

Process Modelling in Rotomolding – Practical Benefits and More

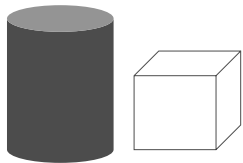


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I Want To Rotomold a New Product But...

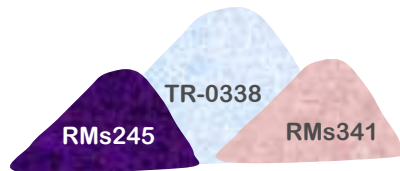
What if we found an easier way?

1 I need to design and make a mold...



❌ TIME
❌ MONEY
❌ RESOURCES

2 I need to find the right material/resin ...



3 I need to find the right process conditions...

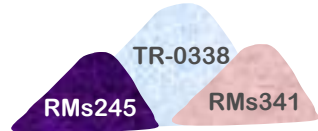
Parameter	Set Point
Oven Temp	?
Cook Time	?
Rotation Speed	?

The solution – Simulation

**** Realize benefits by changing these inputs**

1 - Define Inputs

Material and Powder Properties



Mold Design/Materials



Process Conditions

Parameter	Set Point
Oven Temp	?
Cook Time	?
Rotation Speed	?

2 – Run Designed Simulation

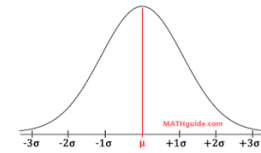


RotoSim™

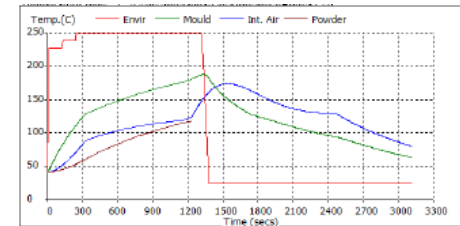
Necessary to Establish Confidence in Simulation and Outputs

3 – Use Outputs to Guide Operations

Thickness Distributions



PIAT Curves/Degree of Cure



How Do We Establish Confidence in our Simulation?

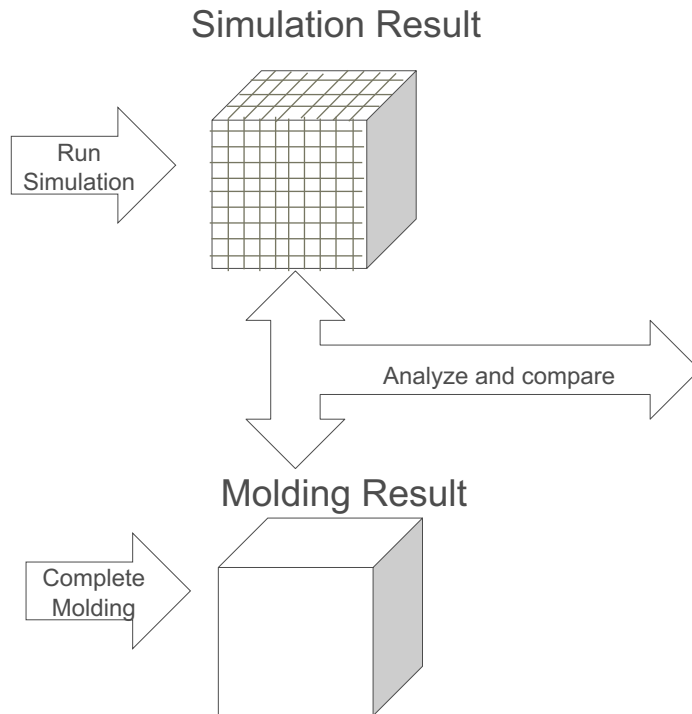
VALIDATION:

Simulation Input:

- Resin = thermal properties, powder size, etc.
- Mold = Size, material, etc.
- Oven temp = Variable
- Oven time = Variable

Experimental molding trial

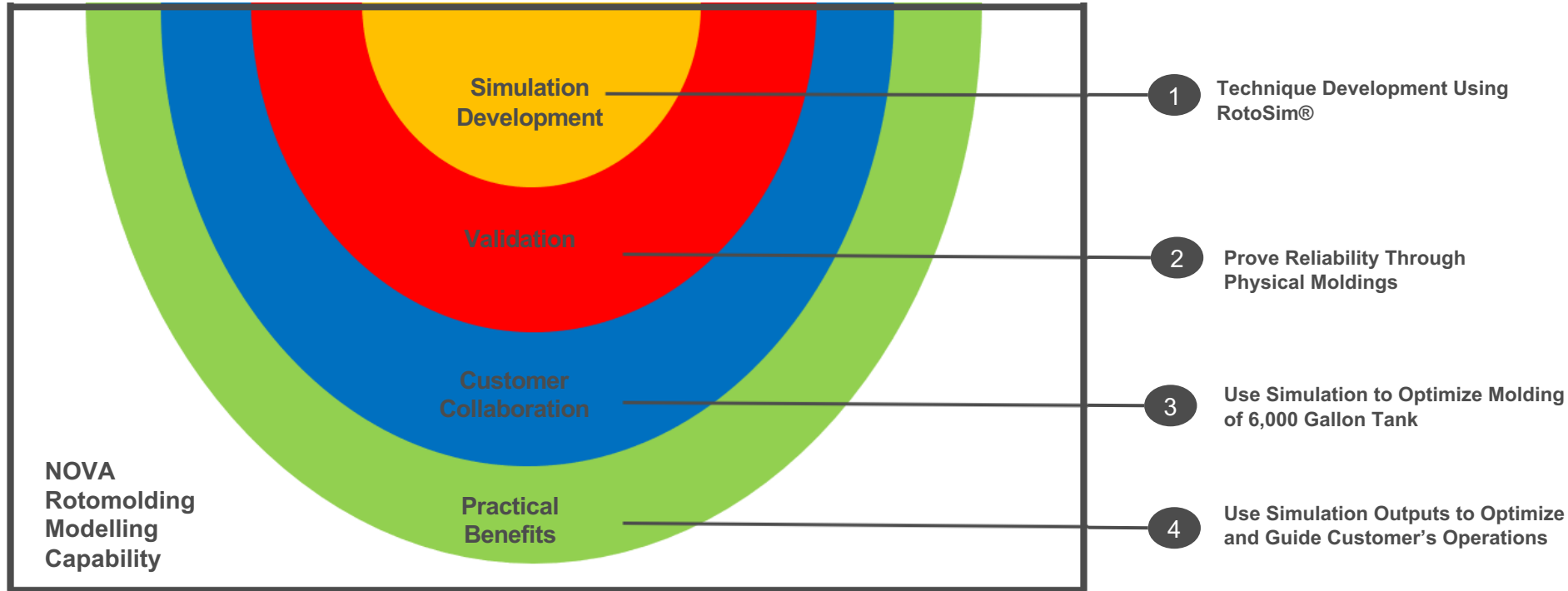
- Resin = RMs245
- Mold = Standard Test Cube
- Oven temp = 520 F
- Oven time = 18 minutes



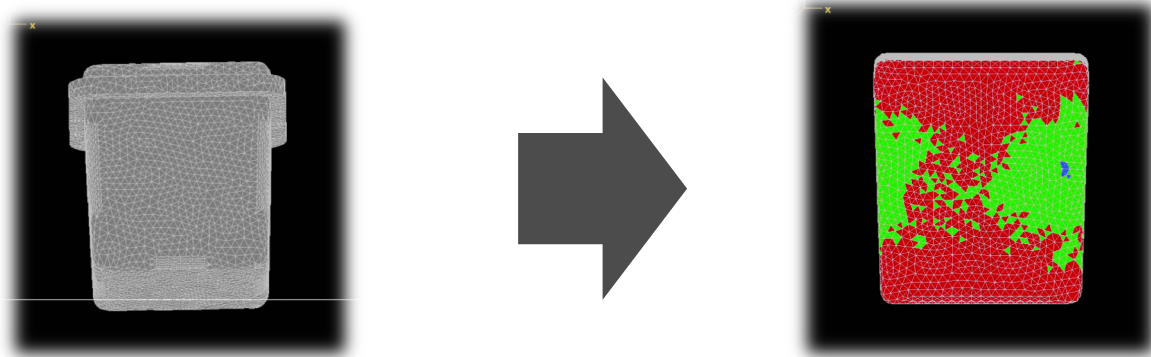
Property	Simulation	Real life
As-molded Density	0.9462	0.9459
Thickness Variation	0.015"	0.012"
Degree of Cure	1233	1400
PIAT	380 F	410 F

What Objectives did we set out for?

SIMULATION SERVICE MODEL FOR NOVA CUSTOMERS



Step One: Set up Simulation with RotoSim®



1. Material Data:

- SURPASS® RMs245
- Density = 0.945 g/cc
- Melting point = 267 °F
- Etc.

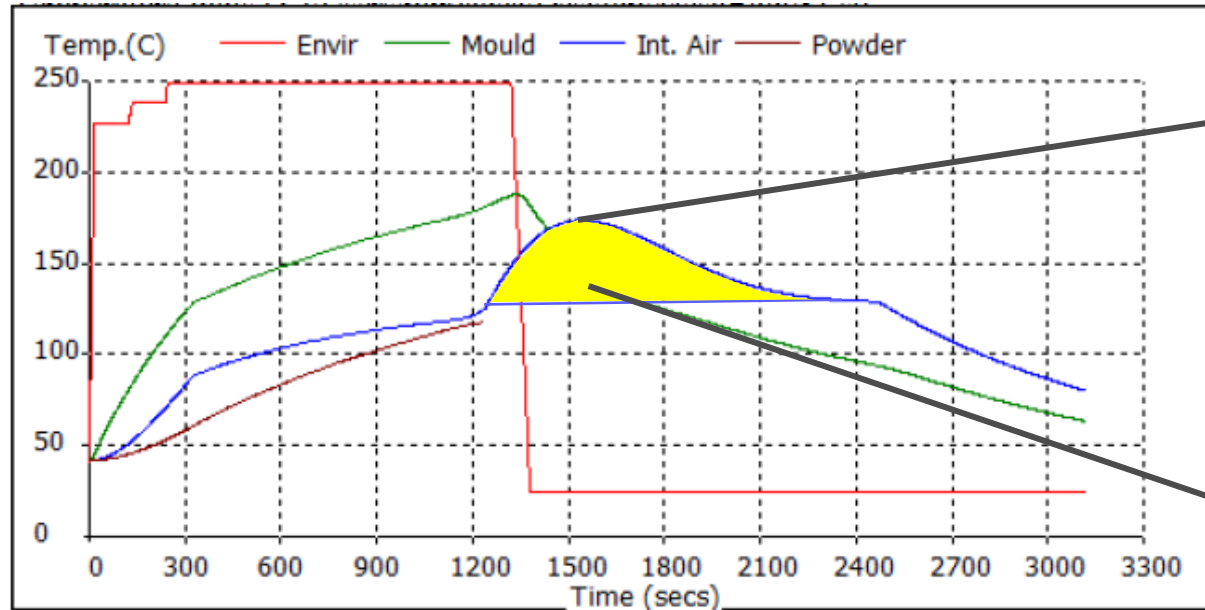
2. Mold/Part (SolidWorks)

- 18" standard test cube mold
- Cast aluminum
- Part thickness = 0.125 "

3. Process conditions

- Oven temperatures: 480 F, 520 F, 560 F, 600 F
- Cook Times: 20 to 32 minutes
- Arm Speed: 4 to 8 rpm

Outputs – PIAT and Degree of Cure



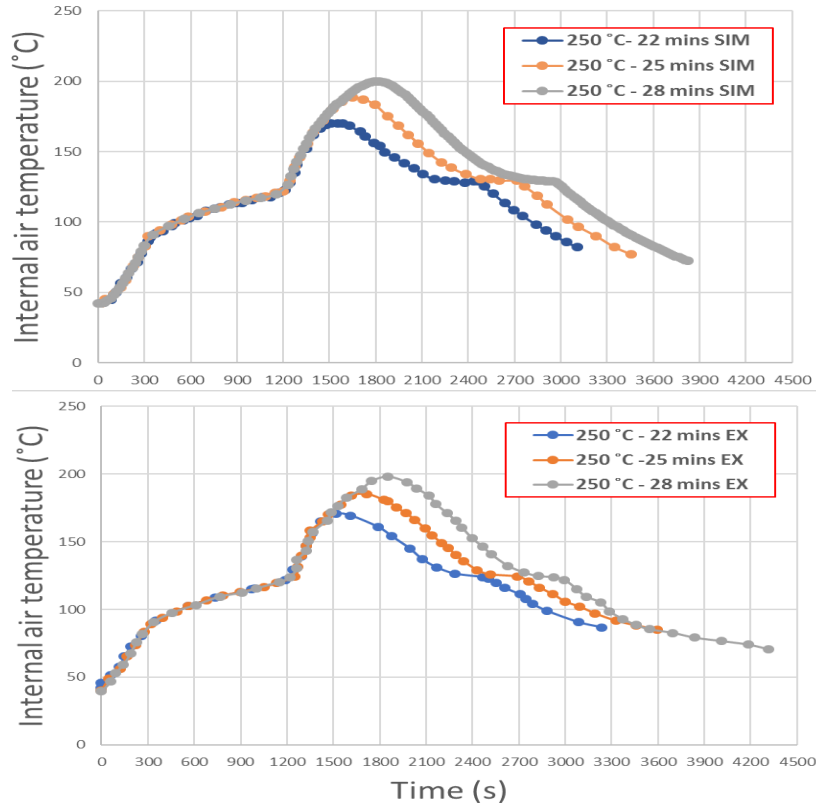
PIAT: 180 °C

Degree of Cure: 433.8 °C min

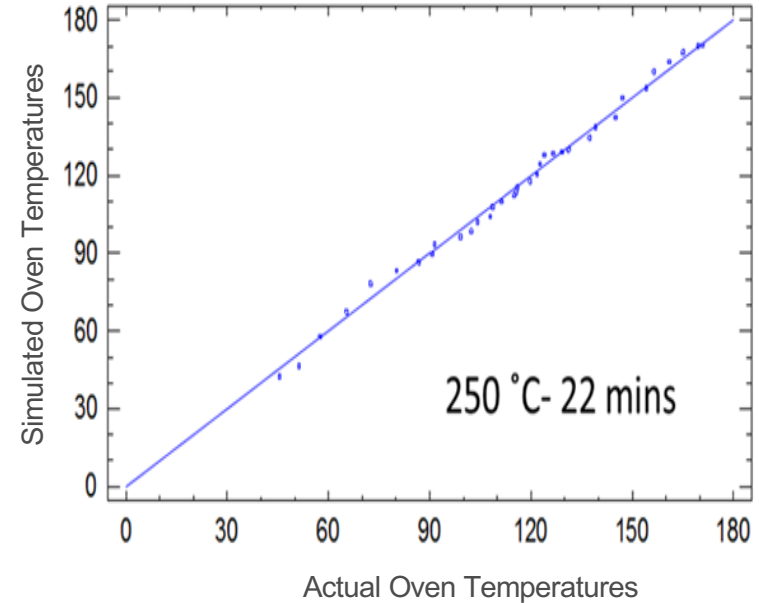
****Use Degree of Cure and PIAT values as predictors of performance****

Step 2: Validation with experimental results

Simulated & Experimental PIAT Curves at 250 °C at different oven times



Predicted vs. observed oven temperatures



Step 3: Scale up to 6,000 Gallon Tank (Customer Collaboration)

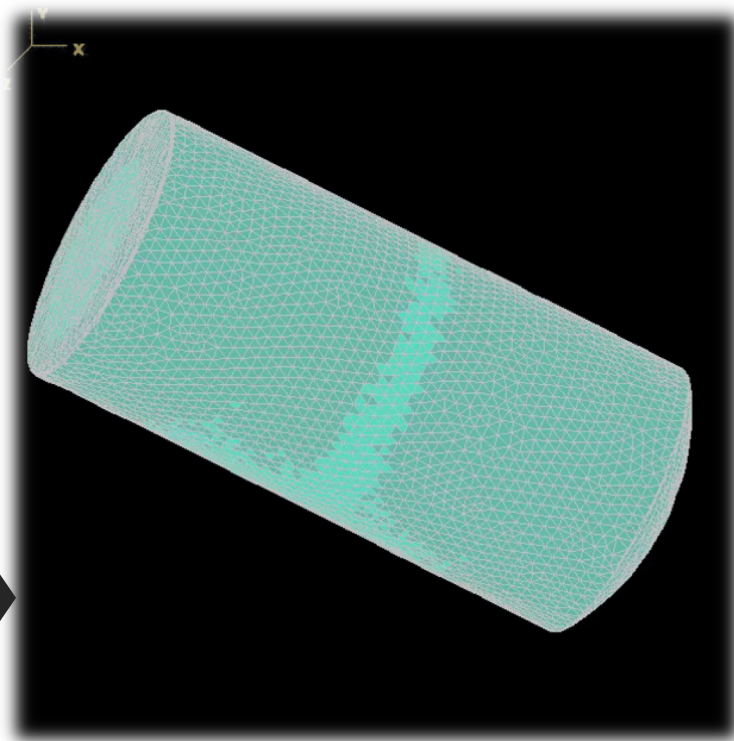
We helped our customer explore:

- ✓ **New mold**
- ✓ **New material/resin**
- ✓ **Optimal conditions**



18" Test Cube

SCALE UP



6,000 Gallon Tank

Inputs

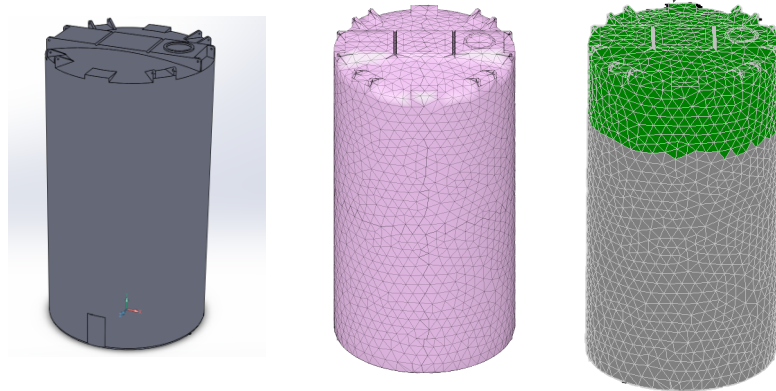
34 Simulations saved:

- ✓ ~130,000 lbs resin
- ✓ 272 hours machine time

Conditions	Levels		
Arm speed (RPM)	Low	High	
Temperature (°C)	Low	Medium	High
Cook Time (min)	Low	Medium	High
Resin	RMs245	Low MI HDPE	
Shot weight (lbs)	Low	High	

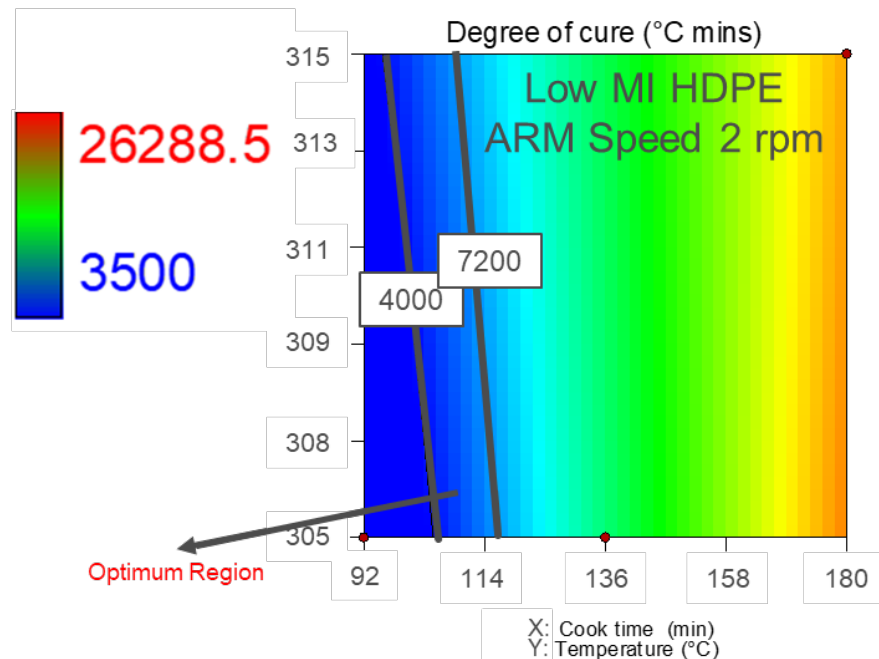
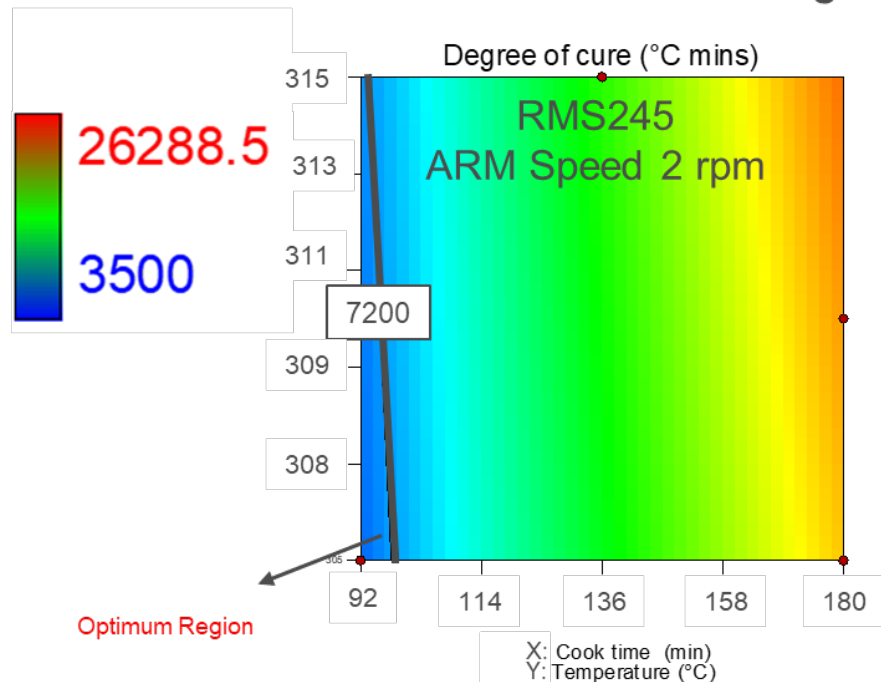
OUTPUTS:

1. Degree of Cure (from PIAT)
2. Thickness Distribution



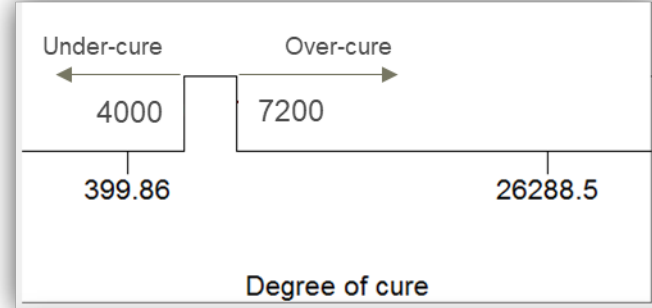
Outputs

OBJECTIVE: D.o.C Range must be between 4000-7200

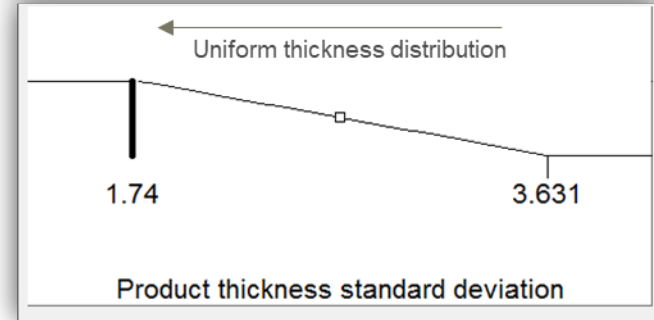


Find Processing Conditions Such That:

1) Degree of cure is
between 4000 to 7200

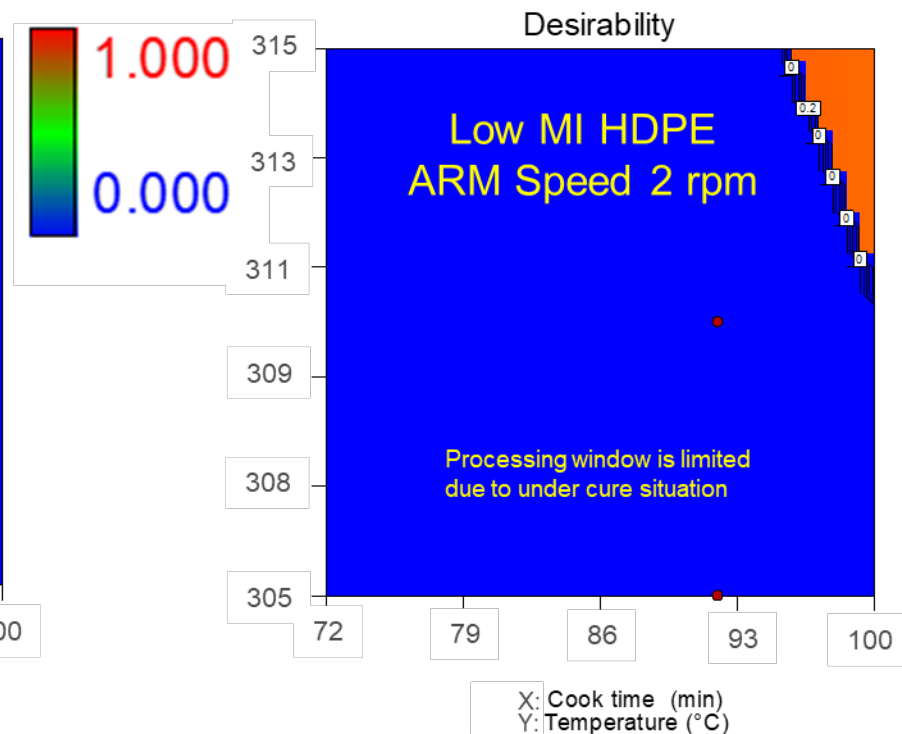
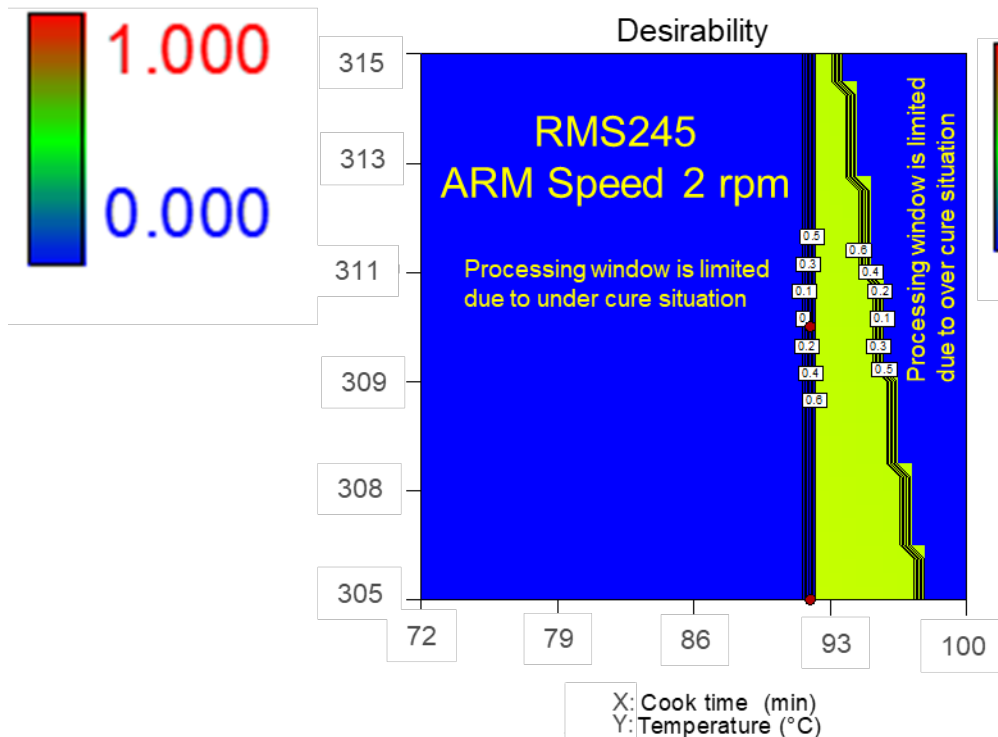


2) Minimize thickness variation



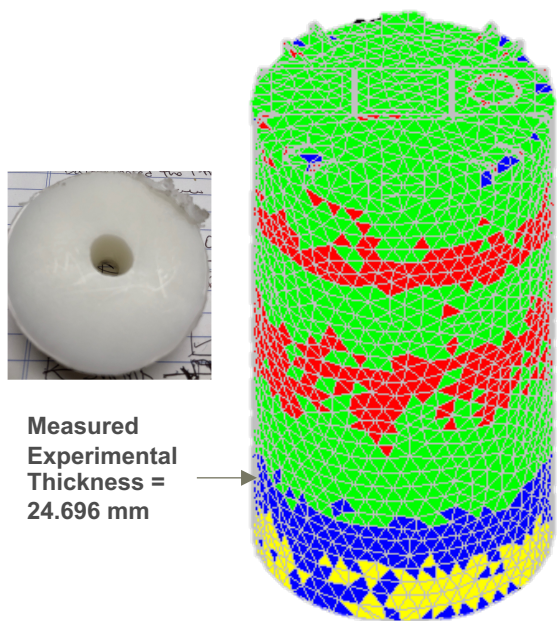
**Possible to optimize other outputs (eg: cycle time) **

RESULTS: Optimization & processing window (lower window)



RESULTS: Thickness Distribution

Note: Increasing ARM Speed drastically improved thickness Variation

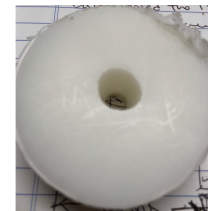
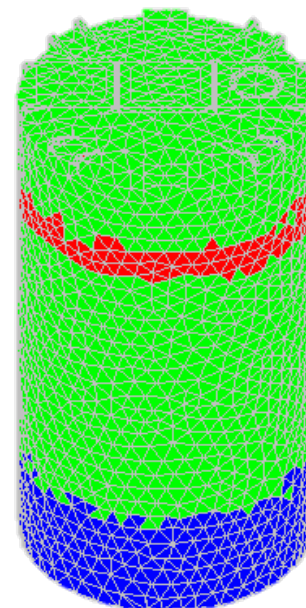


Measured
Experimental
Thickness =
24.696 mm

RM245 (1.7 MI)

ARM Speed 2 rpm, 92 min, 305 °C (580 °F)

Thickness range		Colour
	Thickness \leq 20 mm	Red
20 mm	< Thickness \leq 24.46 mm	Green
24.46 mm	< Thickness \leq 28 mm	Blue
	Thickness $>$ 28 mm	Yellow



Measured
Experimental
Thickness =
22.352 mm

Low MI HDPE

ARM Speed 2 rpm, 92 min, 305 °C (580 °F)

Closing Comments and Future Outlook

Benefits of Simulation Realized:

- Bypassed molding trials through 34 simulations which saved:
 - ~130,000 lbs resin
 - 272 hours of machine time
- Found optimal conditions to make parts with perfect cure and uniform thickness distribution

**Simulation is the future
and NOVA is here to
embrace it**





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