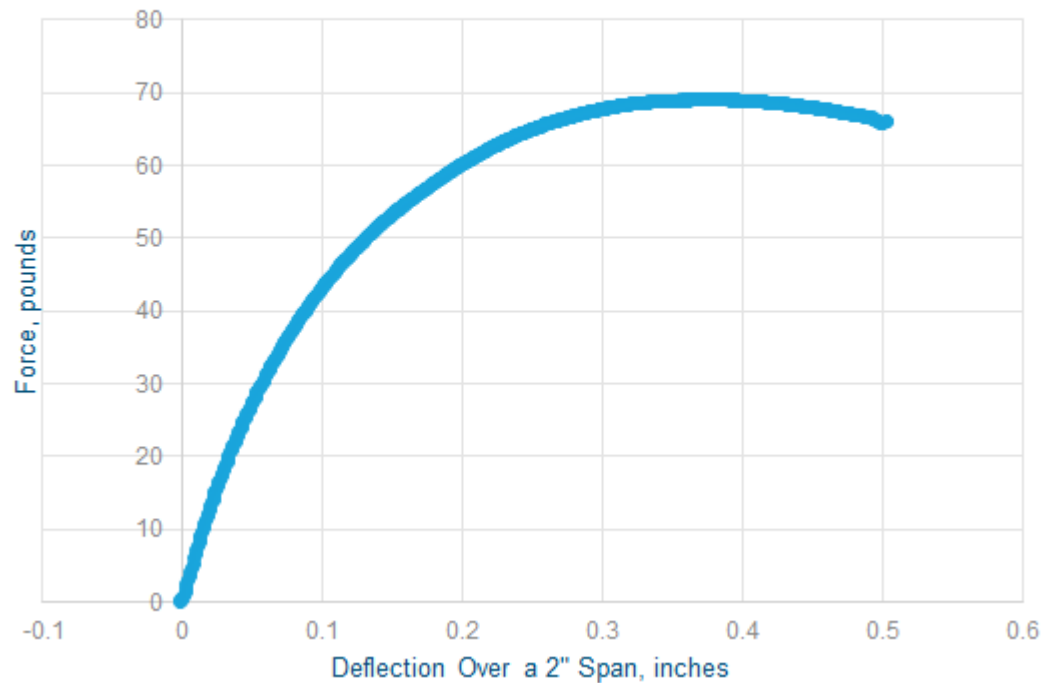


Expressed in percentage terms, a 10% reduction in weight/ thickness costs about 16% in peak impact strength over the thickness range tested.

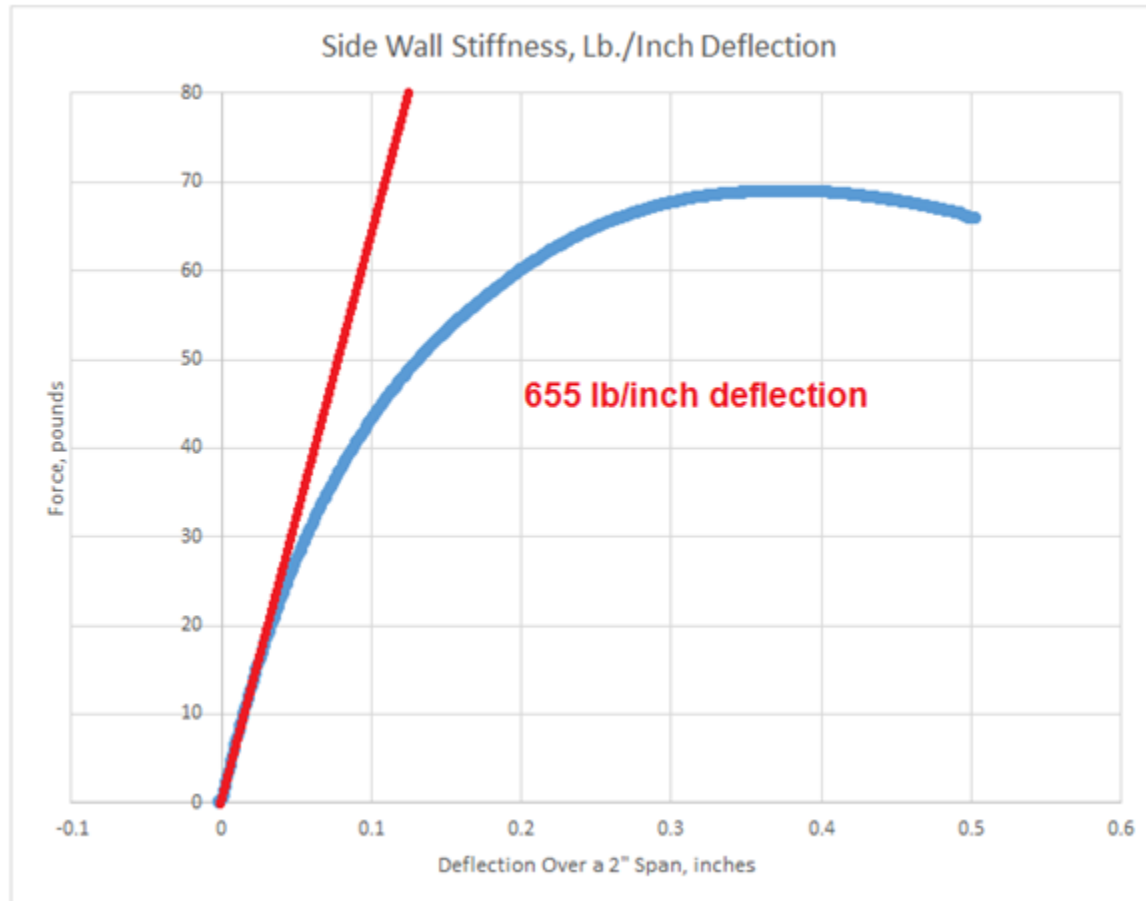
2. Side Wall Stiffness



Side Wall Stiffness, Lb./Inch Deflection



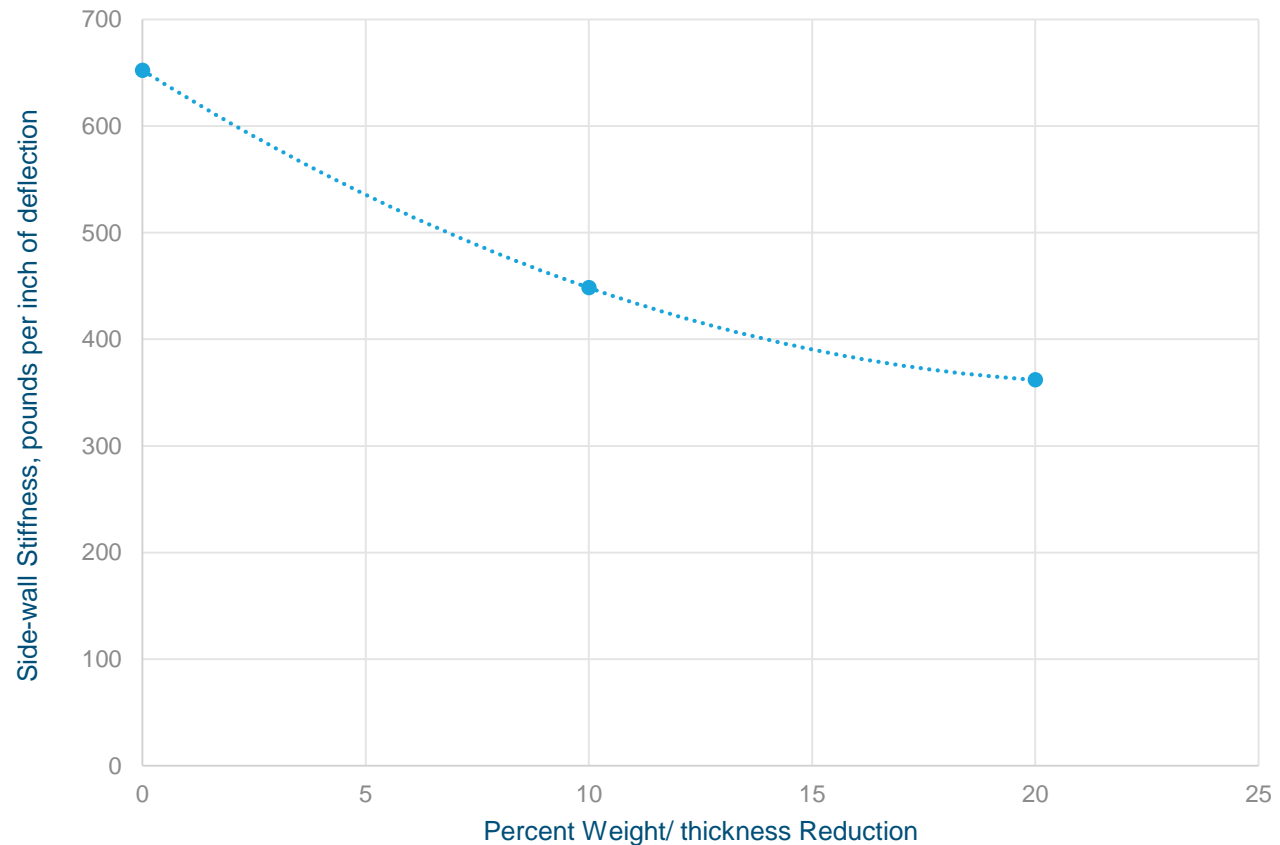
2. Side Wall Stiffness



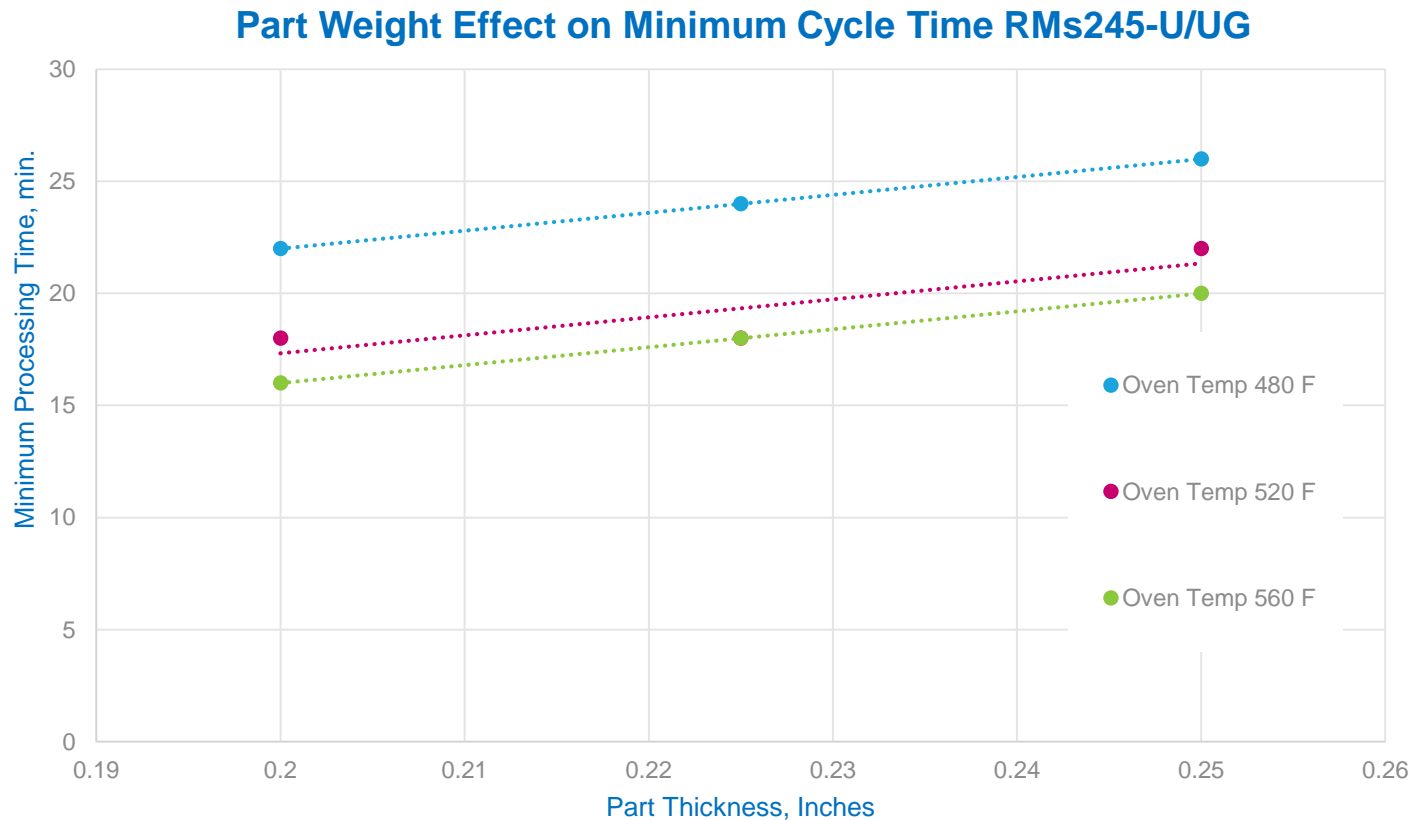
2. Side Wall Stiffness

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

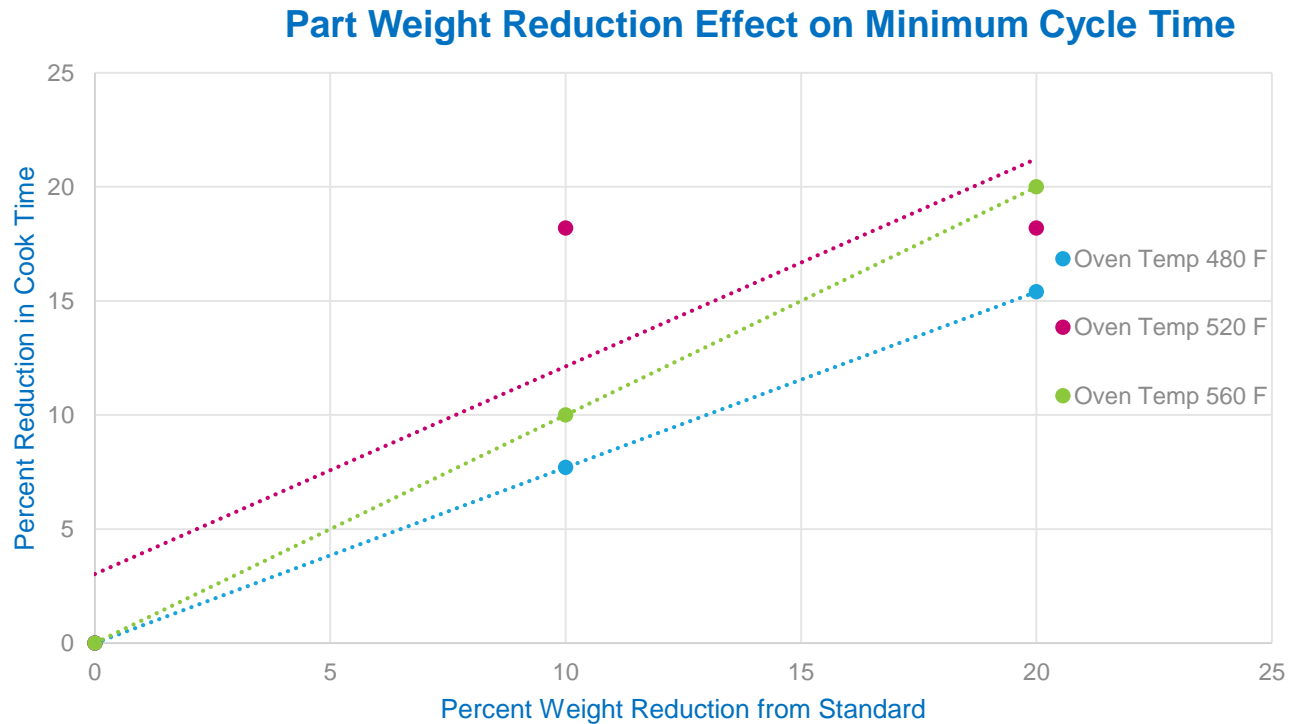
Avg. Side Wall Stiffness, lb./in Deflection RMs245-U/UG



3. Process Speed (minimum cycle time)



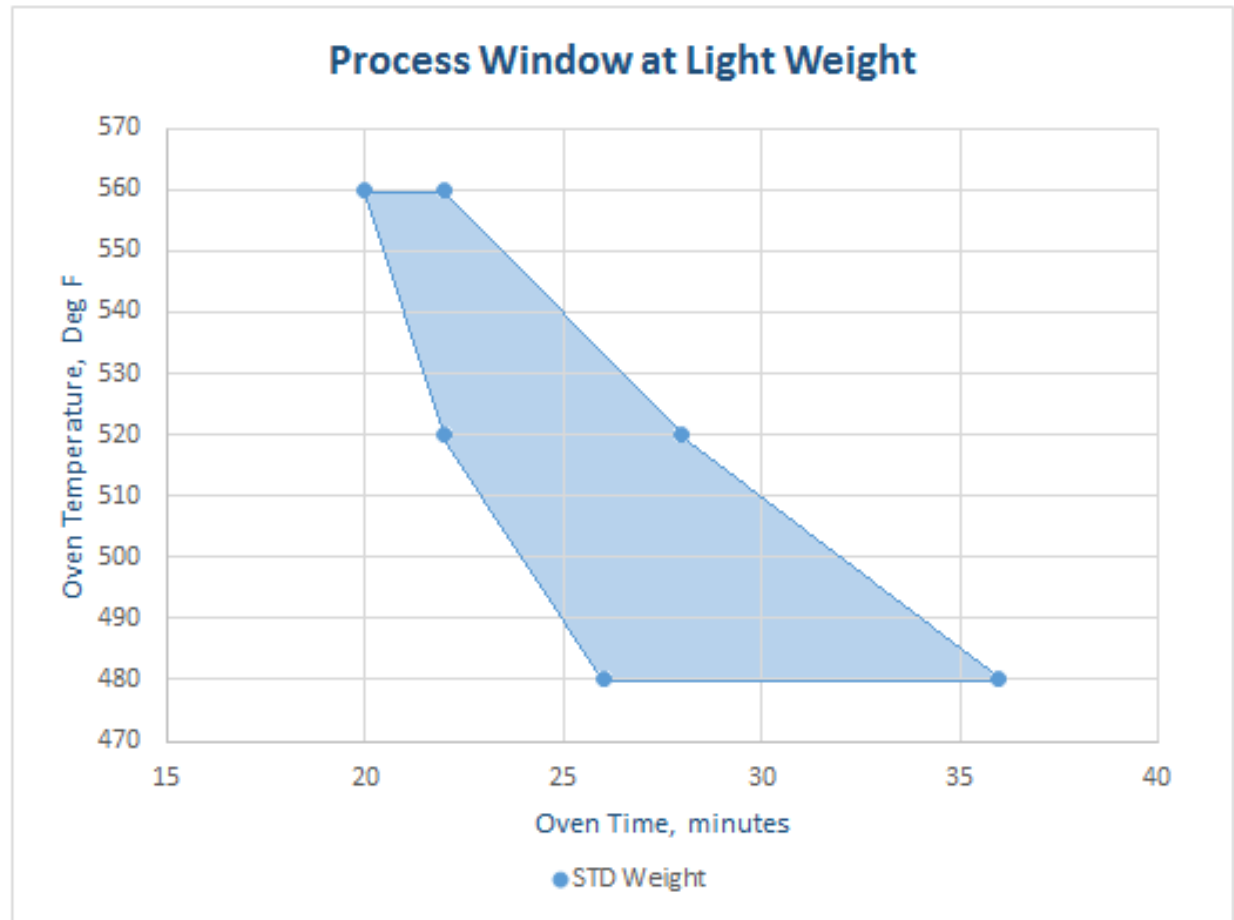
3. Process Speed (minimum cycle time)



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

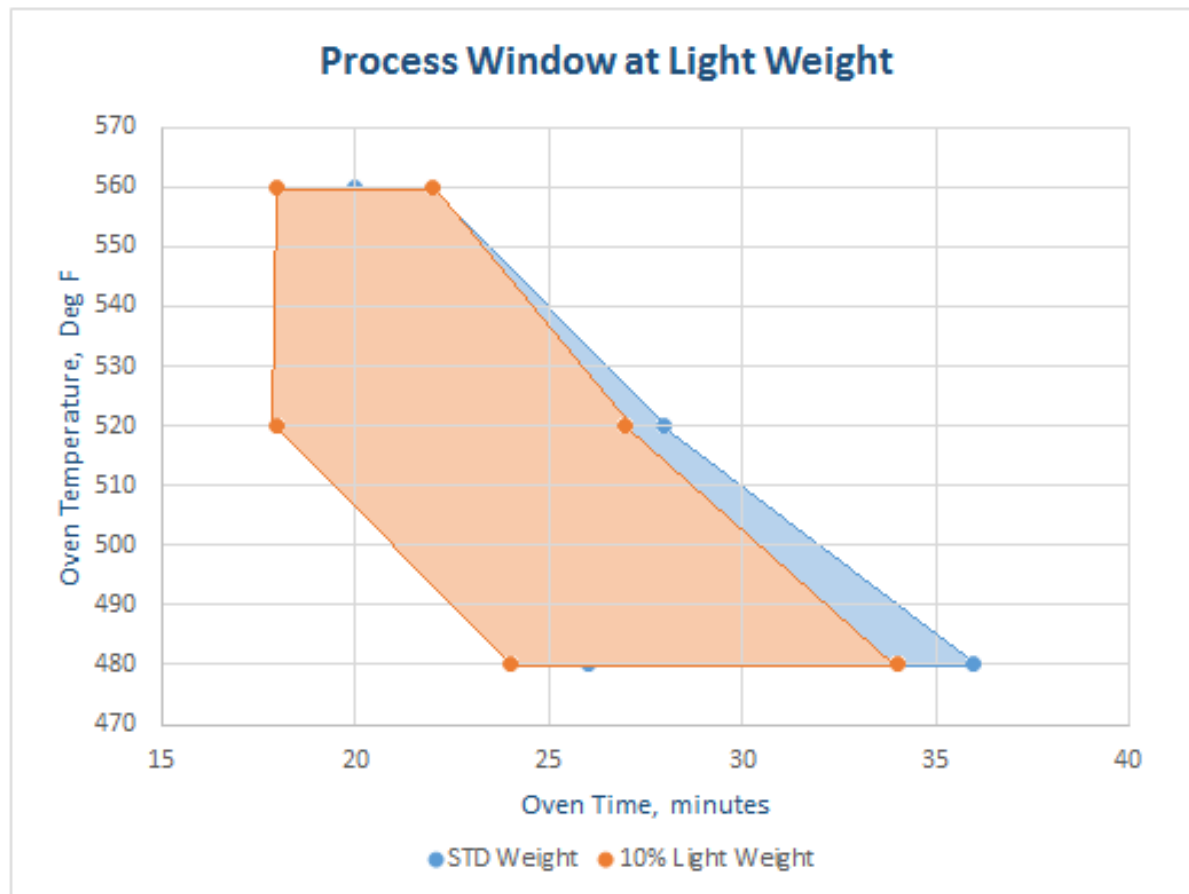
4. Process Window

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



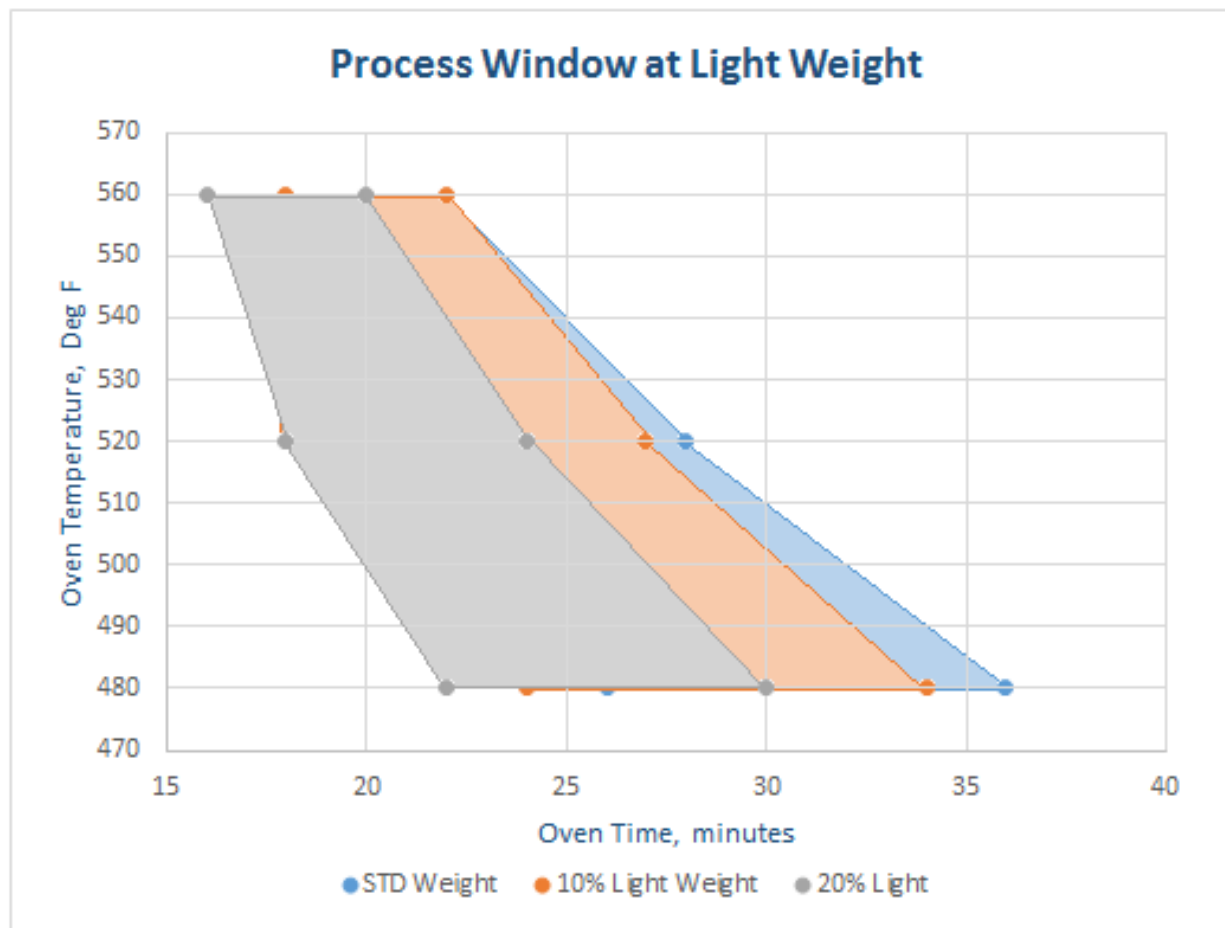
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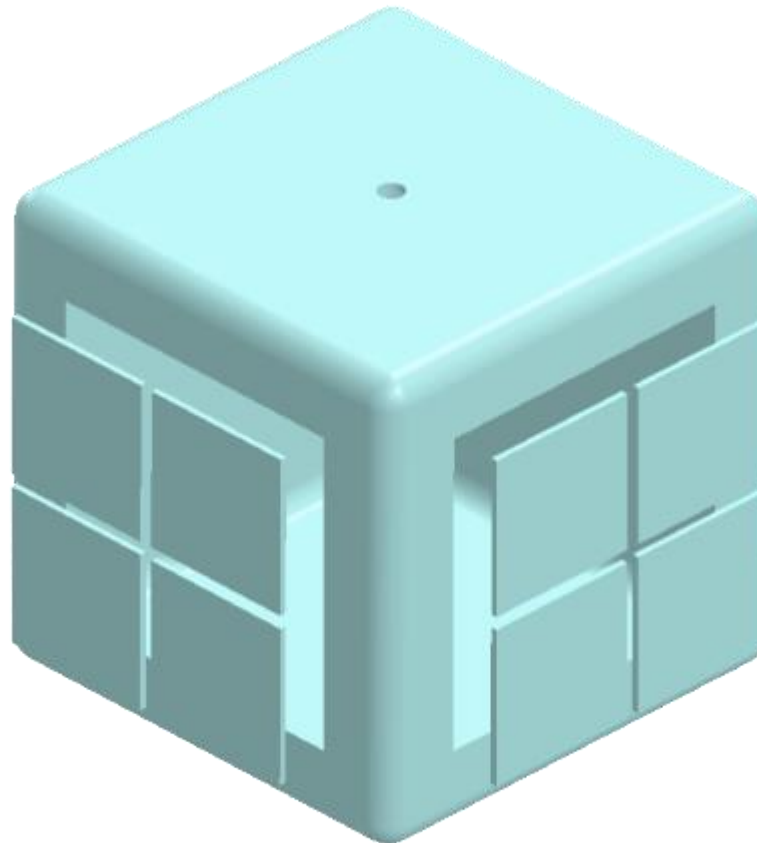
4. Process Window

- 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.



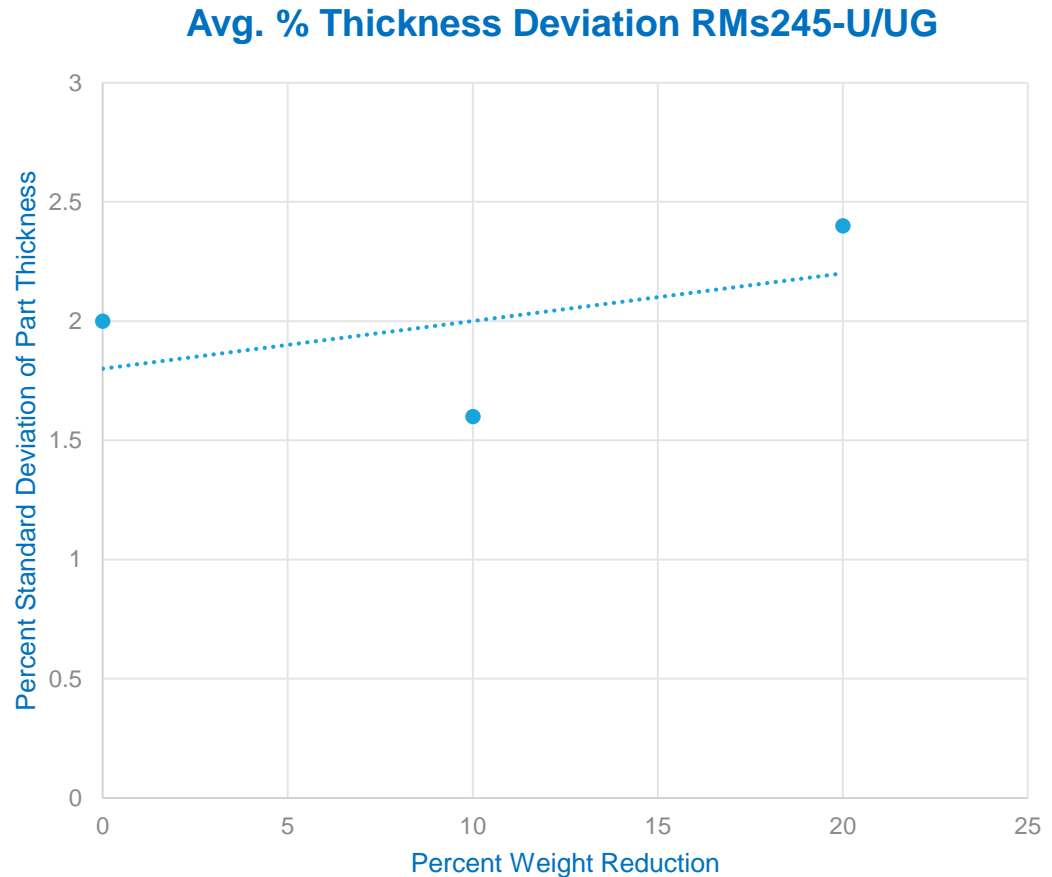
5. Thickness Distribution

- 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 615° F
- 5-MI MDPE

NEW

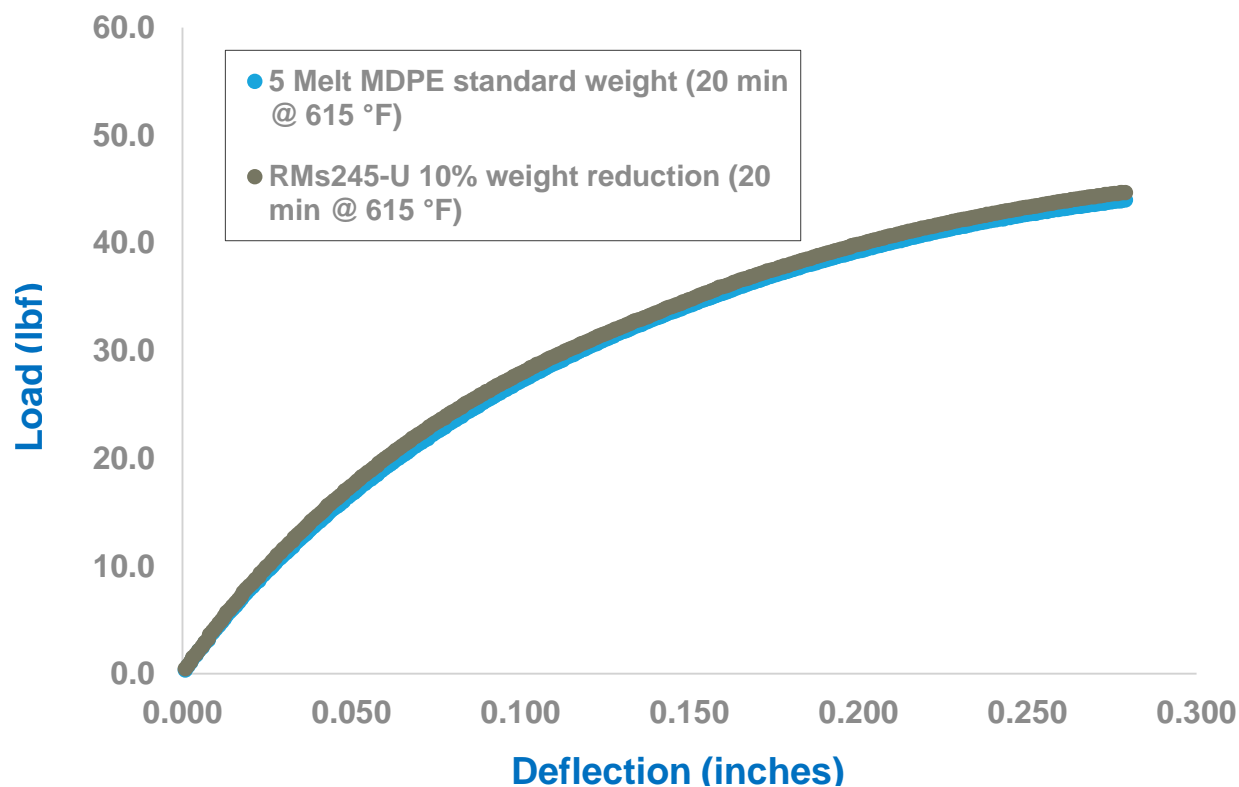
- 99-pound shot weight
- 10% (11 pound) weight reduction
- 20 minute cook at 615° F
- RMs245-UG SURPASS® resin



Real World Example

Thanks to Dura-Cast Ltd.

275 Gallon Bio Diesel Tanks - Side Wall Stiffness



- 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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