

Cool Aide Case Study

Process Optimization Committee

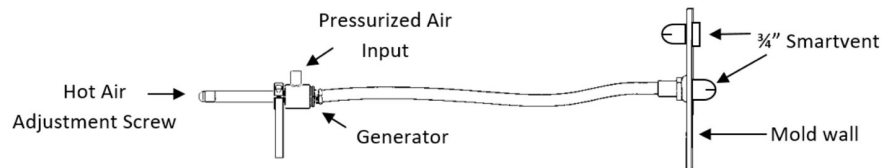
Corey Eystad

Heather Fennell

Ron Joannou Jr.

Joey Morsi

Bob Mueller



ROTOMART COOL AIDE

Internal Air Cooling Device User Manual

IMPORTANT SAFETY INSTRUCTIONS – READ BEFORE SETTING UP AND USING THE COOL AIDE DEVICE. NOT FOLLOWING THESE INSTRUCTIONS MAY CAUSE DAMAGE TO THE MOLD AND/OR INJURY TO THE OPERATORS.

Do not exceed line air pressures of 50 PSI. Be sure to adjust and check prior to using this device.

Be absolutely sure that the exhaust vent is not clogged and has free flowing air. Check at time of installation of the Cool Aide and frequently during the production run.

It is recommended that Smartvents be used in conjunction with the Cool Aide device. Even though they too can clog, they are less likely to which causes pressure build up in the mold.

Two vents are required in each mold cavity using the Internal Air Cooler "Cool Aide" It is important that the additional "exhaust" vent does not clog and that it will allow for the free passage of air. Check their condition regularly during production runs.

The hot air adjustment screw has been set at the factory and must not be adjusted by the user. Never operate the device with the hot air exhaust screw in a closed position or otherwise blocked. Doing so will result in increased pressures that could cause damage to the mold or injury to the operator.

INSTALLATION-

MOLD MUST HAVE TWO (2) OR MORE VENT HOLES, one for cold air input and one or more for exhaust (pressure relief). NOTE: It is recommended that Smartvents be used in conjunction with the Cool Aide for both the input and exhaust vents.

1. Drill a secondary 3/4" vent hole into the mold and insert a Smartvent
2. Ensure both input and exit vent holes are clear of blockages from mold parts or shielding.
3. Insert the cold air side of the Cool Aide into a Smartvent and then into a .796" diameter hole through the mold wall using a light friction fit.
4. Set and ensure line pressure at 50 psi maximum and connect the air supply to the pressurized air inlet noted in the above diagram.
5. Attach the Cool Aide to one of the frame members of the mold using clamps or bolts.
6. Be sure hot air exhaust end of the Cool Aide is not blocked or obstructed.
7. Utilize machine control to turn air on and off at the appropriate time in the cooling cycle.





Internal Cooling Study

Heather Fennell
Technical Service Engineer





Purpose

- Preliminary study to investigate:
 - Cycle time improvement
 - Changes in mechanical properties
 - Identify future work

Trial Details

- Four part thicknesses with 2 IAT conditions
- Total of 16 molded parts
 - 8 control
 - 8 internal cooled
- Cooling recipe consistent across all conditions
 - Utilizing both air and misting
 - Cool Aide triggered after PIAT
- Resin
 - 5 g/ 10 min MI 0.935 g/ cm³ Density
- Article Testing
 - ARM Impact
 - Density
 - DSC
 - Dimensional Analysis



Run Log

- Oven IAT produced parts in PIAT range (370 – 410 °F)
- Demolding IAT defined as 170 °F
- Total machine time 52 hours
- Total article testing 5 hours

Run Order	Part Thickness (in)	Oven IAT (°F)	PIAT (°F)	Internal Cooling
A1	0.125	325	371	N
A5	0.125	325	371	Y
A2	0.250	325	395	N
A6	0.250	325	396	Y
A3	0.500	325	395	N
A7	0.500	325	399	Y
A4	0.625	325	399	N
A8	0.625	325	394	Y
B1	0.125	345	388	N
B5	0.125	345	378	Y
B2	0.250	345	405	N
B6	0.250	345	400	Y
B3	0.500	345	408	N
B7	0.500	345	409	Y
B4	0.625	345	409	N
B8	0.625	345	408	Y

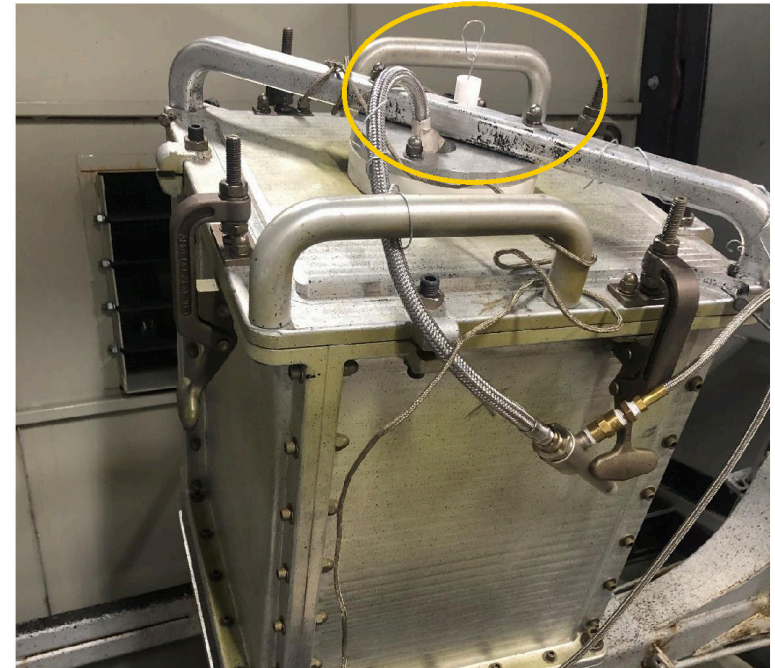
Machine Details

- Shell Polymers Rotational Molding Center of Excellence
 - Located at Pennsylvania College of Technology in Williamsport, PA
- STP Rotomachinery Inc. LRM 1500 In-line Gas Shuttle
 - Equipped with Automatic Process Management (A.P.M) to control the process via IAT



Mold Details

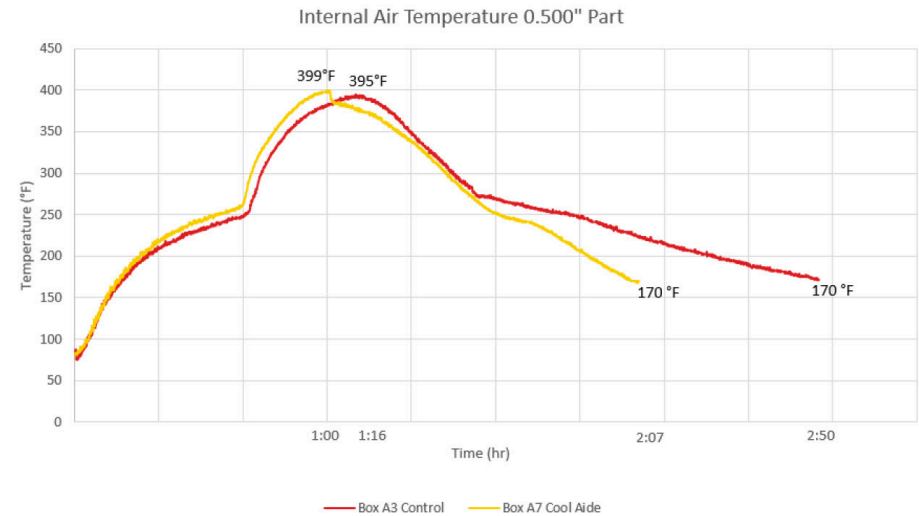
- CNC Aluminium Cube
- Dual Venting Capabilities
- Produced 24 ARM impact samples
- Cool Aide Inlet Pressure
 - Safety procedures prior to triggering system
 - 7 PSI at inlet
 - Increased to 10 PSI to achieve cycle time reduction



Cycle Time Reduction

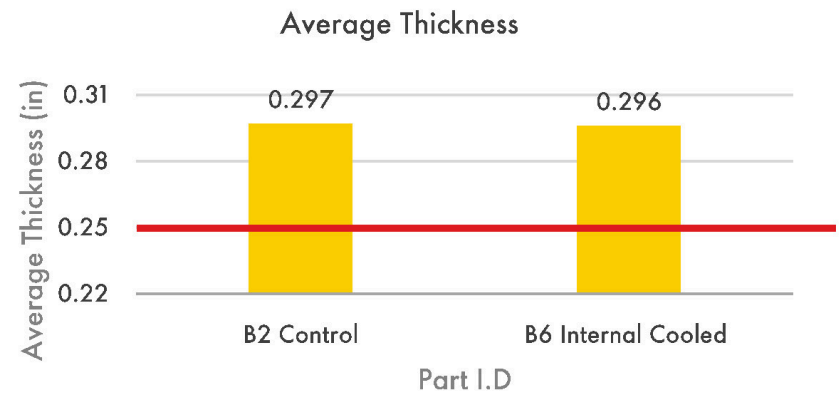
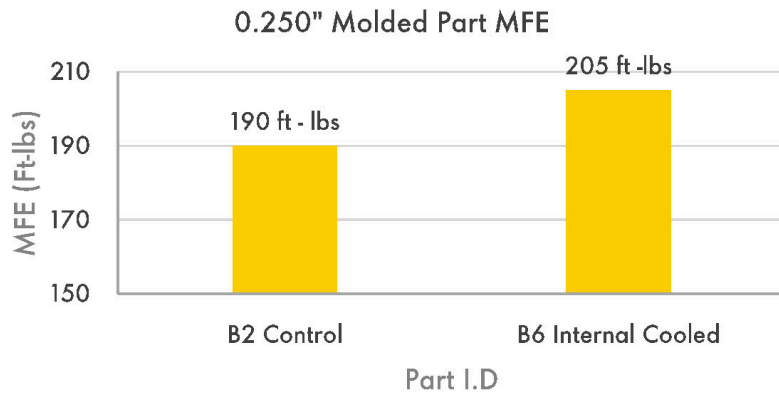
- Thinner gauge parts had less of an impact
- Inlet pressure of 7 PSI had less of an impact
- Cycle time observations measured from PIAT to demold IAT
 - 28 min reduction in 0.500" part

Part Thickness (in)	Cycle Time Reduction
0.125	10%
0.250	15%
0.500	20%
0.625	30%



Article Testing

- No change in density in control vs internal cooled
 - DSC confirmed % crystallinity was consistent
- Impact properties increased slightly due to internal cooling
 - Additional testing required to determine a trend



Dimensional Analysis

- Visual Inspection using T square at most warped side
- Warpage decreased for internal cooled parts
- 0.125" and 0.250" parts produced straight wall parts at both conditions





Conclusions

- 10 – 30% cycle time reduction was achieved in a lab setting
- Parts produced with internal cooling showed improved flatness (decreased warpage)

Future Work

- Define cool aide settings to produce optimal cooling
 - Include a diffuser at inlet
- Additional testing focused on 0.250" parts
- Investigate different materials





Acknowledgements

- Pennsylvania College of Technology
- Christopher Gagliano – Pennsylvania College of Technology
- Nathan Rader-Edkin – Pennsylvania College of Technology
- Rob Donaldson – Shell Polymers
- Ron Joannou – Formed Plastics



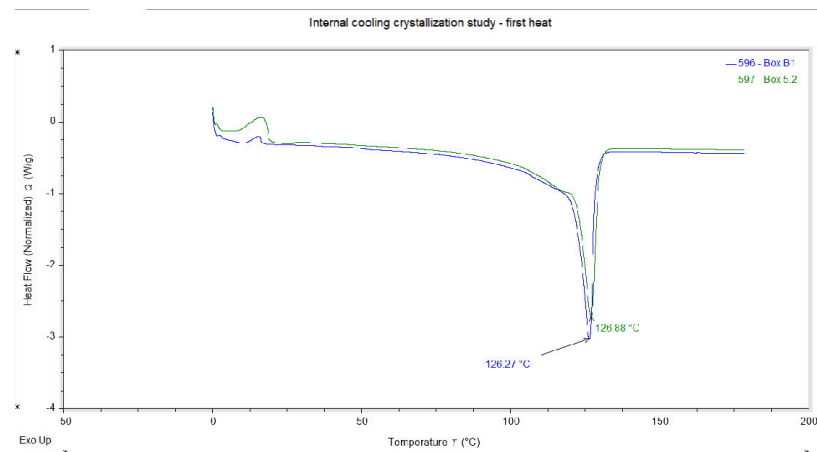
Appendix

Bulk Density

Test Number	Time (Sec)	Weight (g)	Bulk Density (g/cc)
1	23.96	112.60	36.17
2	23.75	112.74	36.31
3	23.73	112.43	36.00
Average	23.81	112.59	36.16

Sieve Analysis Results

Sieve	Tare	Weight	Retain %
30	374.24	374.27	0.03
35	347.09	347.74	0.65
40	351.85	365.81	13.96
60	323.35	373.38	50.03
80	327.30	345.11	17.81
120	348.35	358.66	10.31
Pan	374.46	381.64	7.18



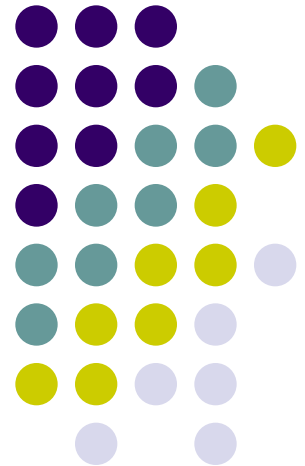
Formed Plastics, Inc.

Internal Air Cooling

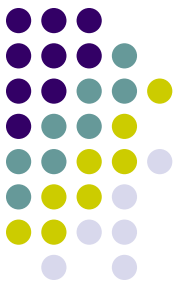
Process Optimization Committee

Ron Joannou

Joey Morsi



Typical Processing Conditions



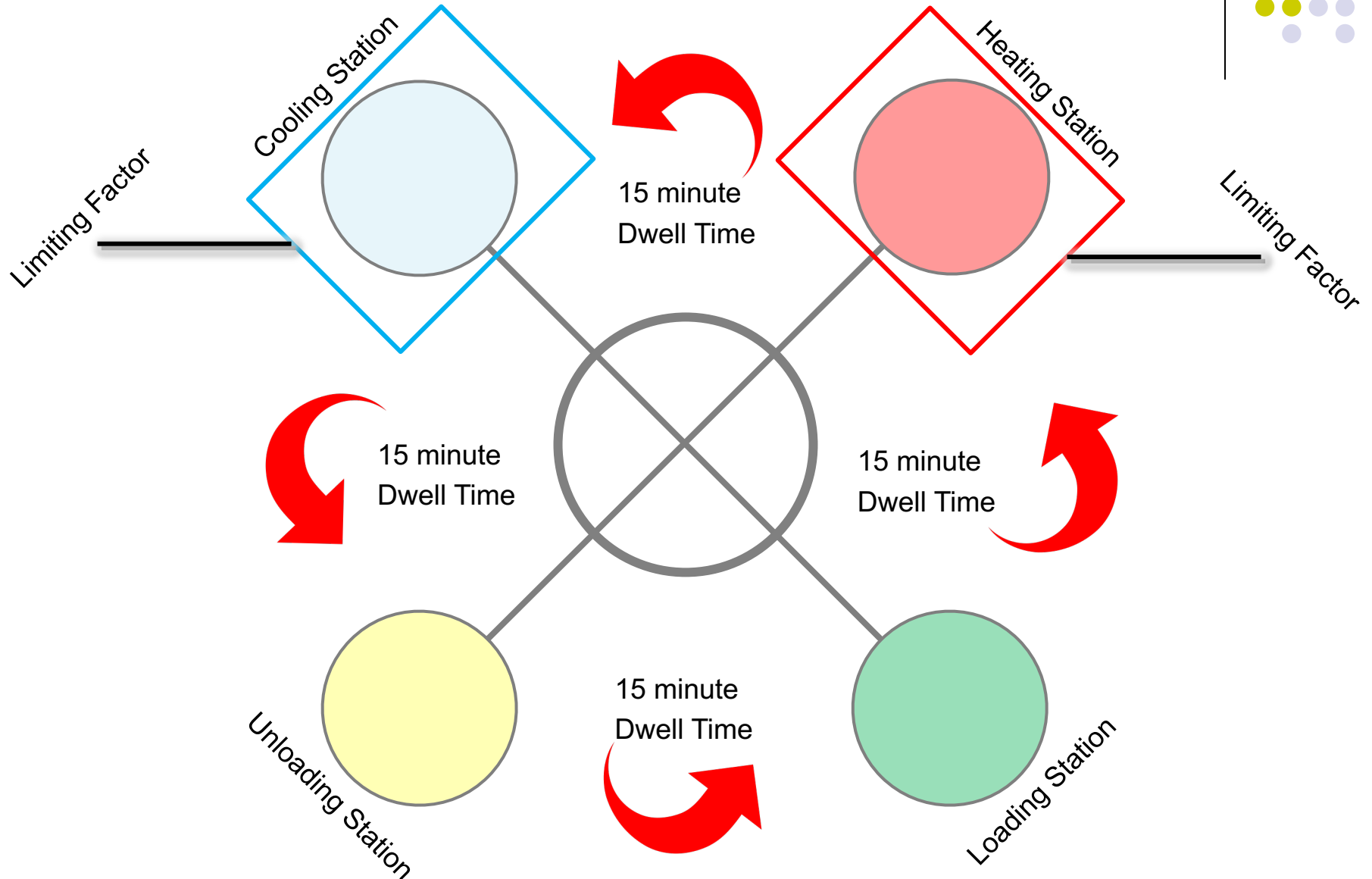
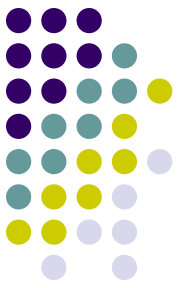
**0.125"-0.250"
Wall Thickness**

**4-Arm
Carousel
Machine**

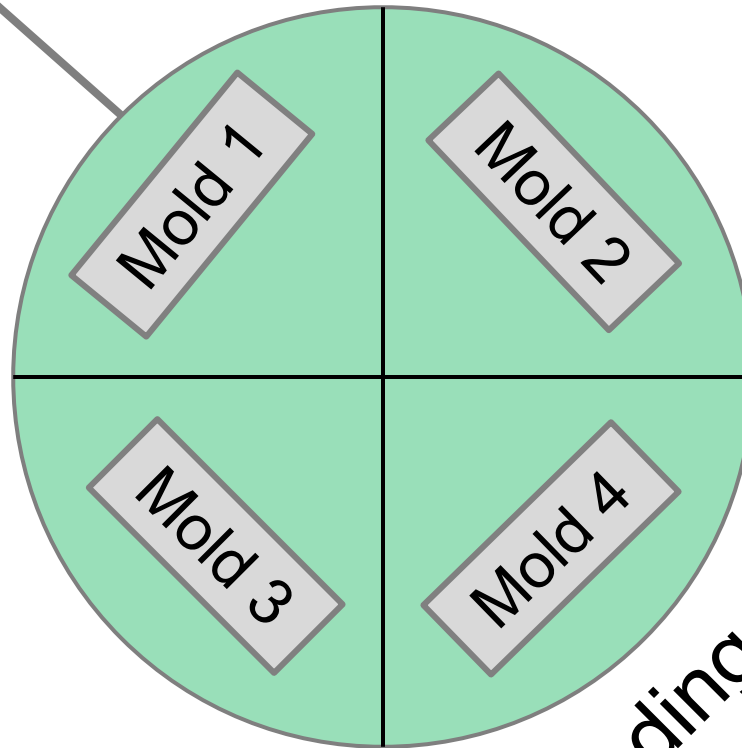
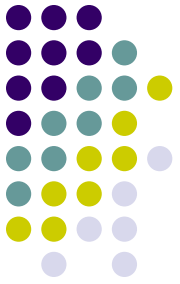
**Output:
8 Shots per
8 Hour Shift
per 1 Mold**

Standard Processing

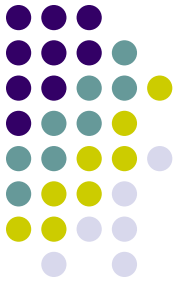
“Typical Rotational Molding Cycle”



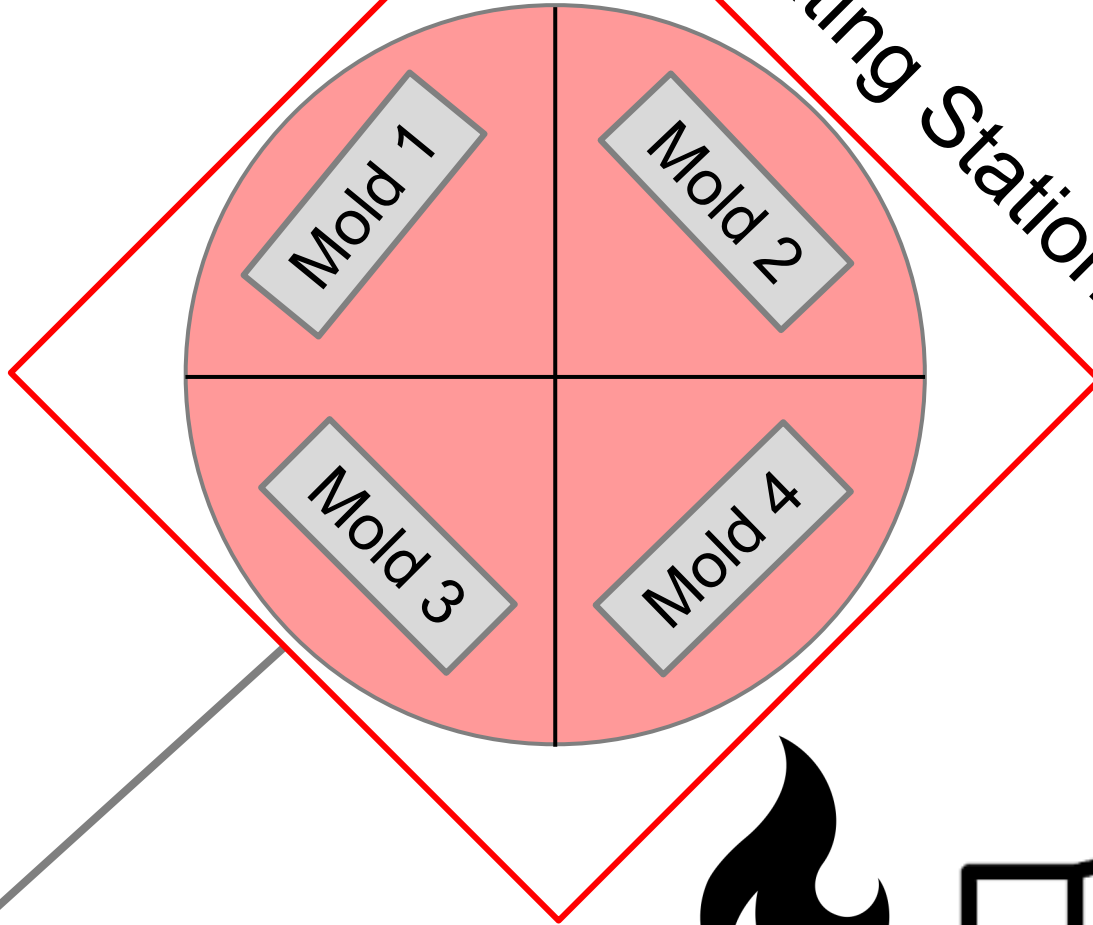
**Generally
4 Molds per Arm**

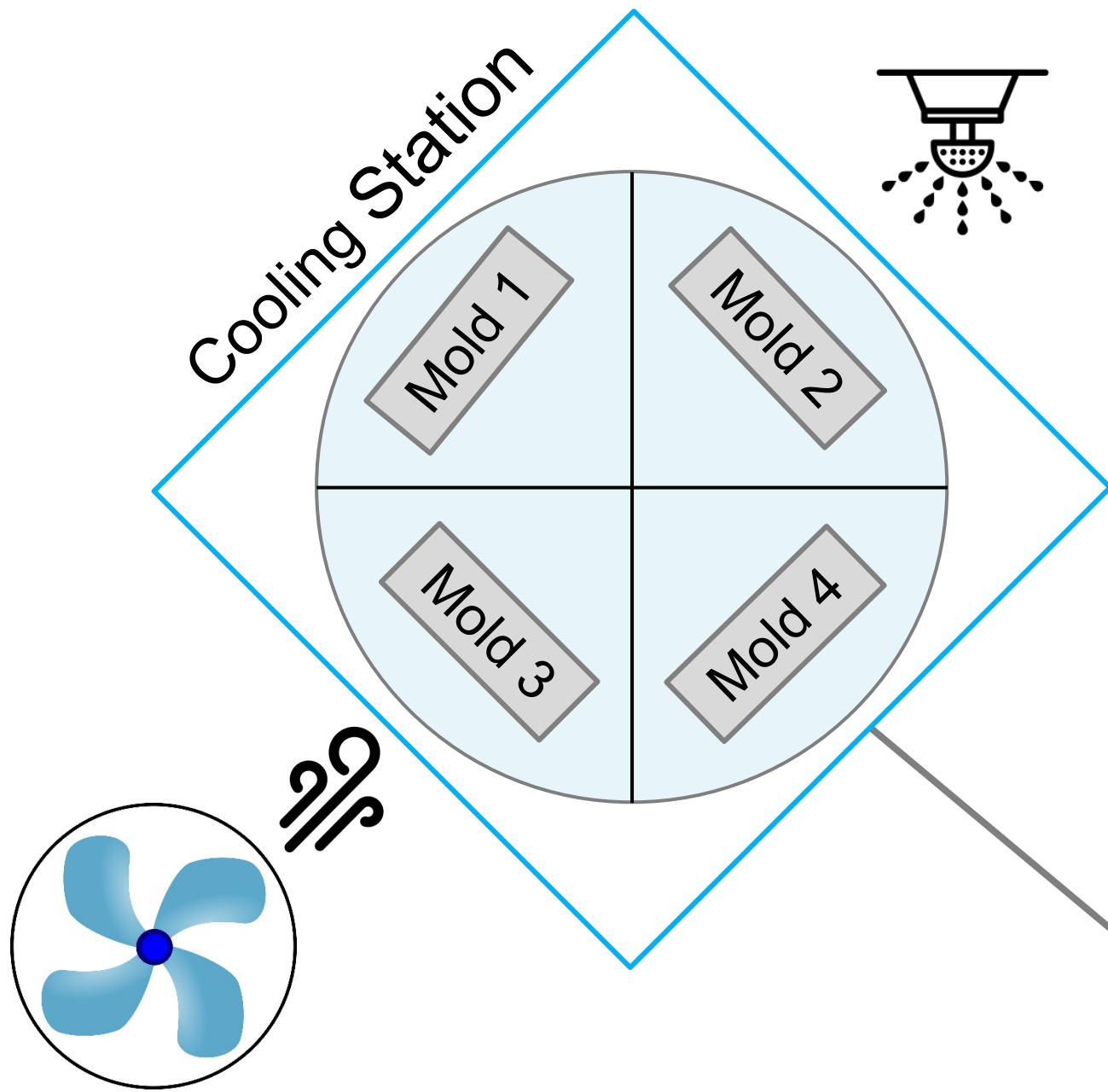


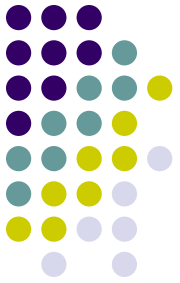
Loading Station



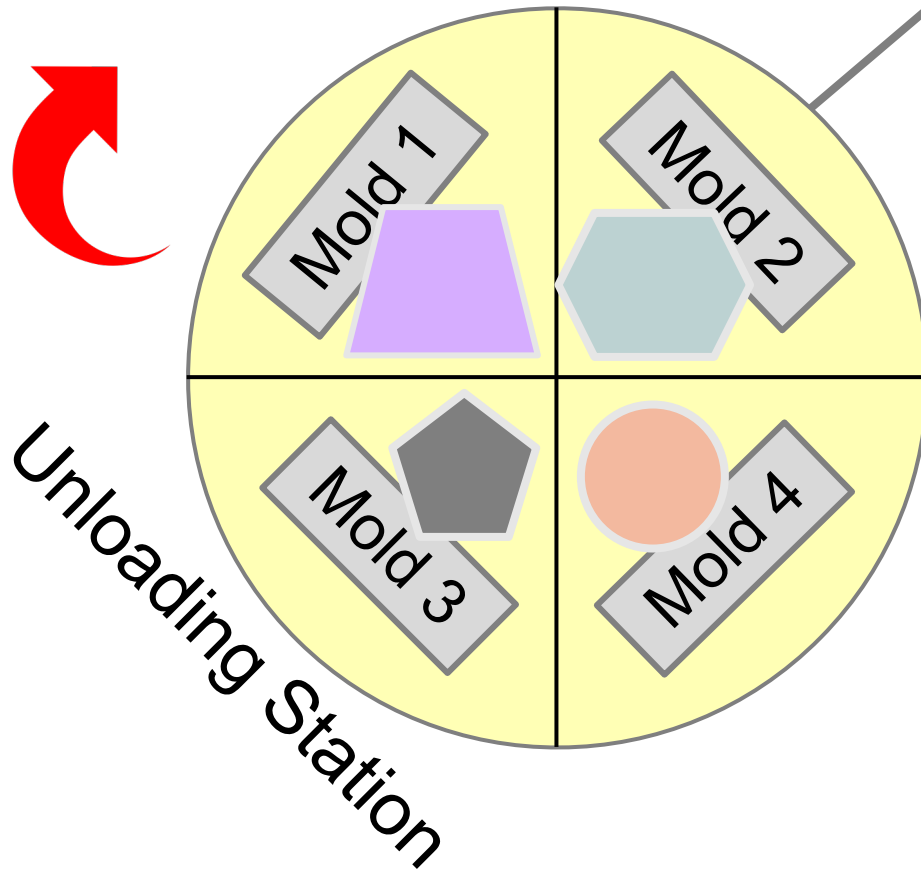
Heating Station





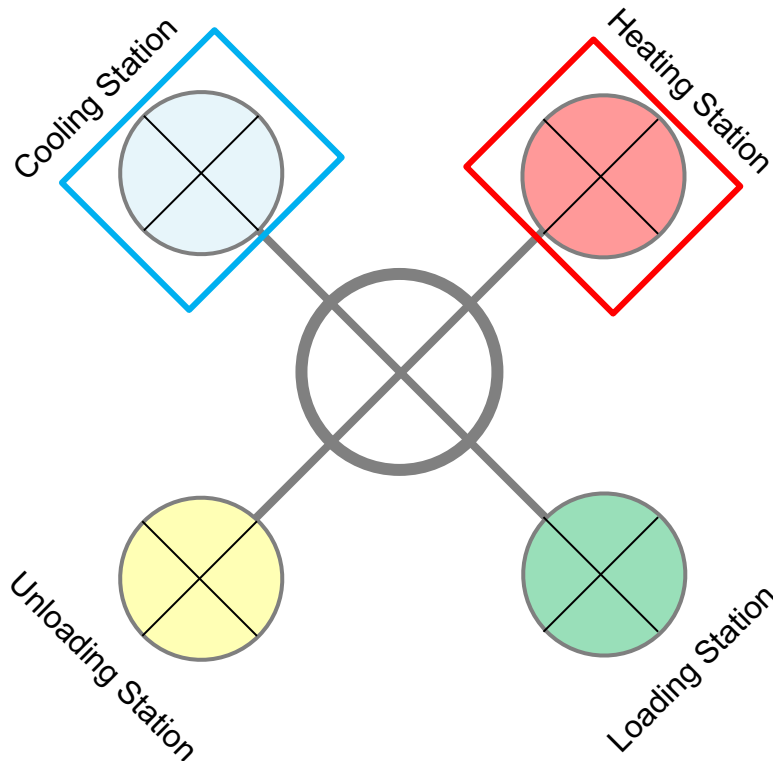
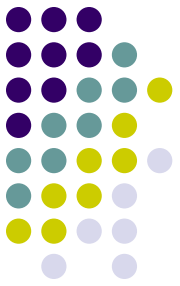


4 Parts per Arm



Standard Processing

“Typical Rotational Molding Cycle”

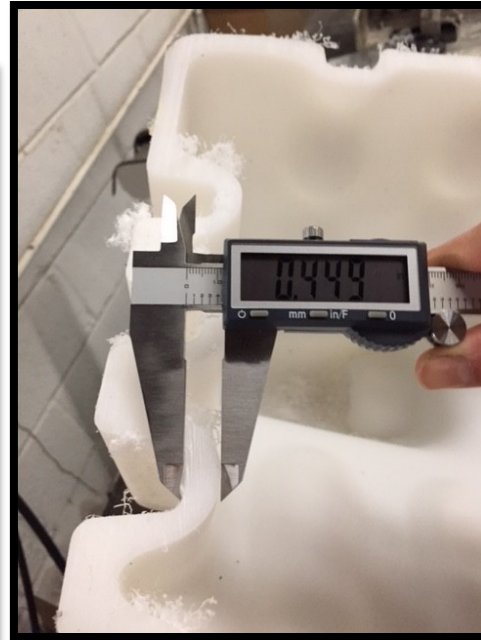
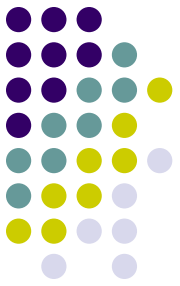


Cycle Yield – One Machine

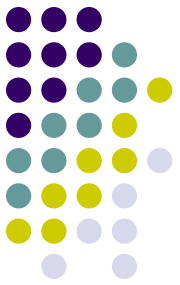
- 4 Molds per Arm
- 4 Arms per Machine
- 16 Parts per Hour
- 8 Hours per Shift

Total: 128 Parts per Shift

What Happens If You Introduce a Part Requiring Heavy Wall Thickness?



Part – Ex. #1



	Cooler Time (Minutes)	Cooling Fan	Water Spray	Exhaust Fan
1	32.0	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
2	0.0	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3	0.0	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4	0.0	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5	0.0	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6	0.0	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7	0.0	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

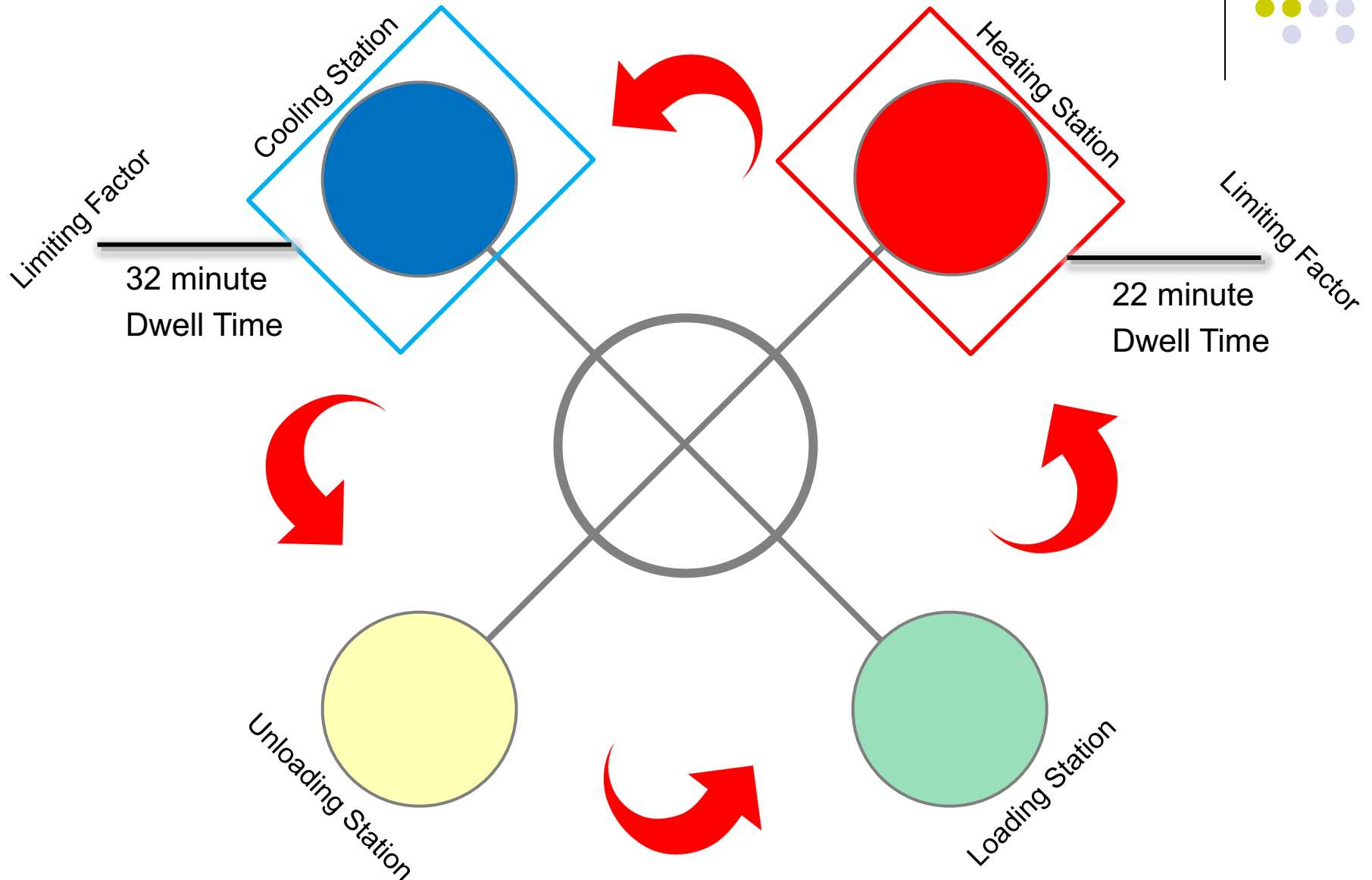
Total Cooling Cycle Time

	High	Low
Gas Delay	4.0	0.0
Gas Time	20.0	0.0

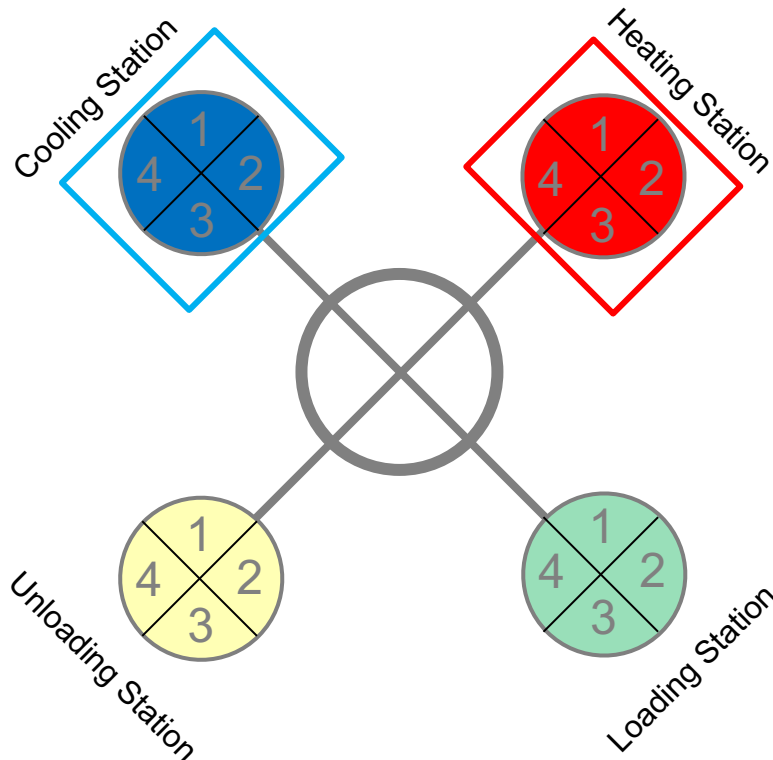
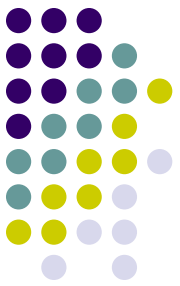
Arm 1 Setup

☒ Undo

Part – Ex. #1 Cycle



Part – Ex. #1 Cycle



Adjusted Cycle Time

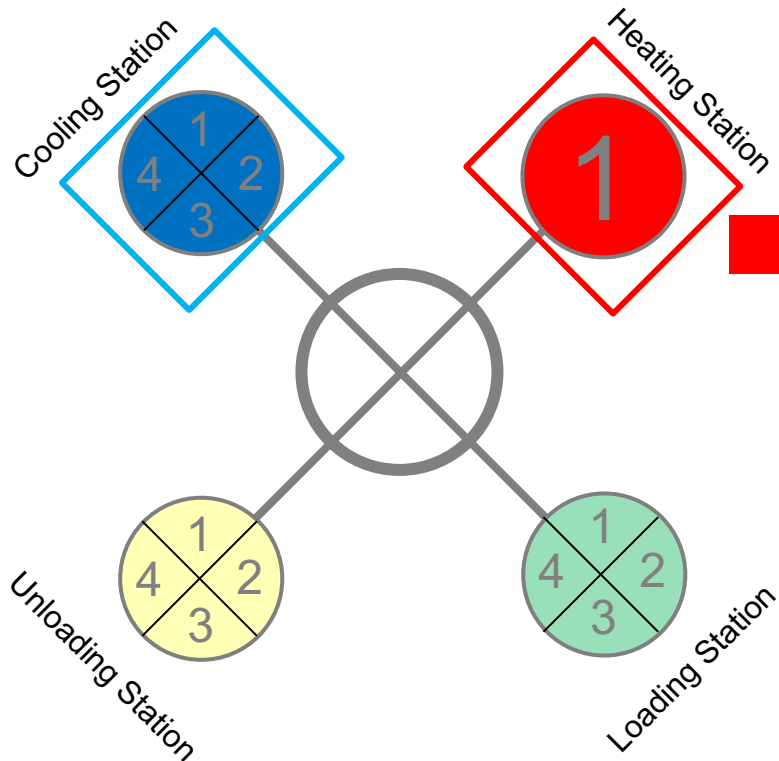
- 15 Minute Loading
- 22 Minute Heating
- 32 Minute Cooling
- 15 Minute Unloading

Total: 1 Hr 24 Minutes

or

91 Parts per Shift

Part – Ex. #1 Cycle



Adjusted Cycle Time

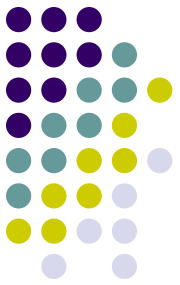
- 15 Minute Loading
- 22 Minute Heating
- 32 Minute Cooling
- 15 Minute Unloading

Total: 1 Hr 24 Minutes

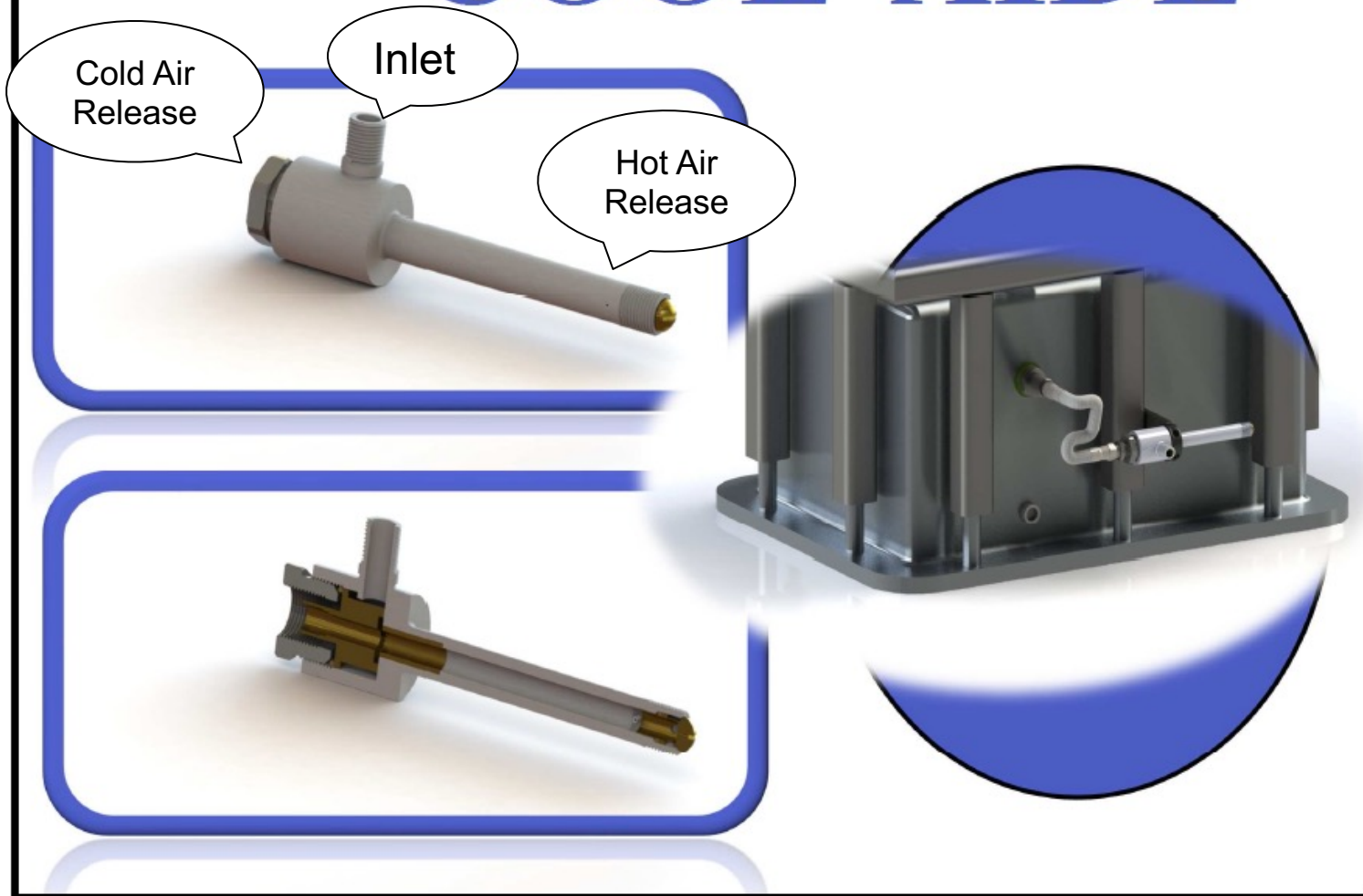
or

74 Parts per Shift

Product



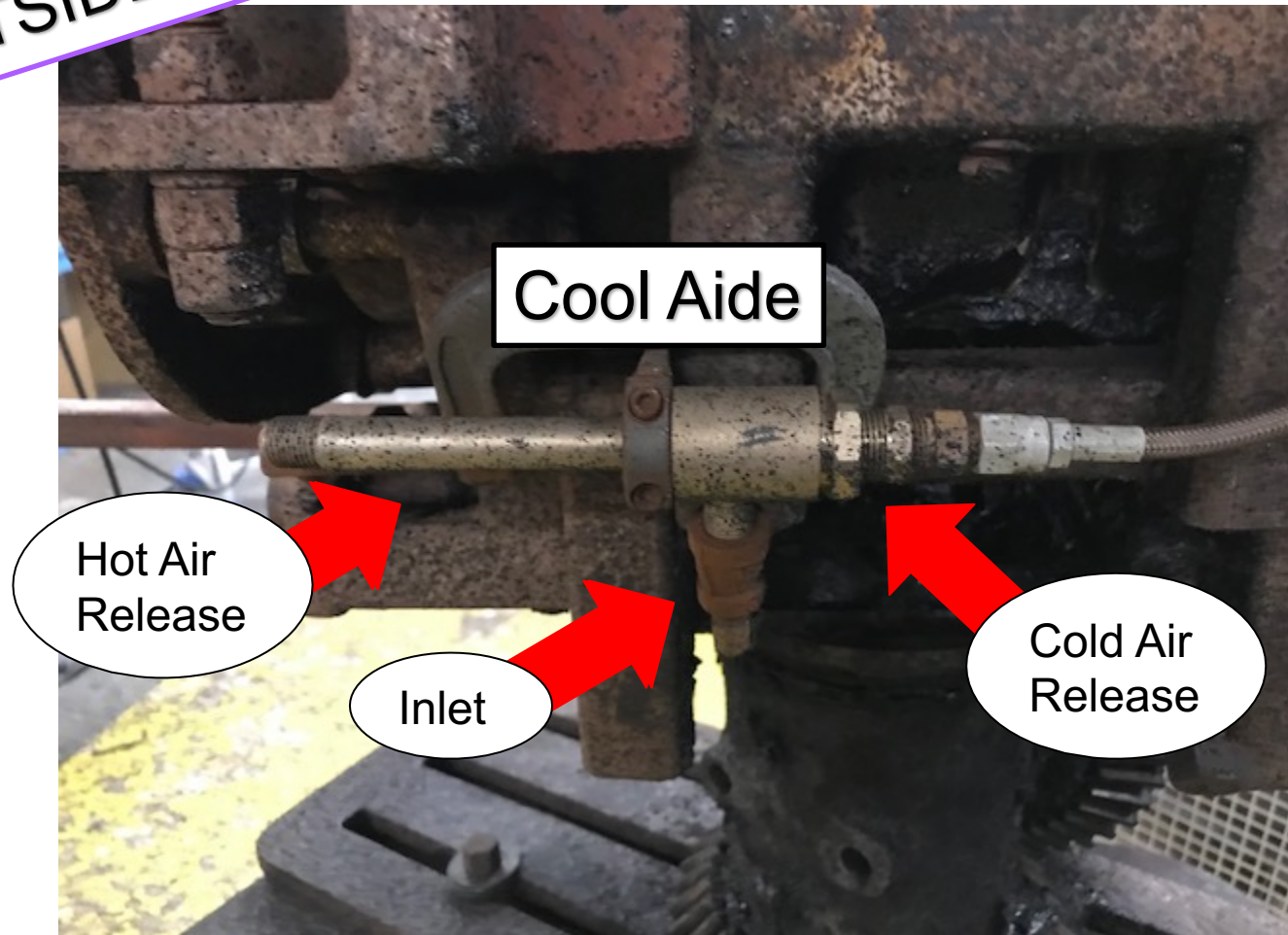
COOL AIDE



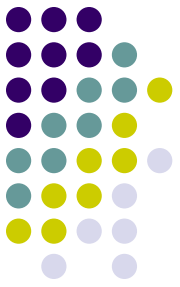
Installation- Ex. #1



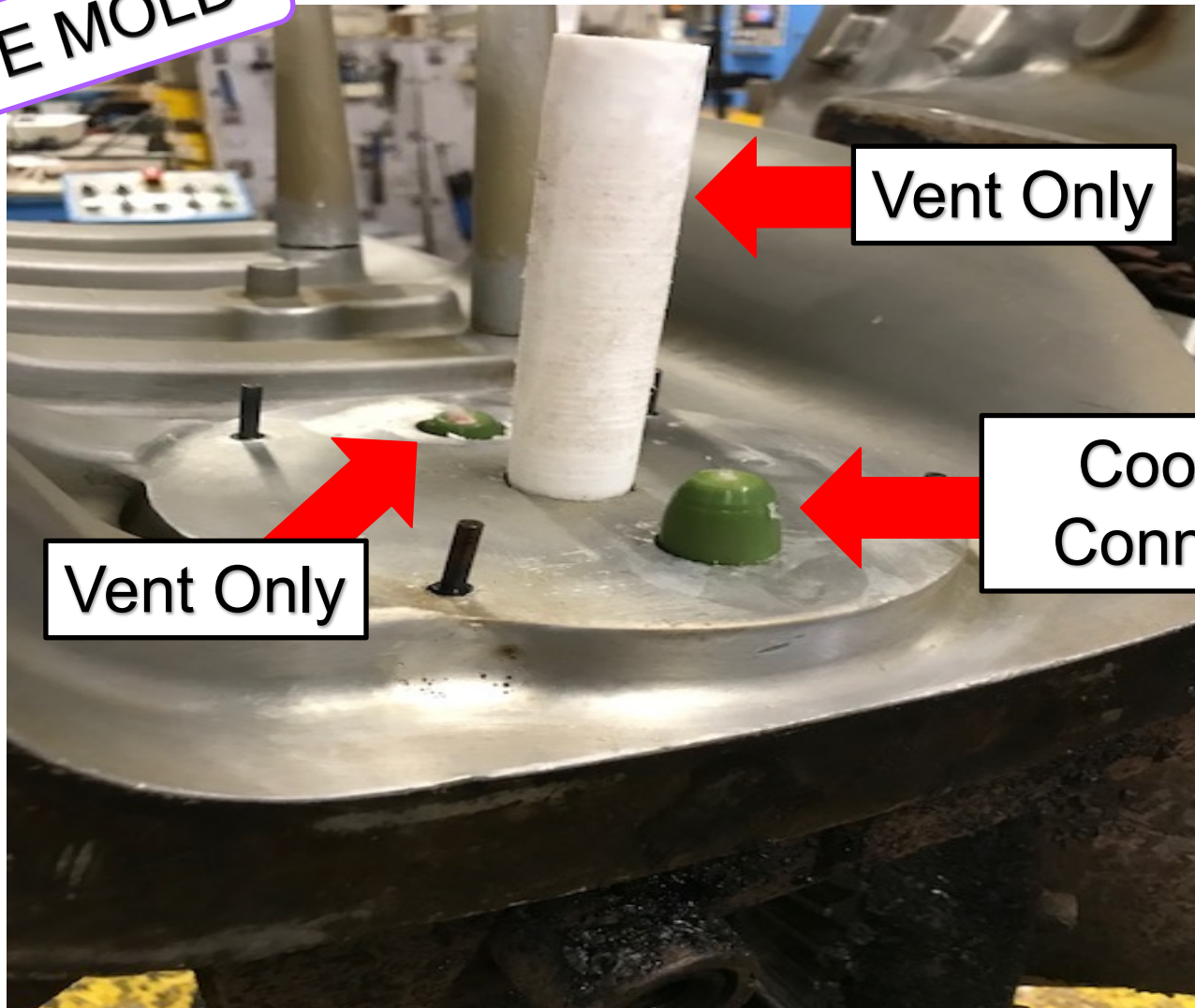
OUTSIDE MOLD



Installation-Ex. #1



INSIDE MOLD



Results – Ex. # 1



BEFORE

	Cooler Time (Minutes)	Cooling Fan	Water Spray	Exhaust Fan
1	32.0	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
2	0.0	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3	0.0	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4	0.0	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5	0.0	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6	0.0	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7	0.0	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Total Cooling Cycle Time

	High	Low
Gas Delay	4.0	0.0
Gas Time	20.0	0.0

Arm 1 Setup Undo

AFTER

	Cooler Time (Minutes)	Cooling Fan	Water Spray	Exhaust Fan	Pulse Off Revs. 0-8
1	11.0	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	3
2	7.0	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
3	2.0	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
4	0.0	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5	0.0	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
6	0.0	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
7	0.0	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

Total Cooling Cycle Time - 20.0

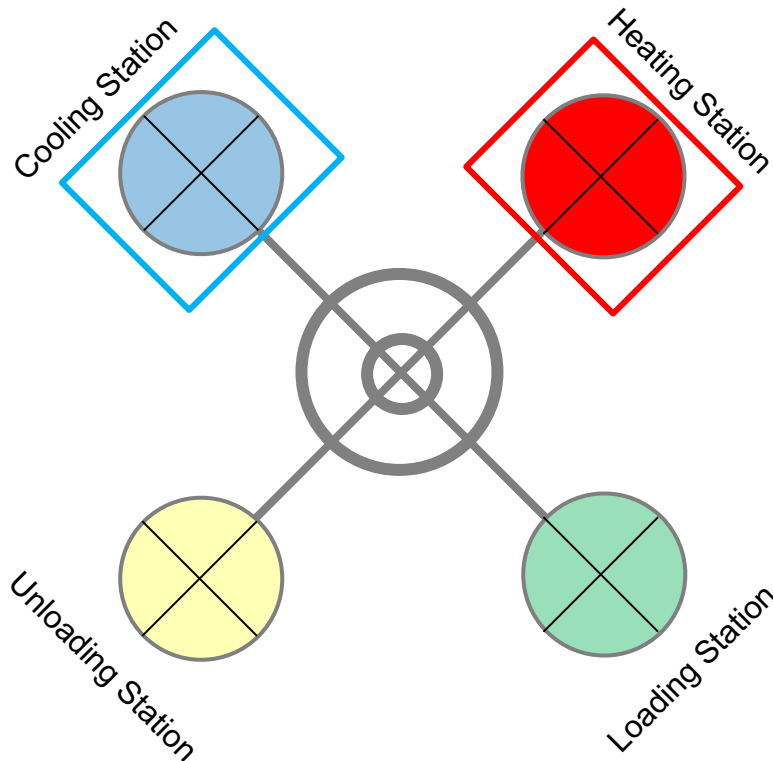
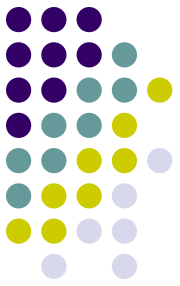
	High	Low
Gas Delay	4.0	0.0
Gas Time	20.0	20.0

IRT Parameters
Water On temp
Water Off temp
Exit Cool temp
or air secs

38%
Improvement

Standard Processing

“Typical Rotational Molding Cycle”



Adjusted Cycle Time

- 15 Minute Loading
- 22 Minute Heating
- 20 Minute Cooling
- 15 Minute Unloading

Total: 1 Hr 12 Minutes

vs.

1 Hr 24 Minutes

(15 more parts per shift)

Part – Ex. # 2



As-Molded State

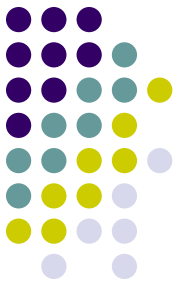
0.500"
Wall Thickness

100 lb.
Shot Charge

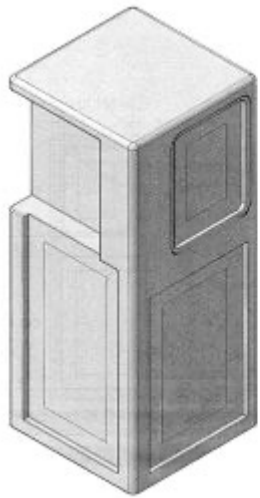
61.0" Tall



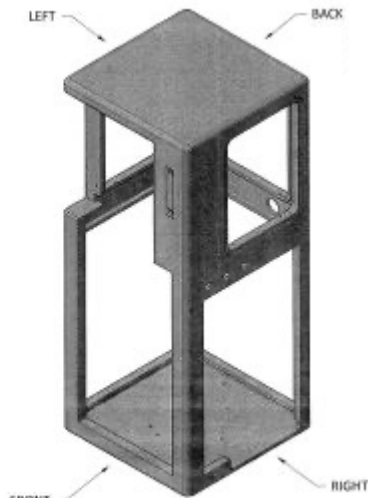
Installation- Ex. #2



- 3 Active Vent Tubes
- 1 Smart Vent for Hook Up - Cooling

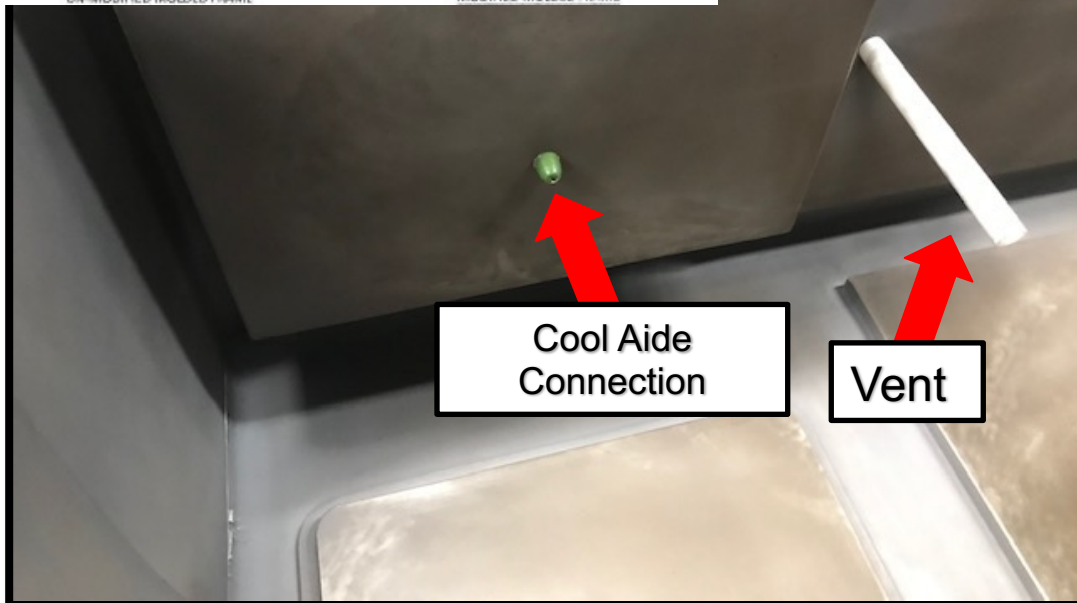


UN-MODIFIED MOLDED FRAME



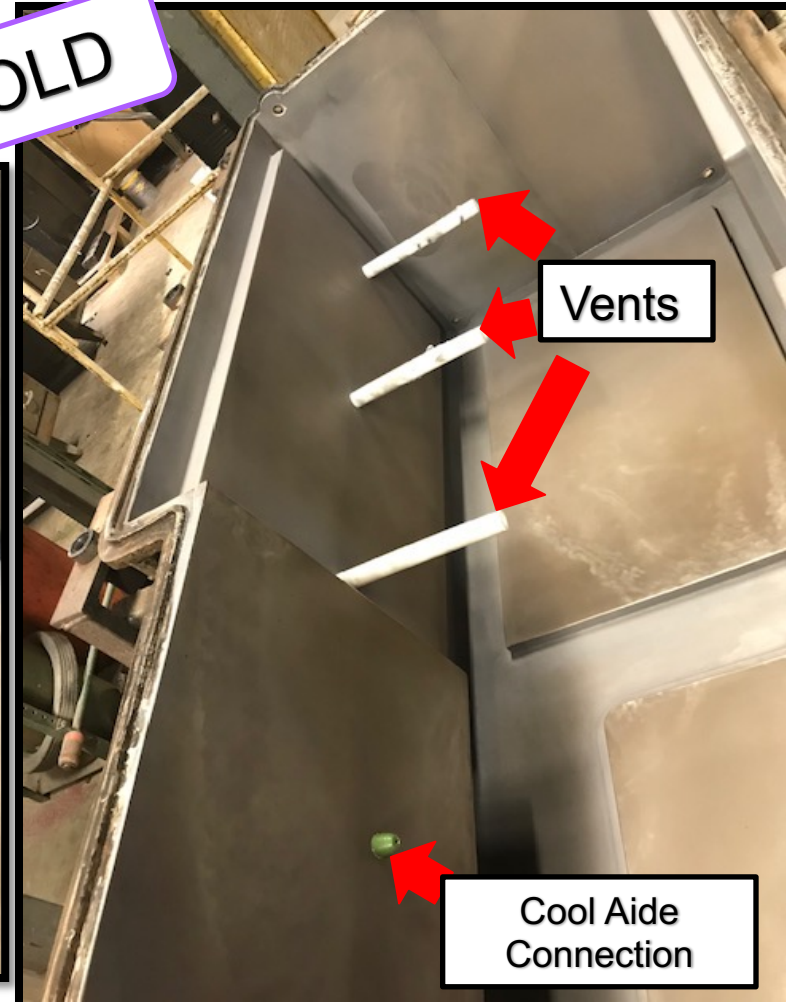
MODIFIED MOLDED FRAME

INSIDE MOLD



Cool Aide
Connection

Vent



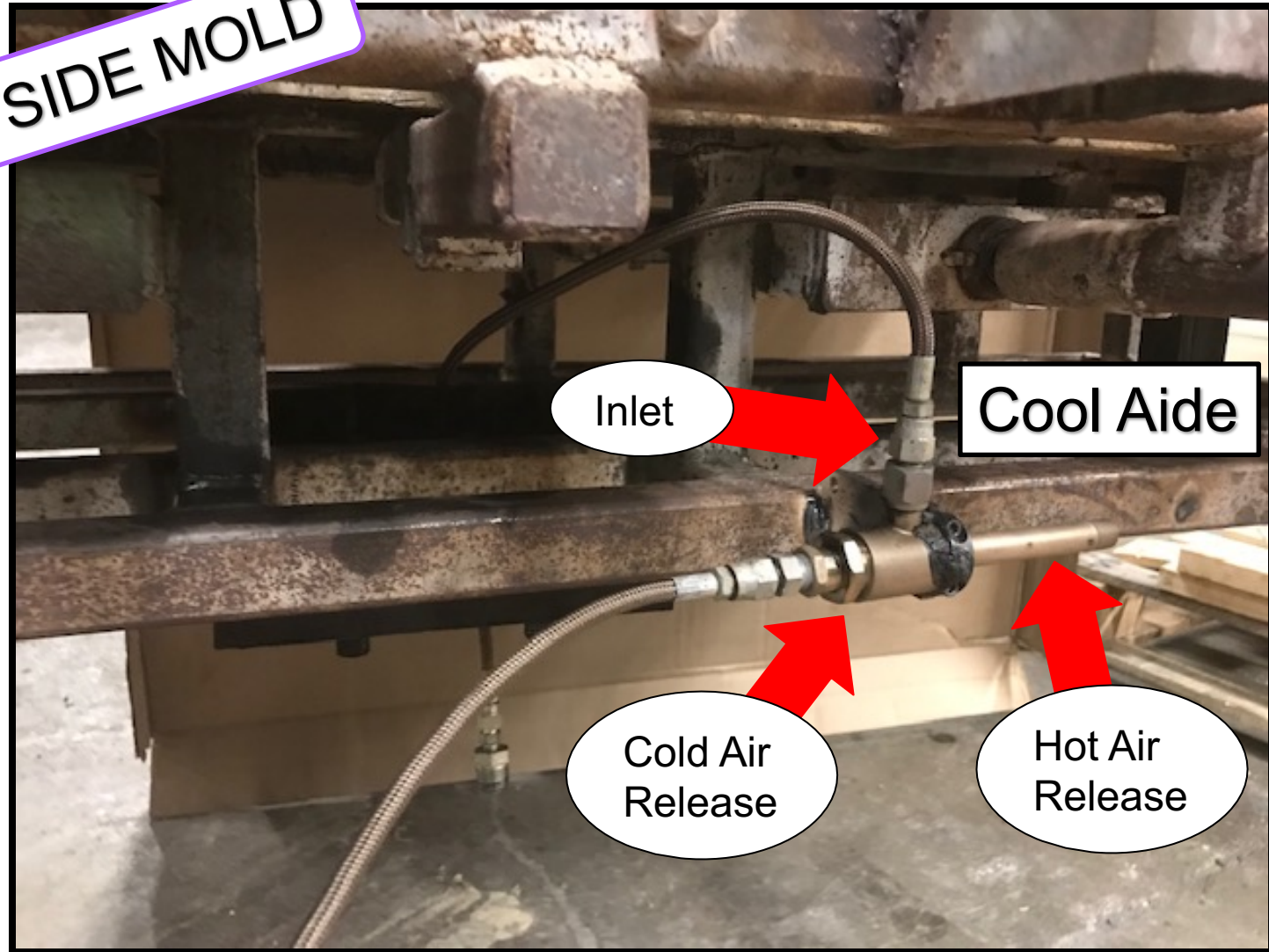
Vents

Cool Aide
Connection

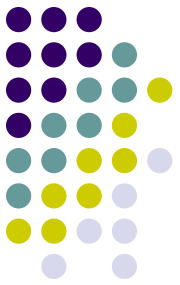
Installation- Ex. #2



OUTSIDE MOLD



Results – Ex. # 2



BEFORE

Oven Settings		Pre-Cool Settings		Cooler Settings		
Step	Cooler Time (Minutes)	Cooling Fan	Water Spray	Exhaust Fan	Pulse Off Revs. 0-8	
1	45.00	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	0	
2	0.0	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
3	0.0	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
4	0.0	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
5	0.0	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
6	0.0	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
7	0.0	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Total Cooling Cycle Time						45.0

AFTER

Oven Time Remaining		User: Operator		12/10/2018 9:20:19 AM		Fault 162 - Oven Empty - Arm 2 Waiting	
0:00		Oven Settings		Pre-Cool Settings		Cooler Settings	
Pre-Cool Time Remaining		Cooler Time (Minutes)		Cooling Fan		Water Spray	
0:00		Step		Exhaust Fan		Pulse Off Revs. 0-8	
Cooler Time Remaining		1		<input checked="" type="checkbox"/>		0	
0:00		2		<input checked="" type="checkbox"/>			
		3		<input checked="" type="checkbox"/>			
		4		<input type="checkbox"/>			
		5		<input type="checkbox"/>			
		6		<input type="checkbox"/>			
		7		<input type="checkbox"/>			
						Total Cooling Cycle Time	
						25.0	

44%
Improvement

INTERNAL COOLING

COOL-AIDE BY ROTO MART

Process Optimization Committee

Corey Eystad – Revolv Mfg

2022





PURPOSE

- The intentions of this test was to reinforce Ron Joannou's case study using Cool Aide
- Identify a method to reduce cycle time on our current parts/future opportunities that have thicker wall.

Cool air inlet

COOL-AIDE

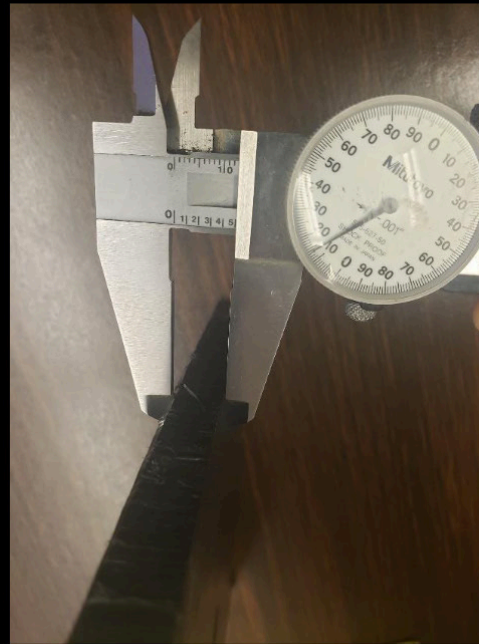
Shop air inlet

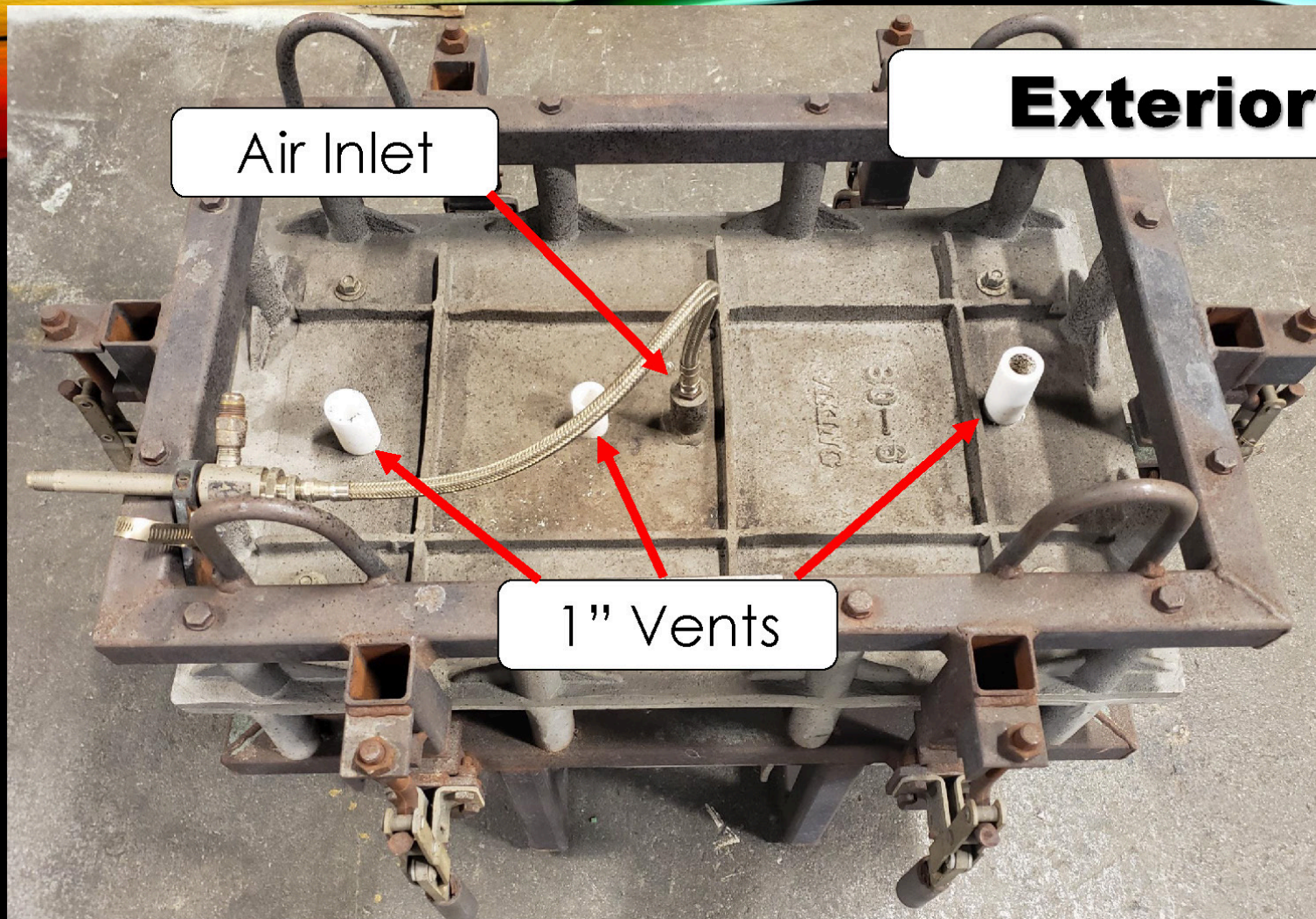
Hot air outlet



TESTING

Using a Ferry 330, we took an obsolete cast aluminum mold and produced a part that has a $\frac{1}{2}$ " wall. The part is roughly 23" x 13" x 12". We were not concerned about warpage at this stage as much as we are about overall cycle reduction.



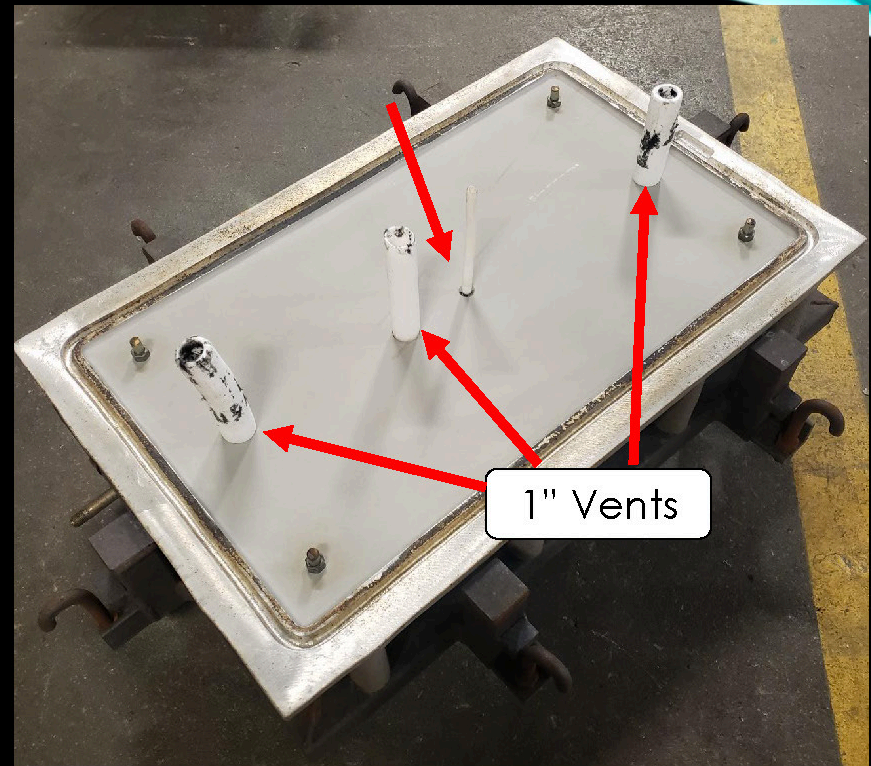


Exterior

Air Inlet

1" Vents

Interior



We used fiberglass for venting media

RUN #1

			Step 1	Step 2	Step 3	Step 4	Step 5
		Oven Temp (°F):	600				
		Oven Time (min):	26				
		Arm Speed (rpm):	3.5				
		Plate Speed (rpm):	0.5				
		Reverse Time (min):	4				
COOLING			Delay (min)	Time (min)	Cool Fan	Water	Exhaust
		Pre-Cool:					
		Cooling Step 1:		14	X		
		Cooling Step 2:		4		X	
		Cooling Step 3:		5	X		
		Cooling Step 4:		4		X	
		Cooling Step 5:		7	X		
		Cooling Step 6:					
			Total Cool Time:	34			

*34 minute cool time with no internal air, just fan and water.

RUN #6

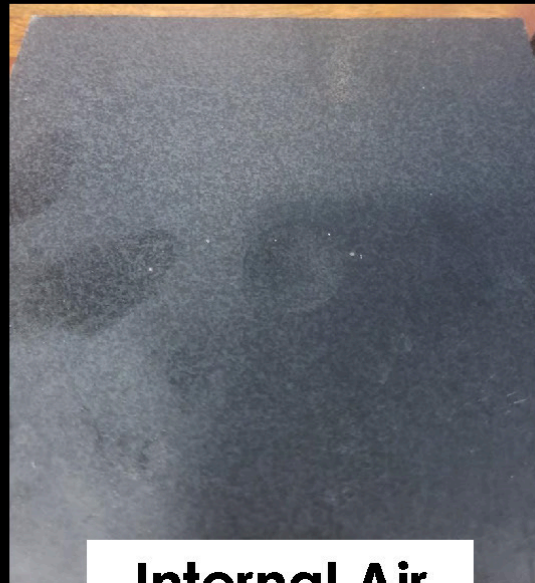
*23 minute cool time
with using the Cool-
Aide internal air.

COOLING AIR	Delay (min)	Time (min)
High:	6	18
Low:		

			Step 1	Step 2	Step 3	Step 4	Step 5
		Oven Temp (°F):	600				
		Oven Time (min):	26				
		Arm Speed (rpm):	3.5				
		Plate Speed (rpm):	0.5				
		Reverse Time (min):	4				
COOLING			Delay (min)	Time (min)	Cool Fan	Water	Exhaust
		Pre-Cool:					
		Cooling Step 1:		10	X		
		Cooling Step 2:		9		X	
		Cooling Step 3:		4	X		
		Total Cool Time:		23			

IMPACT TEST RESULTS

We conducted an impact test 150ft/lbs @ -40F. As shown in the photos, there was no difference in performance with Cool Aide.



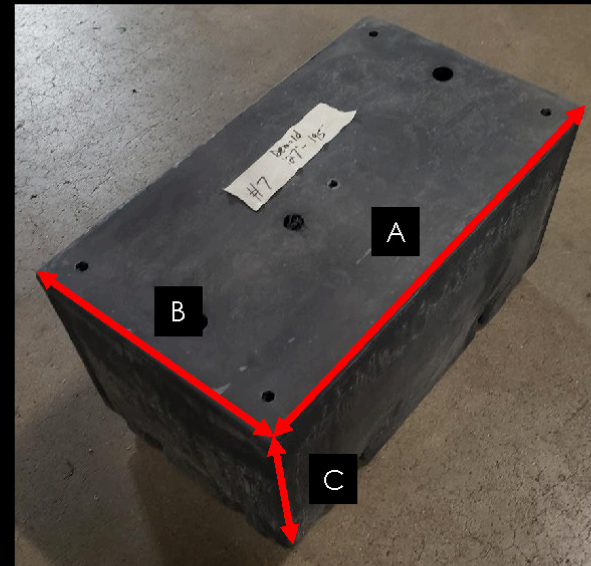
Internal Air



No Internal Air

SHRINK RATE IMPACTS

Run 1	Part # 1 w/out internal air	
	A (L)	23.25"
	B (W)	13.125"
	C (H)	12.125"
Run 7	Part #7 w/ internal air	
	A (L)	23.25"
	B (W)	13.125"
	C (H)	12.125"



RESULTS

- Started with a 34 minute cool time using fans and water
- We ran a total of 6 runs, decreasing the delay of the internal air each run.
- Finished with a 23 minute cool time using fans, water, and Cool-Aide internal air
- The end result was a **32%** reduction in overall cool time.



THANK YOU!

QUESTIONS?