Attendee Copy

VENTING:

PRESSURIZATION

R. Dru Laws – Seljan Company
Regional Meeting, Rolling Meadows, IL
June 4th, 2013

Attendee Copy

Presentation Outline

- Introduction
- Classic Temperature Profile
- Layer Maturation
- Pressure in the Oven Station
- Pressure in the Cooling Station
- Venting/Pressure when Foaming
- Conclusion

A Thought on Training

- By my definition, training is not an investment
- It's a liability …
  - … until you can at least "pay back" the cost associated with the training
- Do you know how much your company spent to get you here?

Training

Finishing is the key

- The hidden value of "investment training" is in the finishing of it
- Our industry is not at a shortage of starters
  - We need finishers
  - (Imagine trying to sell an un-finished rotomolded part)
- Decide now you will be a finisher, and turn your attendance here into *investment training*
- Finishers will always be allowed to return

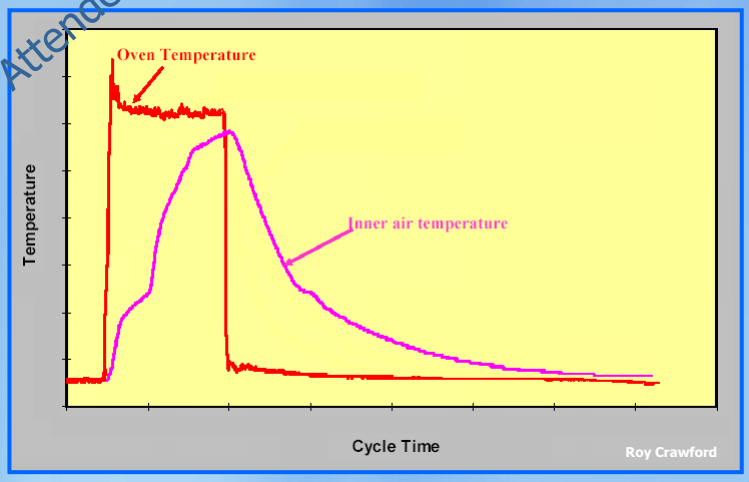
INTRODUCTION

Introduction

- Pressure is just as valuable to our process as temperature
- It provides valuable benefits in the heating and cooling portions of the cycle
- We need to understand it, so we can learn to control it.

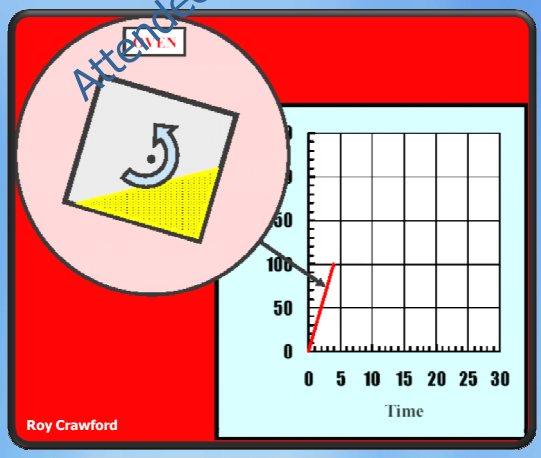
TEMPERATURE PROFILE

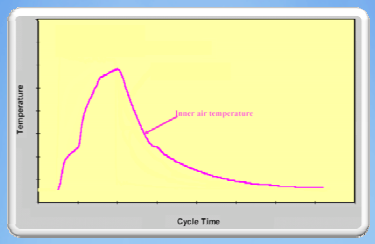
Temperature Profile



SELJAN COMPANY INC.

Temperature Profile





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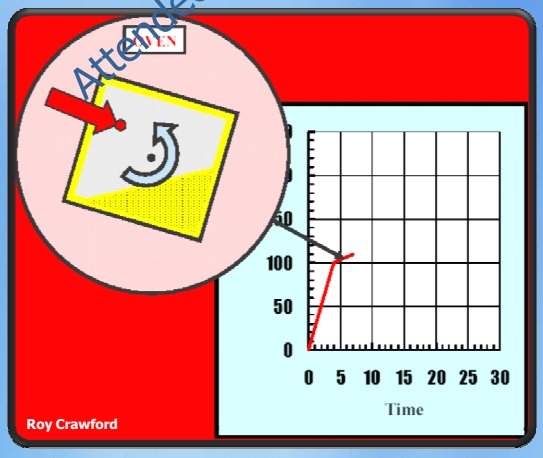
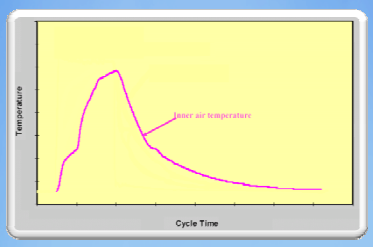
Temperature Profile



Roy Crawford



Temperature Profile

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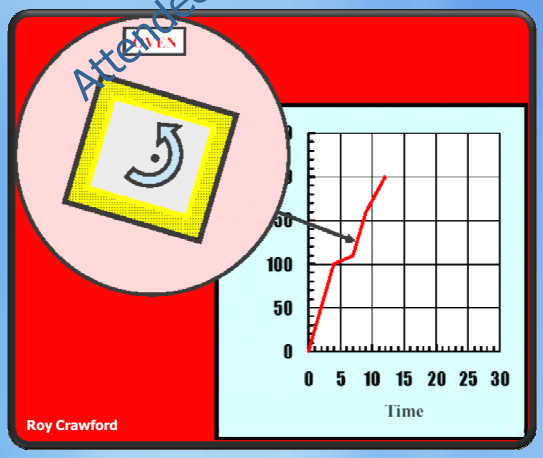
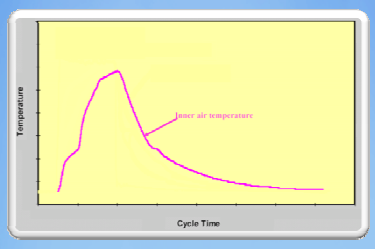


Roy Crawford



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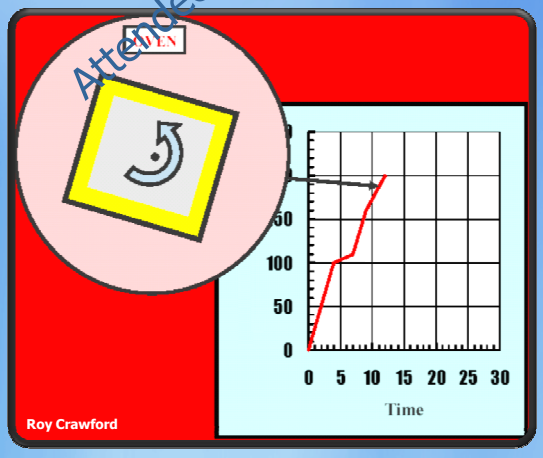

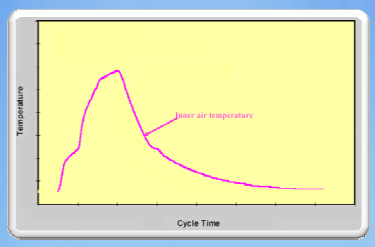

Temperature Profile

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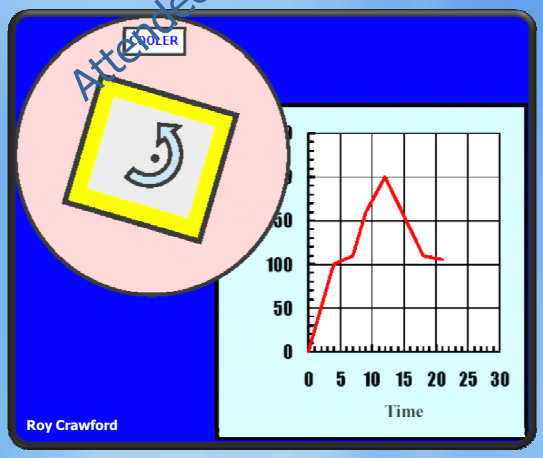

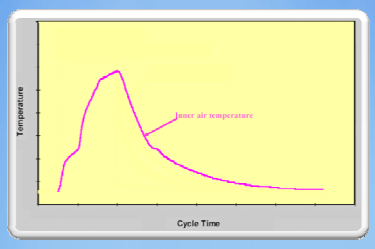

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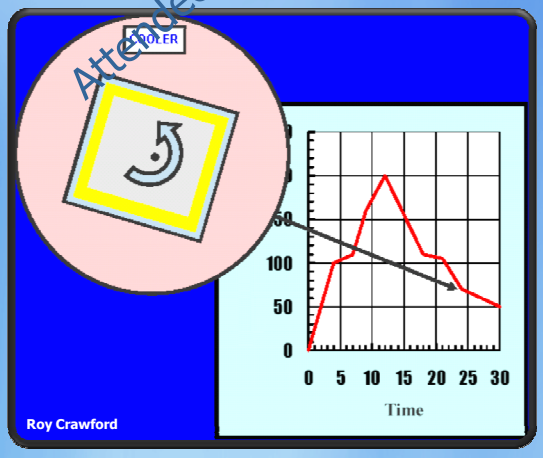
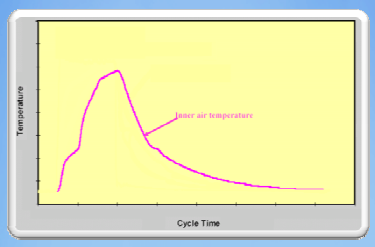
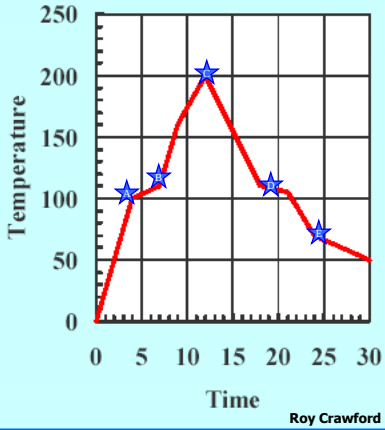




Temperature Profile

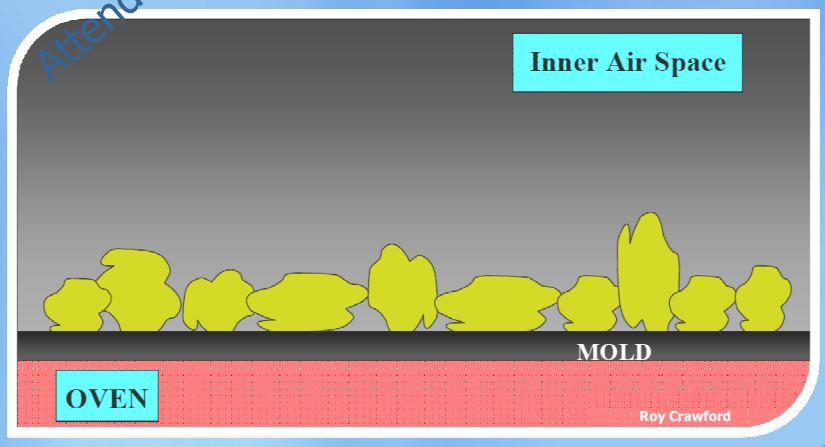
We can thus observe:

A. When powder first sticks to the mold
B. When the powder has been consumed
C. When optimal melt sintering has occurred
D. When solidification is occurring
E. When the plastic separates from the mold



LAYER MATURATION

Layer Maturation



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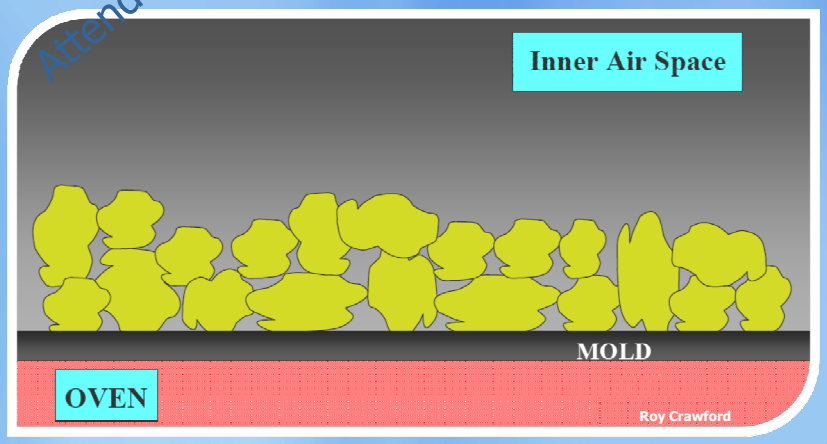

Layer Maturation

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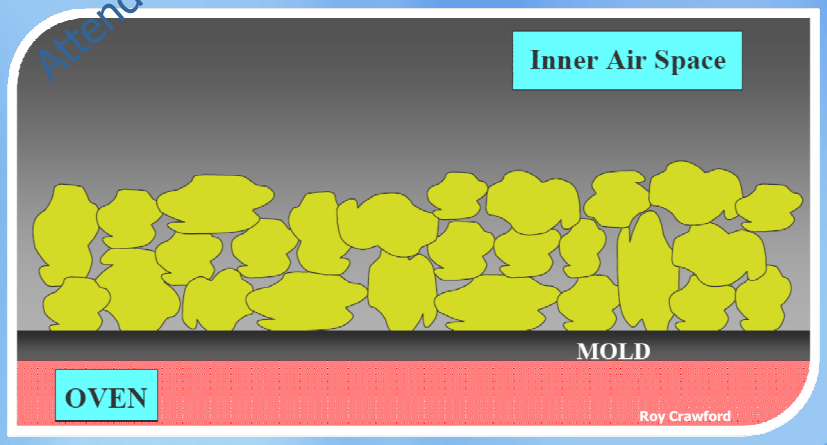

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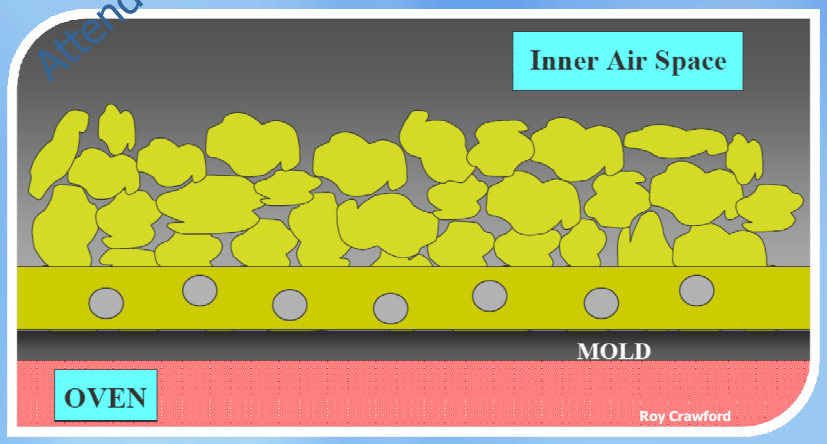

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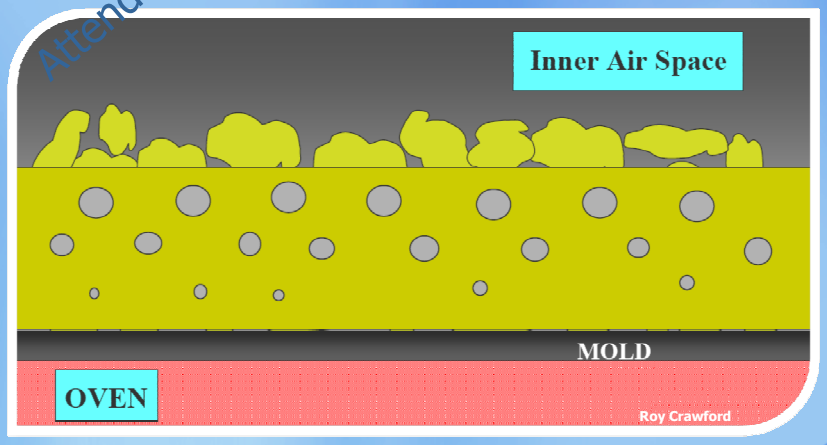

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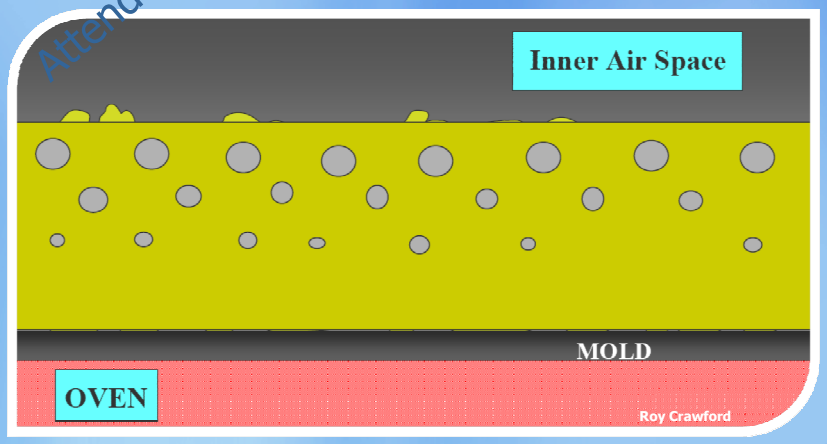

Layer Maturation

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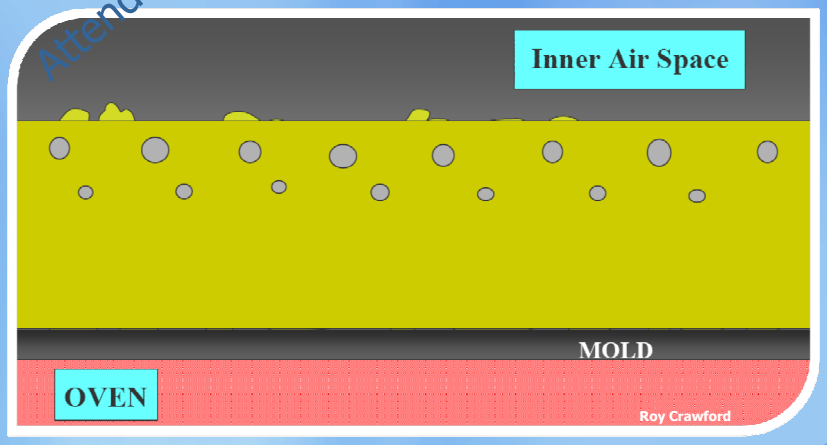

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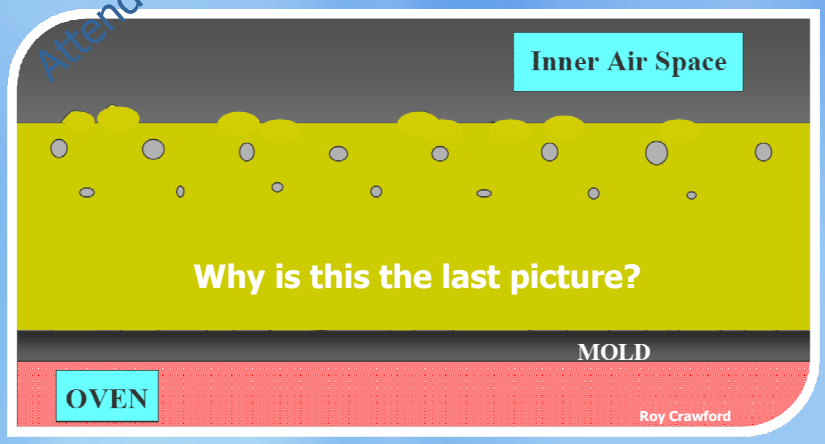


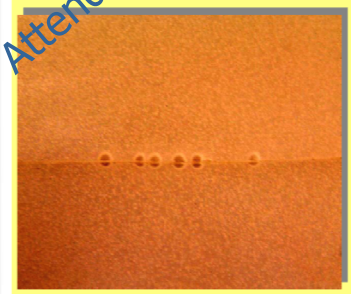
PRESSURE:
IN THE OVEN STATION

What about … Venting & Pressure?

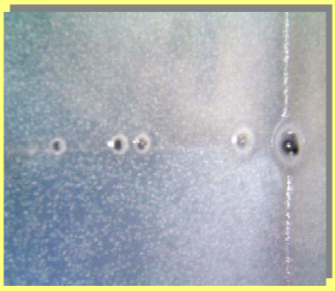
Go here to watch the video

http://youtu.be/xceBXe5YHj0

What about … Venting & Pressure?



Blow-holes at parting line, viewed from the outside



Blow-holes at parting line, viewed from the inside

Roy Crawford

What about …
Venting & Pressure?

SELJAN COMPANY INC.

What is the difference between blow-holes and suck-holes?

Blow-holes at parting line, viewed from the outside

Blow-holes at parting line, viewed from the inside

What about …
Venting & Pressure?

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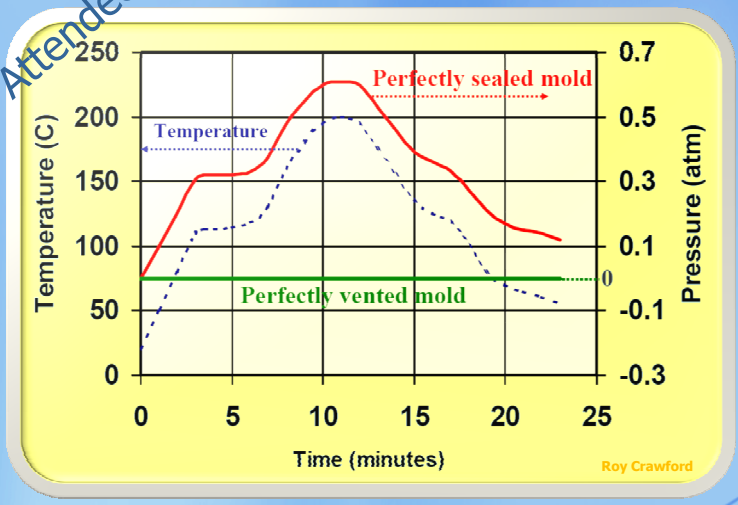
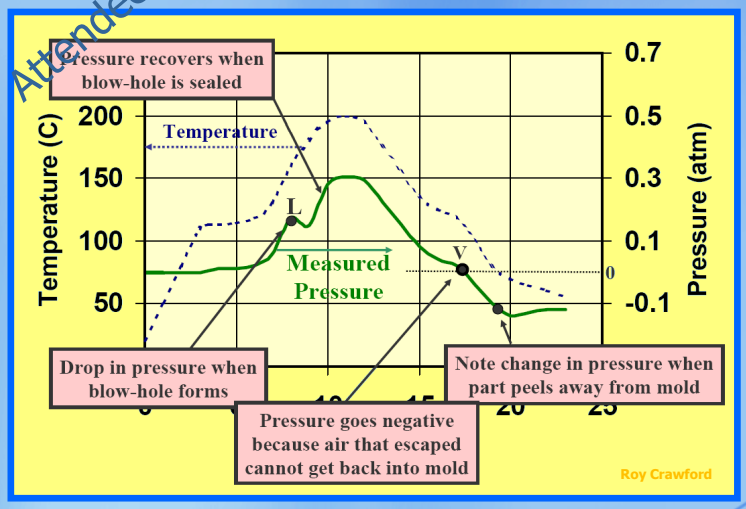


What about … Venting & Pressure?



The next 20 slides are taken from research conducted by Lorenzo Bergamo of Persico in Italy and Dr. Roy Crawford of University of Waikato in New Zealand.

It is published in volume VIII, issue 6 of RotoWorld® magazine, pages 20-28

Credit goes to the authors of said publication.

Pressurization
R&D Leonardo Mold

Pressurization
R&D Leonardo Part

Baseline Cycle

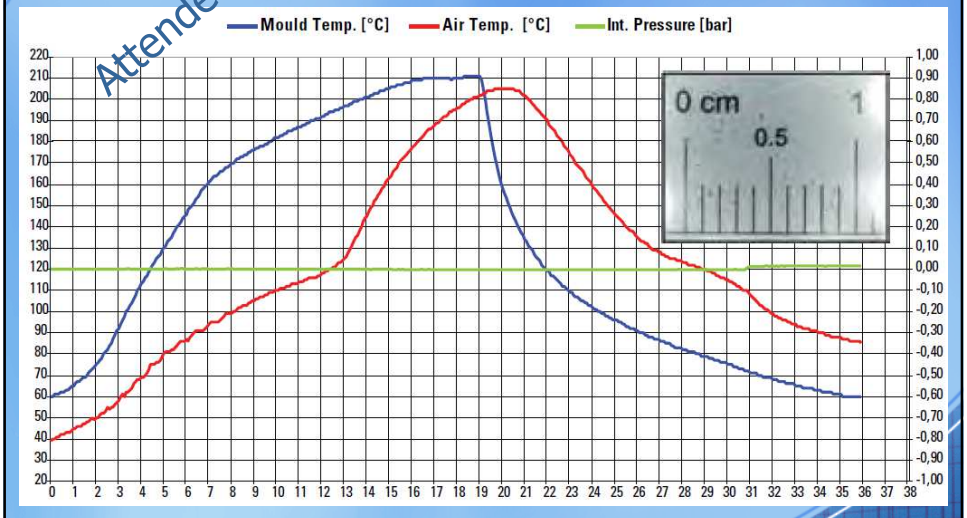
Thickness = 10mm

PIAT = 205°C

Vent = open

MFE = 101 ft-lbs

Baseline Cycle



Max Pressurized Cycle

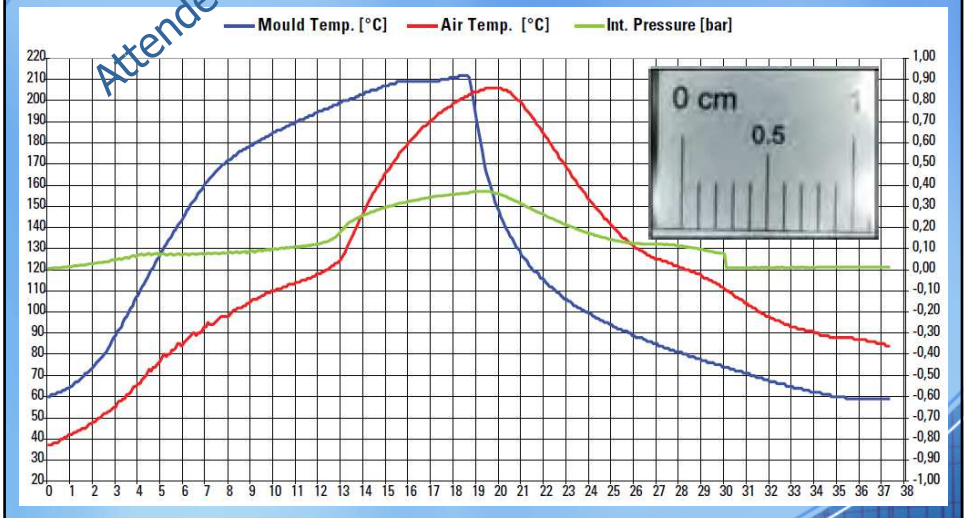
Thickness = 10mm

PIAT = 205°C

Vent = closed (1.4 atm)

MFE = 118 ft-lbs

Max Pressurized Cycle



Pressure: Theory vs. Actual

Thickness = n/a

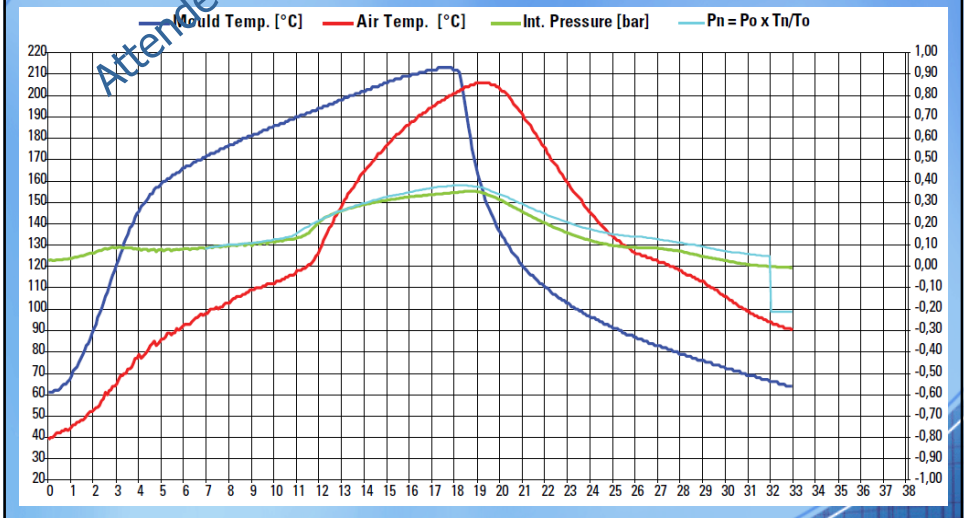
PIAT = 205°C

Vent = theory vs. actual

$P=P_0*(T/T_0)$

Pressure: Theory vs. Actual

Attendee Copy



Reduced PIAT to 180°C, open vent

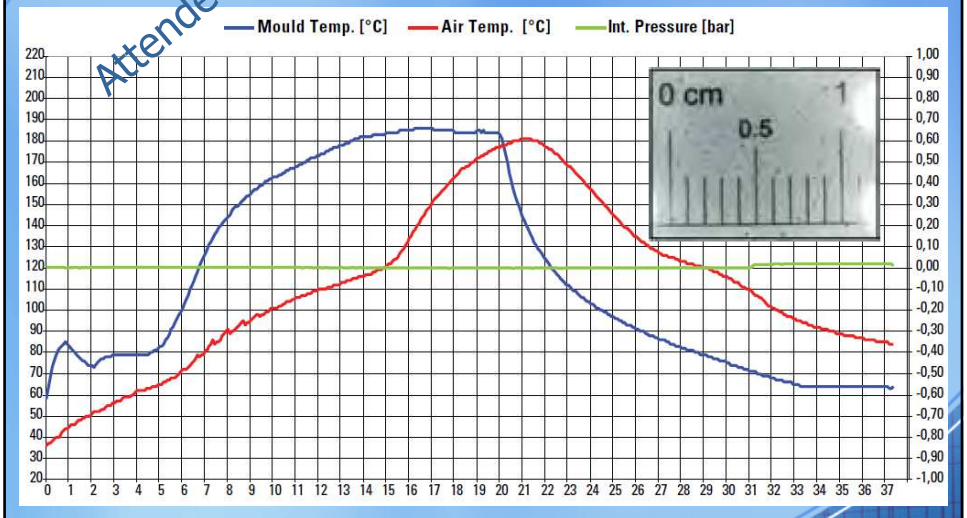
Thickness = 10mm

PIAT = 180°C

Vent = open

MFE = 87 ft-lbs

Reduced PIAT to 180°C, open vent



Reduced PIAT to 180°C, closed vent

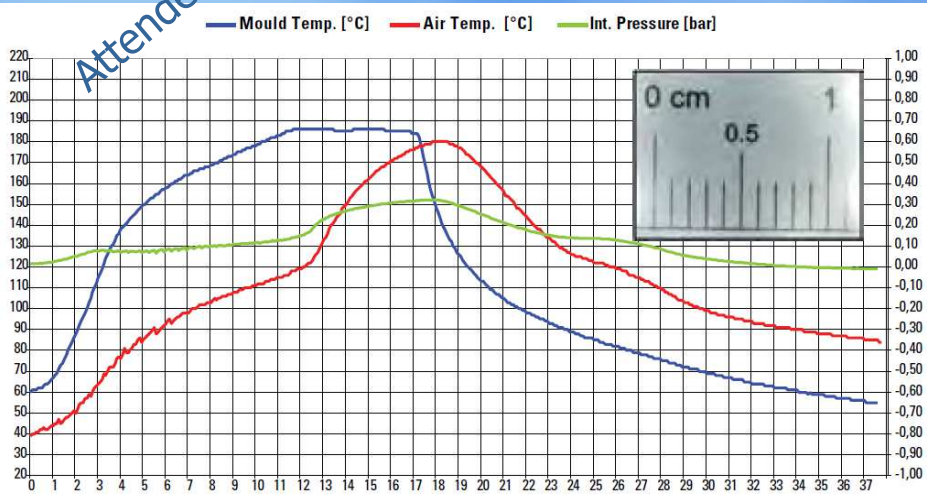
Thickness = 10mm

PIAT = 180°C

Vent = closed (1.32 atm)

MFE = 116 ft-lbs

Reduced PIAT to 180°C, closed vent



Reduced PIAT to 163°C, closed vent

Thickness = 10mm

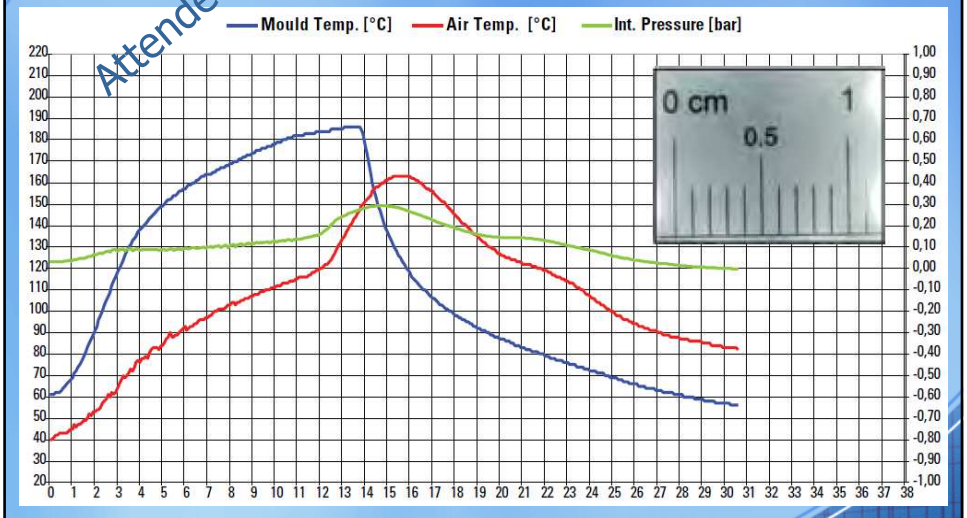
PIAT = 163°C

Vent = closed (1.29 atm)

MFE = 103 ft-lbs

Reduced PIAT to 163°C, closed vent

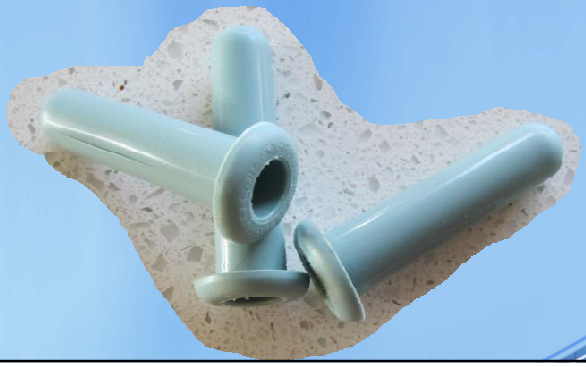
Attendee Copy



PRESSURE:
IN THE OVEN with Supavent

Supavents™

What about those of us who don't have pressure monitoring equipment?



PIAT to 180°C, Supavent

Thickness = 10mm

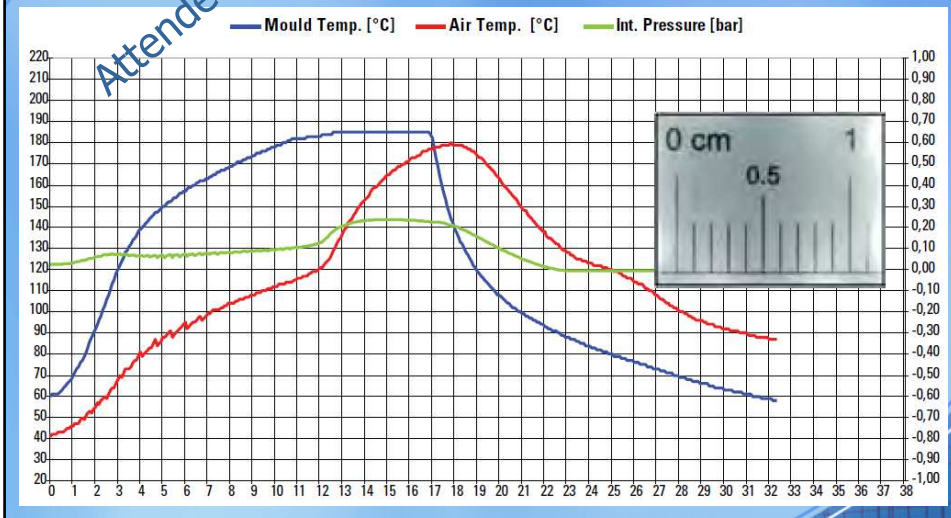
PIAT = 179°C

Vent = Supavent (1.23 atm)

MFE = 98 ft-lbs

PIAT to 180°C, Supavent

Attendee Copy



PIAT to 205°C, Supavent

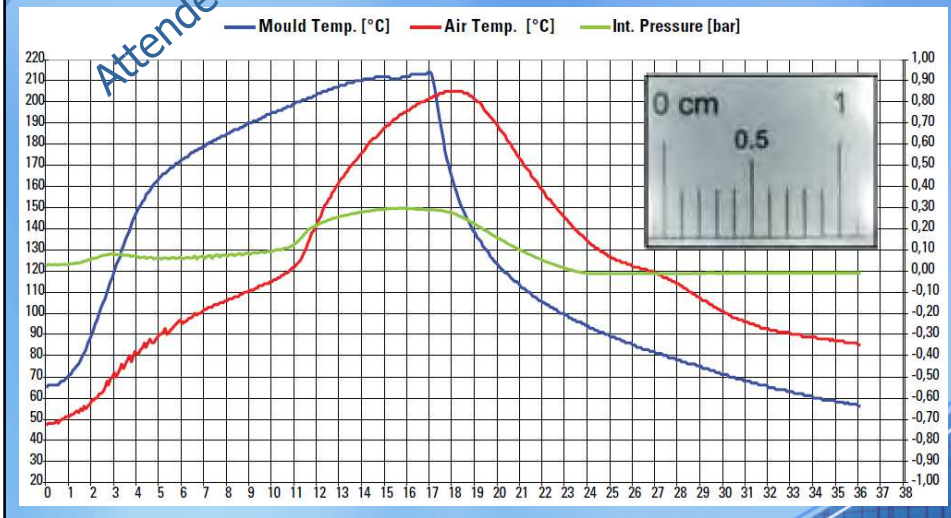
Thickness = 10mm

PIAT = 205°C

Vent = Supavent (1.29 atm)

MFE = 113 ft-lbs

PIAT to 205°C, Supavent



Comparison

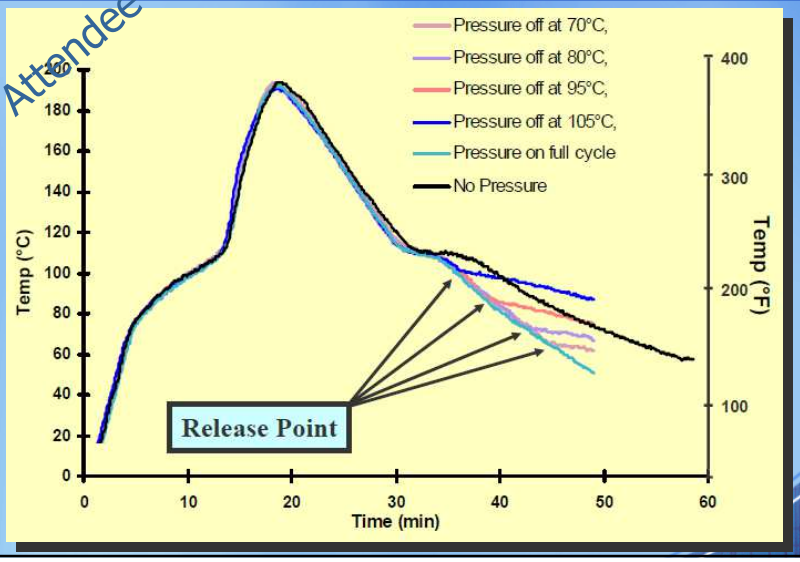
Thickness (mm)	PIAT (°C)	Vent	Pressure (atm)	Bubbles	MFE (ft-lbs)
10	205	Open	0.0	Yes	101
		Supavent	1.29	No	113
		Closed	1.4	No	118
	180	Open	0.0	Yes	87
		Supavent	1.23	No	98
		Closed	1.32	No	116
	160	Closed	1.29	No	103
		Supavent	1.25	?	91

PRESSURE:
IN THE COOLING STATION

Post HAT Pressure

- So long as the plastic stays in COMPLETE contact with the mold, you have total control over the long-term shape of the molded part.
- It's only after it begins to pull away from the tool that you start to loose control over the dimensional stability of the part
- Imagine the extremes!
  - Rotolining
  - Extreme Pre-release

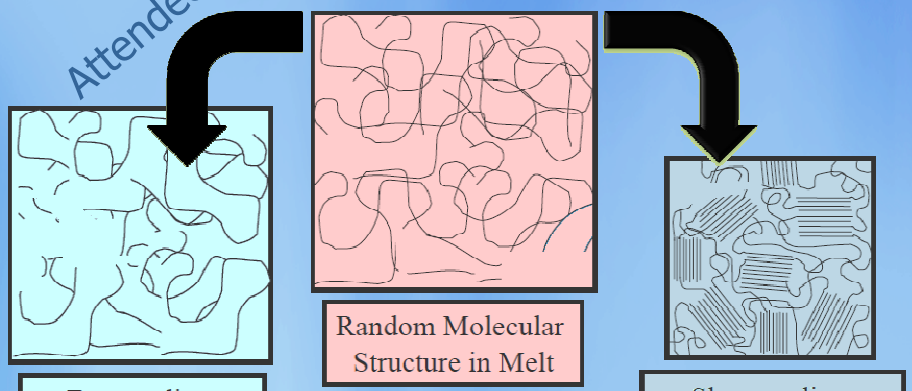
Post HAT Pressure



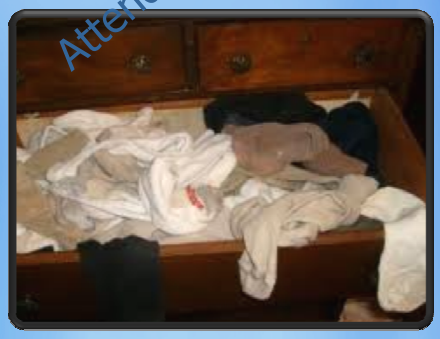
Post RIM Pressure

- Using pressure to keep the part against the mold wall as long as possible will aid in reducing warpage.
- As well as shorten the cooling time
- However, it will also alter other part properties.

Post RIM Pressure



Post PIAT Pressure



Post PIAT Pressure

Early Release

- Slower cooling
- More crystallization
- More shrinkage
- Reduced toughness
- Increases stiffness

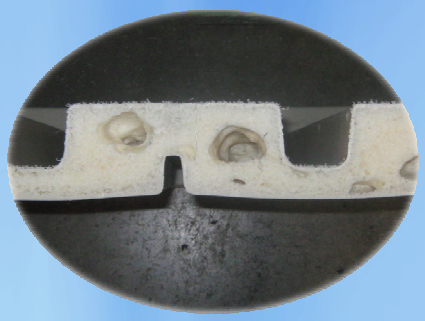
Late Release

- Faster cooling
- Less crystallization
- Less shrinkage
- Improves impact
- Reduces stiffness

FOAMING

Pressure/Venting when Foaming

- Note: Foam expansion is only possible in the absence of resistance.



- Strategic vent placement is crucial.

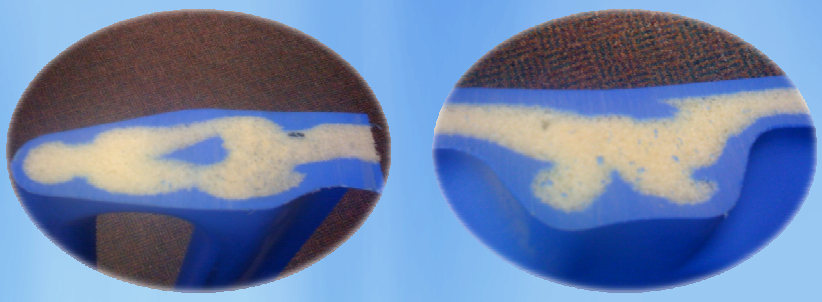
Pressure/Venting when Foaming

- Note: Foam is soft and does not increase stiffness until cooled

- Thus, it needs to be treated similar to non-foamed parts.

Pressure/Venting when Foaming

- Note: Foam migration can manipulate the already formed skin.



- Calculated foam quantity is crucial.

CONCLUSION

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Conclusion

- Pressure is just as valuable to our process as temperature
- It provides valuable benefits in the heating and cooling portions of the cycle
- We need to understand it, so we can learn to control it.

Acknowledgments

- Seljan Company
- University of Waikato & Persico
- RotoWorld Magazine
- Adam @ ARM
- Daven @ Dutchland
- Tom @ Schulman
- You, for your participation

THANK-YOU

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