Optimizing Design Is Hard Enough—What Can You Do About Cosmetics Issues

Jorge Santos

Mold Flow Analyst

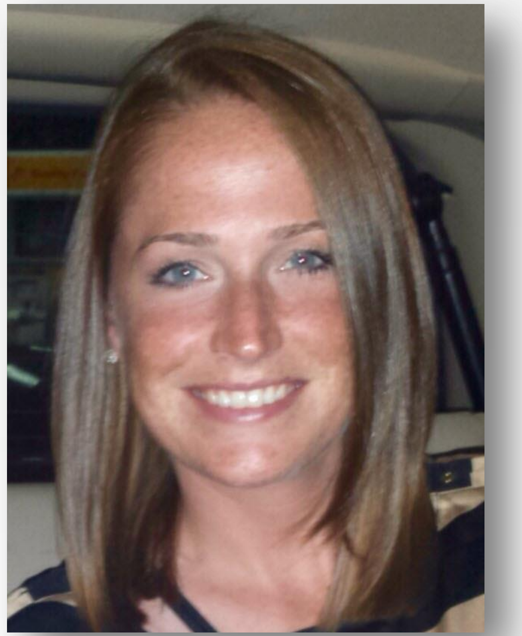
Advance Engineering, Research & Innovation

Class summary

Sometimes after optimizing a design for manufacturing, unexpected issues can occur. This was the situation with a recent case. An existing design had issues with excessive pressure, flash, and sink. The apparent root cause was a premature freeze off. Design iterations were analyzed and a particular option was used and was thought to have solved the issue. However, after the initial success the manufacturing process started to create cosmetic issues. Cosmetic defects can be much more challenging to troubleshoot. This presentation describes this case study, some old techniques, and recently added capabilities (Moldflow Insight 2016 software), such as path lines.

Your Instructors

Jorge Santos has over 25 years of experience in engineering applications, working and developing solutions for the injection molding industry, particularly healthcare. Jorge’s knowledge as a lead senior designer, projected him to become proficient in DFx, as well as a Moldflow and FEA analyst. Currently, Jorge is responsible for supporting the West Innovation team.



Caitlin Tschappat is a Technical Support Specialist and has been working with Autodesk for two and a half years. Her main focus is on Autodesk Moldflow as she has a degree in Plastics Engineering Technology obtained from Penn State Erie – The Behrend College.

Key learning objectives

At the end of this class, you will be able to:

- Discover what's available to troubleshoot cosmetic issues
- Discover the difference between direct cause and root cause
- Discover what you cannot analyze with Simulation Moldflow
- Become familiar with and learn how to apply Simulation Moldflow 2016 path line results

Agenda

- Company Overview
- Case Study Initial Issue
- Case Study – Secondary Issue
- Predicting Cosmetic Defects
- Takeaways

Company Overview

Every Day, West Products…

Touch Millions of People

Saving Lives

Eradicating Disease

Managing Wellness

Autoimmune diseases

Hemophilia

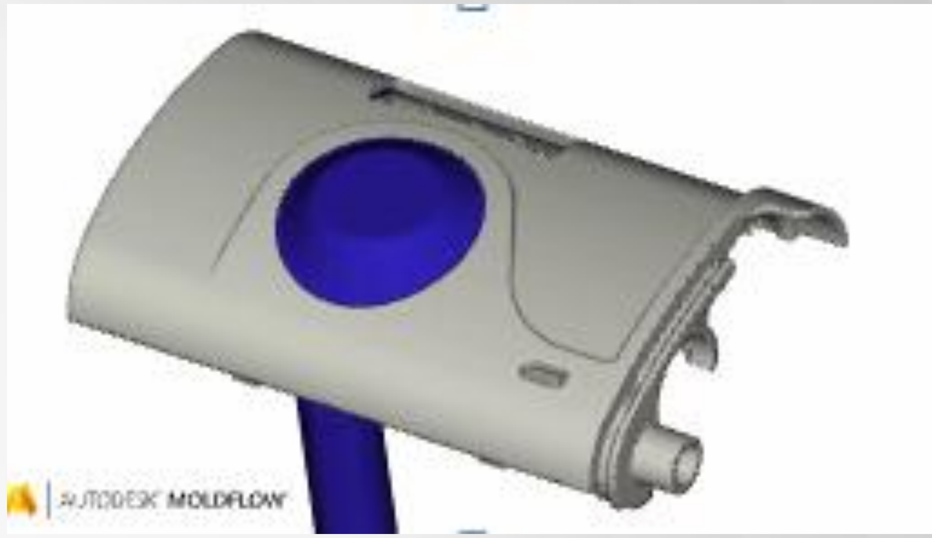
Diabetes

Cancer

West Corporate Profile

- Premier partner to the pharmaceutical and biotech industry
- Founded in 1923
- HQ in Exton, PA
- 7250+ employees
- Global presence: 30+ locations
- Public company NYSE: WST
- 2014 sales: $1.4 billion
- Customer satisfaction, quality and service are the foundation of our business

Product Overview



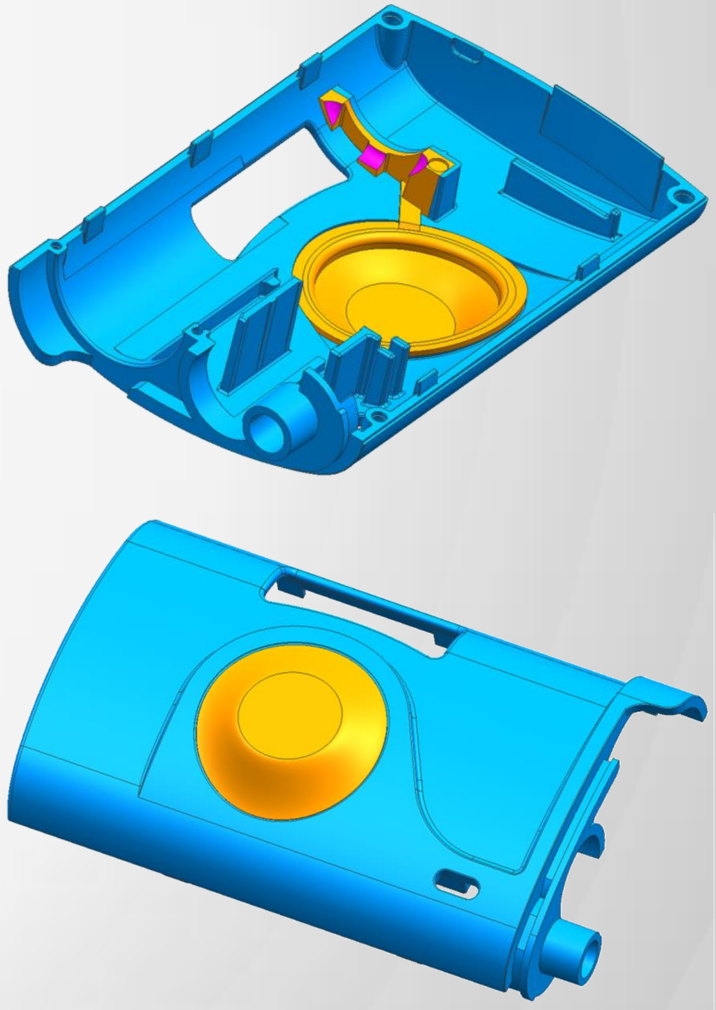
Goal:
To evaluate Fill, and flow behavior.

Material Data:
1st Shot - Makrolon 2458 (Bayer Material Science)
OverMold – Dynaflex G7940 (GLS Corporation)

Gating:
1st Shot - Valve gate Ø .040“
OverMold – Valve Gate Ø .030”

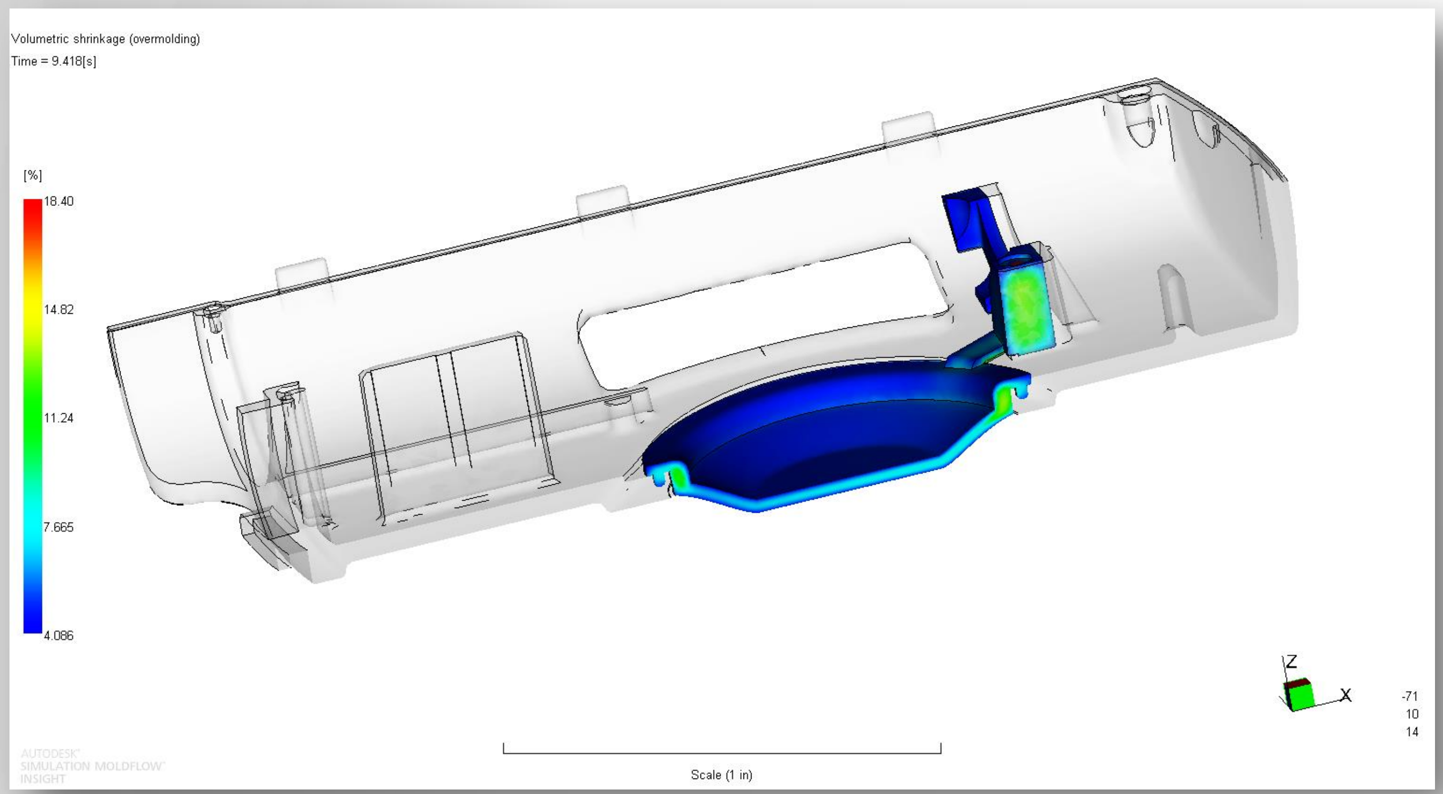
Notes:
Gating information are worst case scenario. Please take in consideration manufacturers recommendations.
Processing parameters used for this analysis, are per Molding Window recommendations and should be used as a starting point.

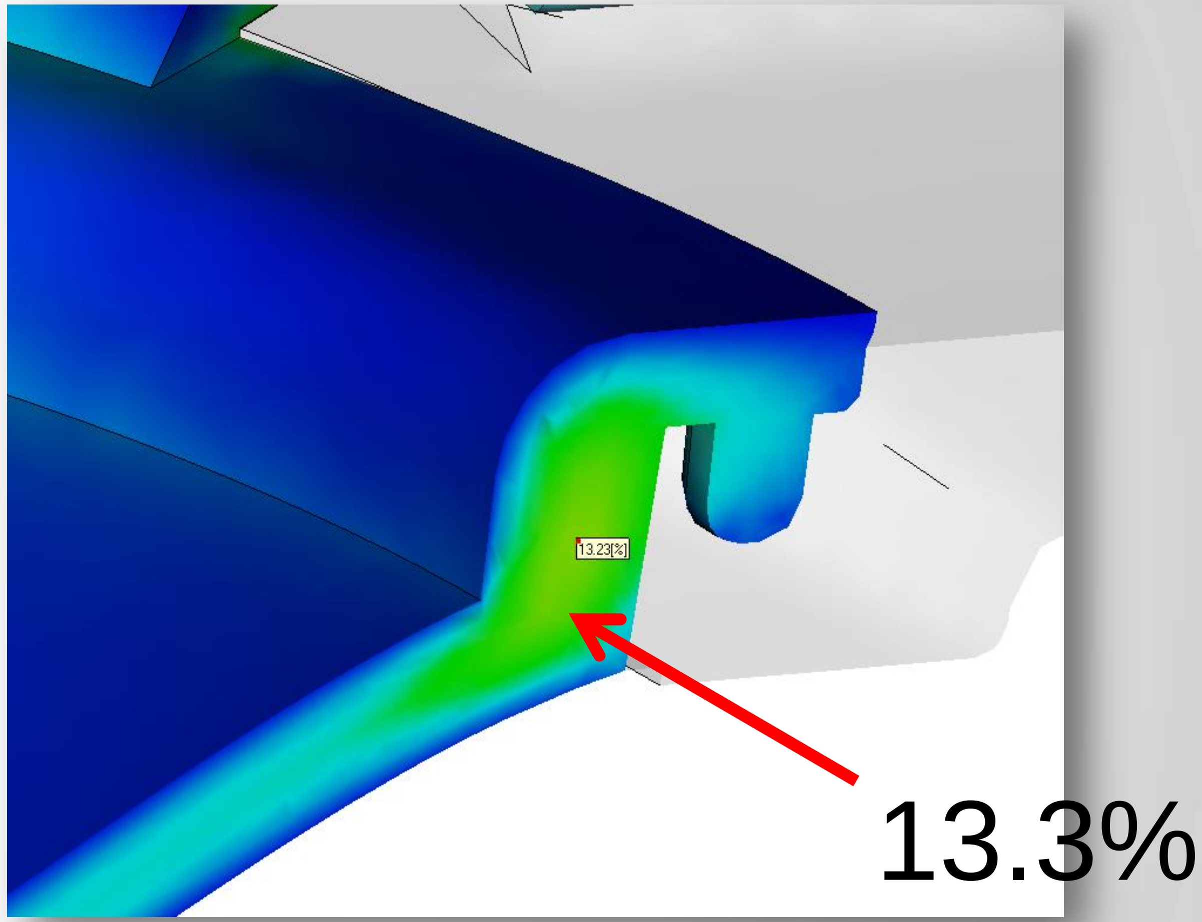
Summary:
The gates type, locations, and size selected, appears to be the most suitable for the selected application. Part quality prediction, mold and melt temperatures are adequate for the processability of this part. Predicted pressures required to fill and pack the part are well within manufacturer's recommended specifications.



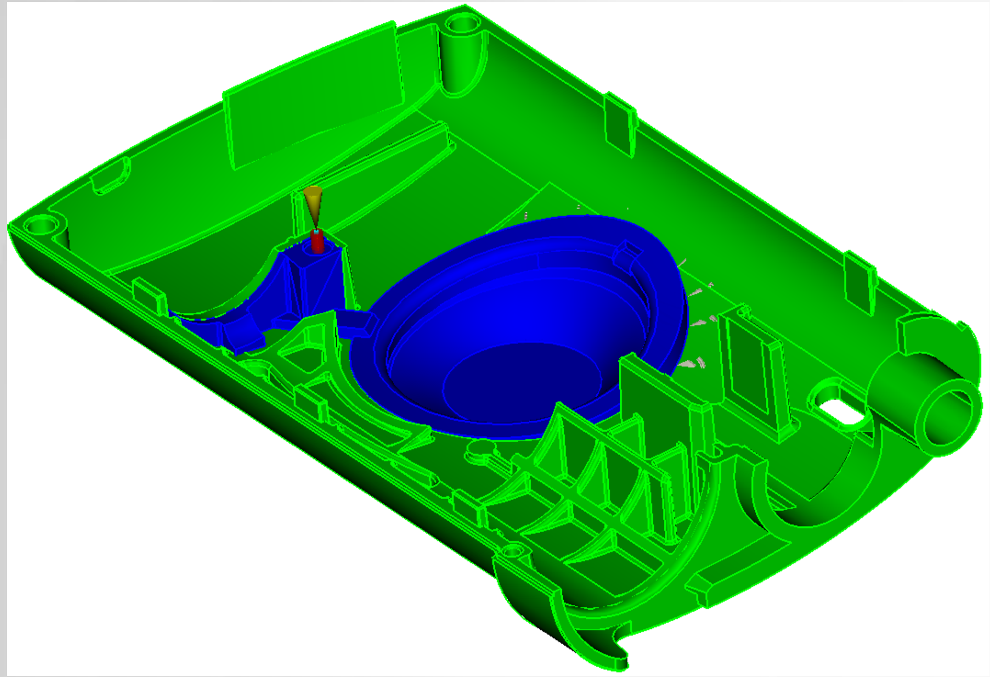
Case Study
Initial Issue

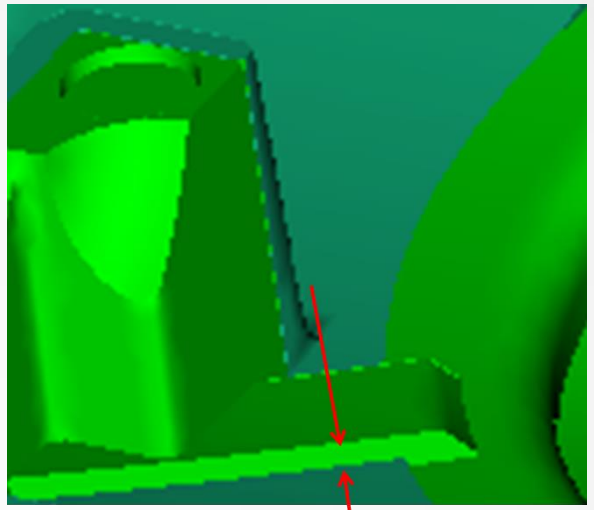
Initial Issue - Sink



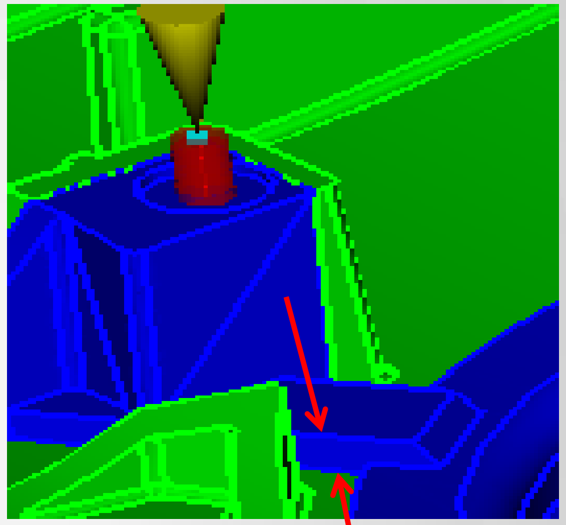


Gate Dimensional Change

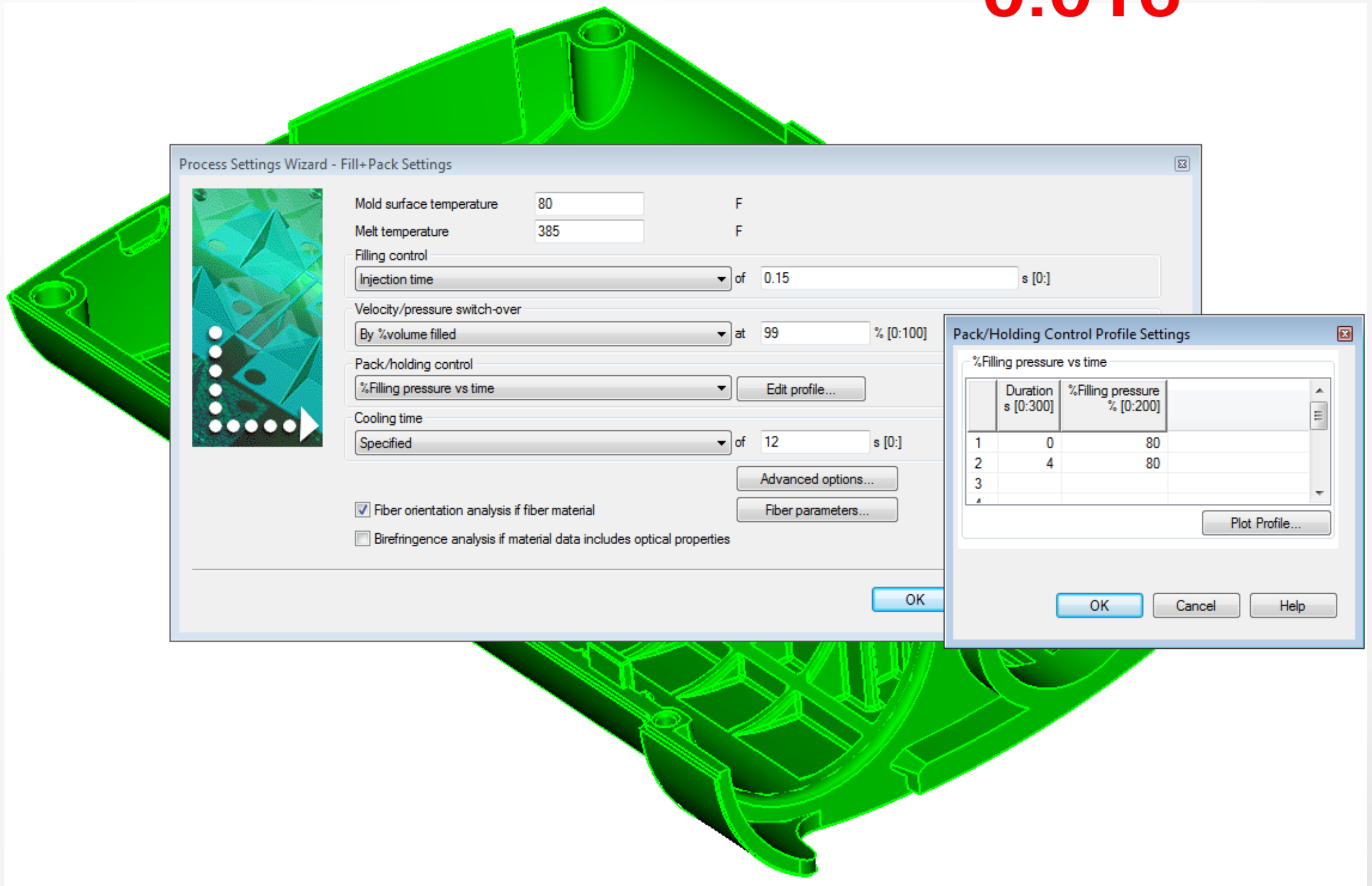




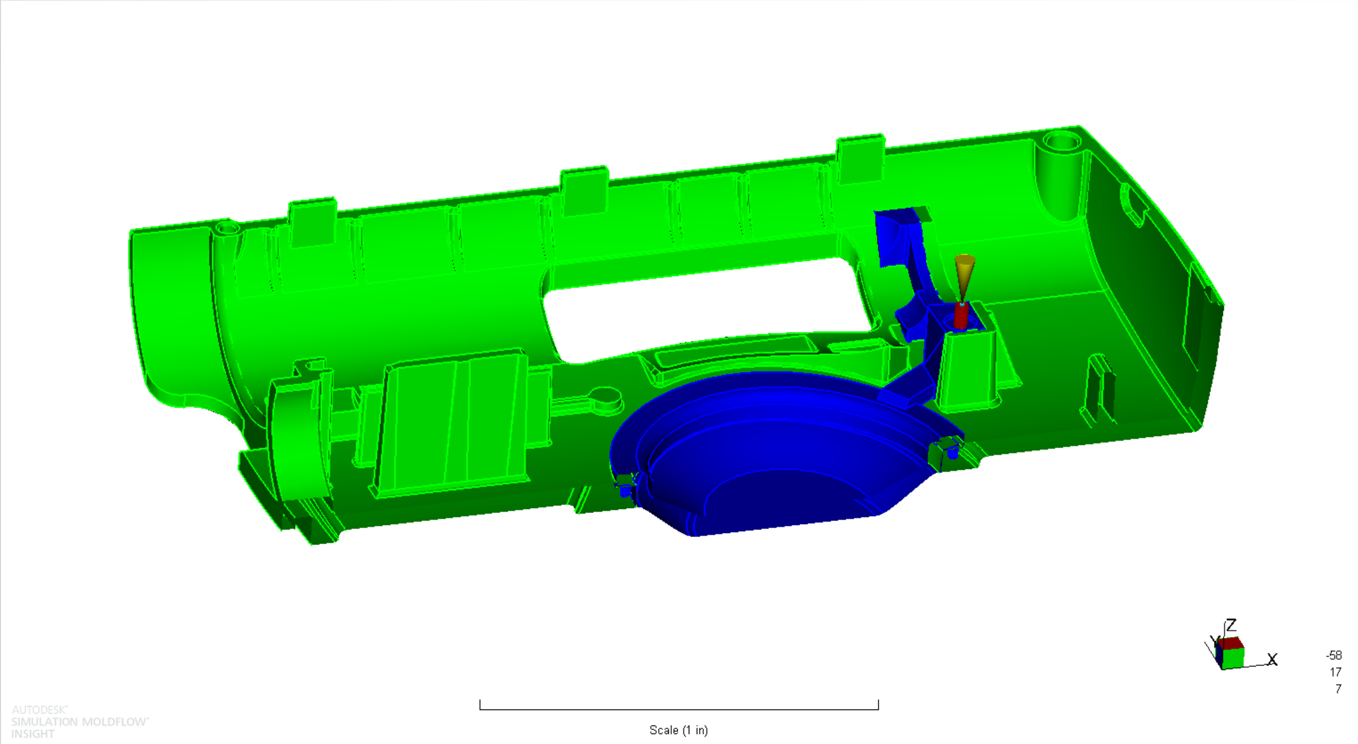
0.016”

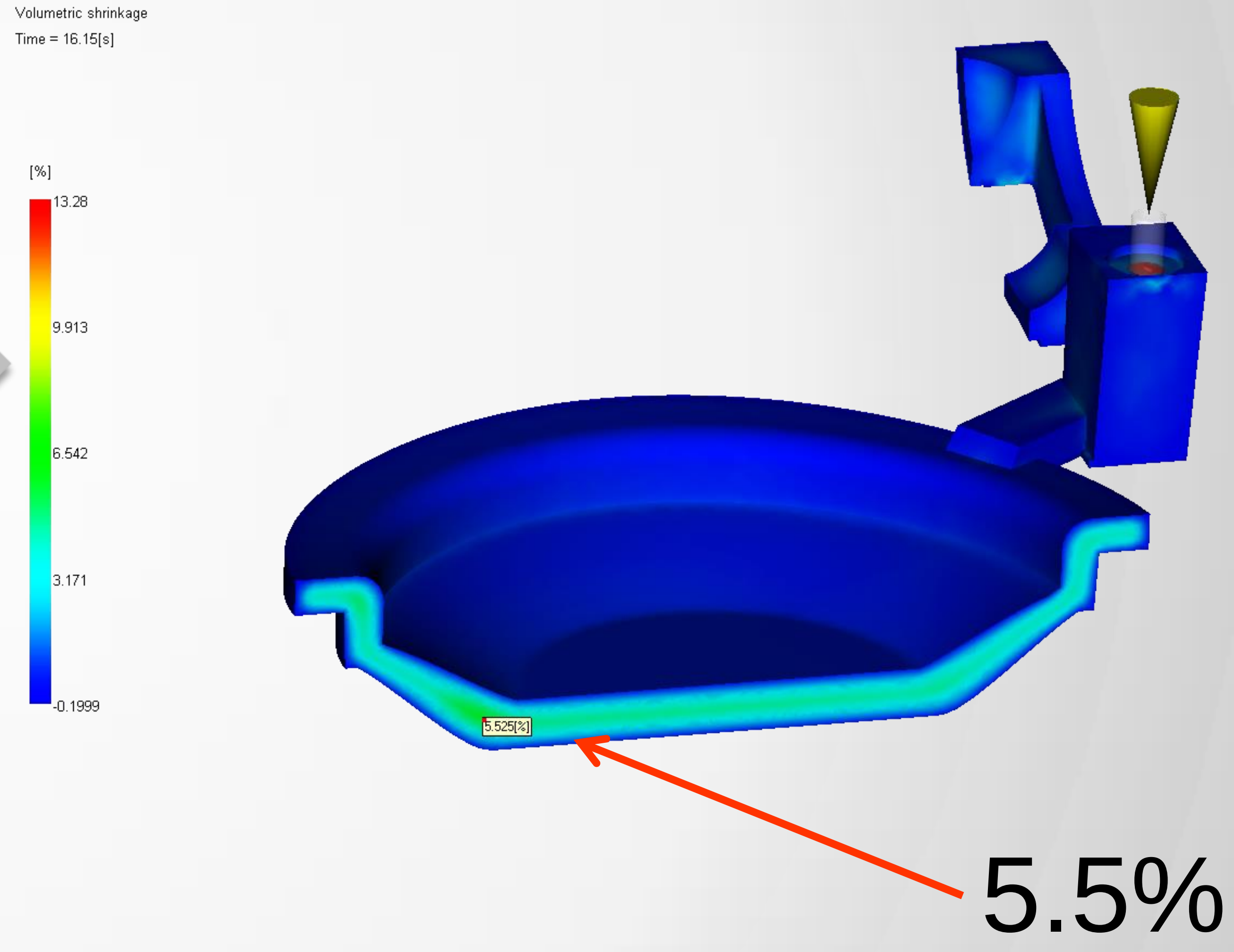


0.022”



Initial Issue – Sink

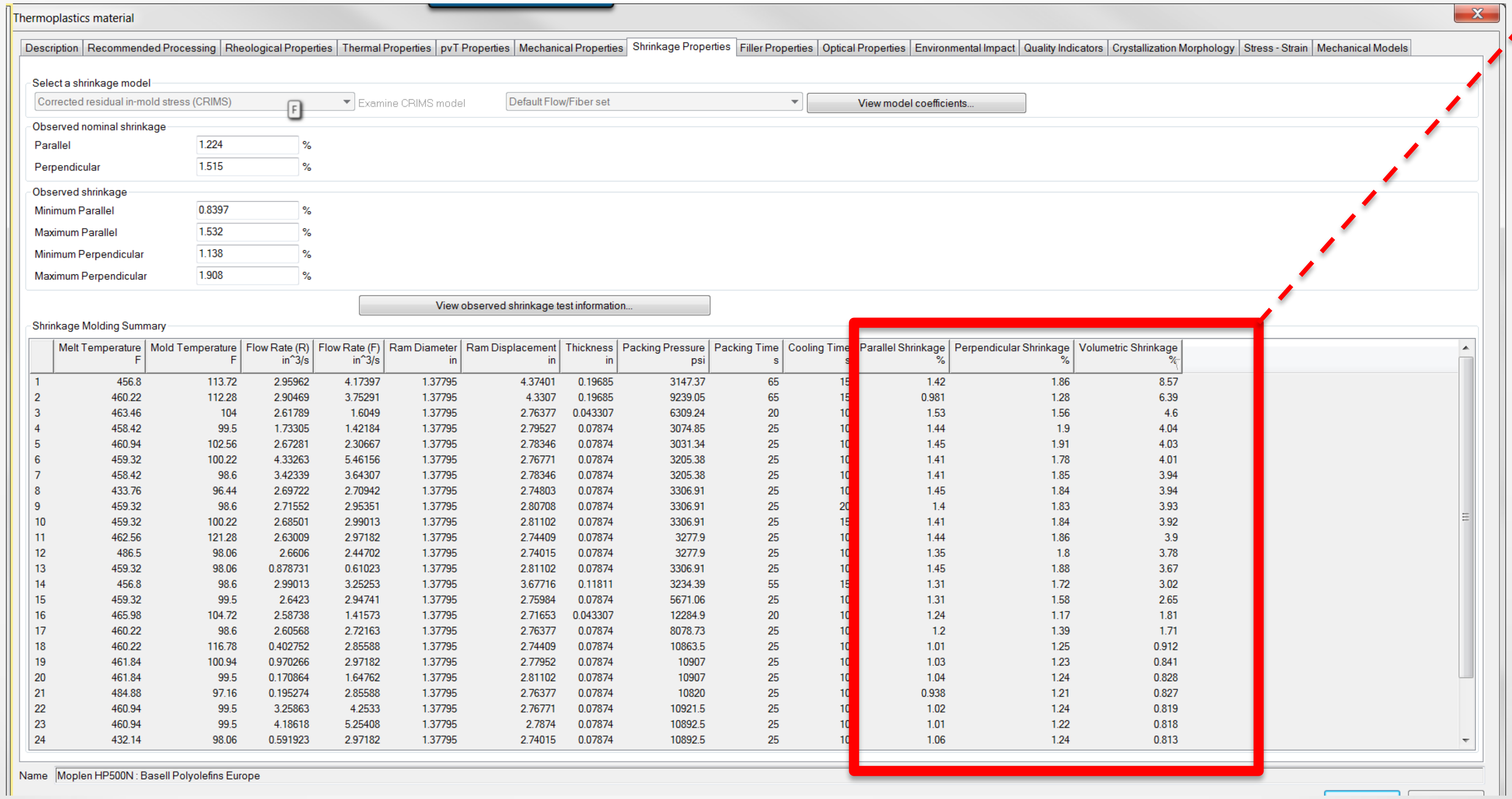




Understanding Volumetric Shrinkage

Parallel Shrinkage %	Perpendicular Shrinkage %	Volumetric Shrinkage %
1.42	1.86	8.57
0.981	1.28	6.39
1.53	1.56	4.6
1.44	1.9	4.04
1.45	1.91	4.03
1.41	1.78	4.01
1.41	1.85	3.94
1.45	1.84	3.94
1.4	1.83	3.93
1.41	1.84	3.92
1.44	1.86	3.9
1.35	1.8	3.78
1.45	1.88	3.67
1.31	1.72	3.02
1.31	1.58	2.65
1.24	1.17	1.81
1.2	1.39	1.71
1.01	1.25	0.912
1.03	1.23	0.841
1.04	1.24	0.828
0.938	1.21	0.827
1.02	1.24	0.819
1.01	1.22	0.818
1.06	1.24	0.813

- Experience
- Actual Shrinkage Data Range
- Typical Values for this Type of Material



Thermoplastics material

Description | Recommended Processing | Rheological Properties | Thermal Properties | pvT Properties | Mechanical Properties | Shrinkage Properties | Filler Properties | Optical Properties | Environmental Impact | Quality Indicators | Crystallization Morphology | Stress - Strain | Mechanical Models

Select a shrinkage model

Corrected residual in-mold stress (CRIMS) | Examine CRIMS model | Default Flow/Fiber set | View model coefficients...

Observed nominal shrinkage

Parallel	1.224	%
Perpendicular	1.515	%

Observed shrinkage

Minimum Parallel	0.8397	%
Maximum Parallel	1.532	%
Minimum Perpendicular	1.138	%
Maximum Perpendicular	1.908	%

View observed shrinkage test information...

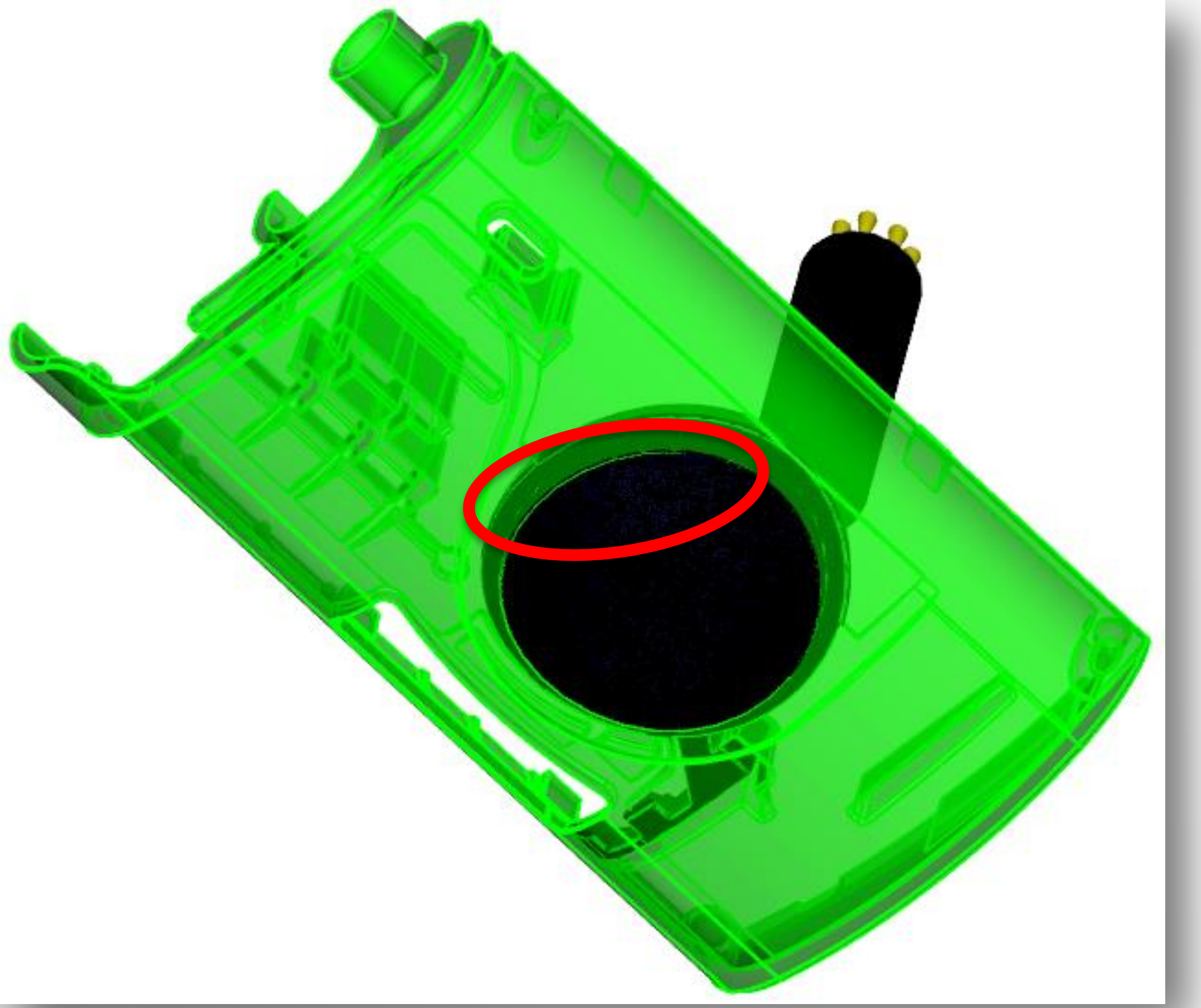
Shrinkage Molding Summary

	Melt Temperature F	Mold Temperature F	Flow Rate (R) in^3/s	Flow Rate (F) in^3/s	Ram Diameter in	Ram Displacement in	Thickness in	Packing Pressure psi	Packing Time s	Cooling Time s	Parallel Shrinkage %	Perpendicular Shrinkage %	Volumetric Shrinkage %
1	456.8	113.72	2.95962	4.17397	1.37795	4.37401	0.19685	3147.37	65	15	1.42	1.86	8.57
2	460.22	112.28	2.90469	3.75291	1.37795	4.3307	0.19685	9239.05	65	15	0.981	1.28	6.39
3	463.46	104	2.61789	1.6049	1.37795	2.76377	0.043307	6309.24	20	10	1.53	1.56	4.6
4	458.42	99.5	1.73305	1.42184	1.37795	2.79527	0.07874	3074.85	25	10	1.44	1.9	4.04
5	460.94	102.56	2.67281	2.30667	1.37795	2.78346	0.07874	3031.34	25	10	1.45	1.91	4.03
6	459.32	100.22	4.33263	5.46156	1.37795	2.76771	0.07874	3205.38	25	10	1.41	1.78	4.01
7	458.42	98.6	3.42339	3.64307	1.37795	2.78346	0.07874	3205.38	25	10	1.41	1.85	3.94
8	433.76	96.44	2.69722	2.70942	1.37795	2.74803	0.07874	3306.91	25	10	1.45	1.84	3.94
9	459.32	98.6	2.71552	2.95351	1.37795	2.80708	0.07874	3306.91	25	20	1.4	1.83	3.93
10	459.32	100.22	2.68501	2.99013	1.37795	2.81102	0.07874	3306.91	25	15	1.41	1.84	3.92
11	462.56	121.28	2.63009	2.97182	1.37795	2.74409	0.07874	3277.9	25	10	1.44	1.86	3.9
12	486.5	98.06	2.6606	2.44702	1.37795	2.74015	0.07874	3277.9	25	10	1.35	1.8	3.78
13	459.32	98.06	0.878731	0.61023	1.37795	2.81102	0.07874	3306.91	25	10	1.45	1.88	3.67
14	456.8	98.6	2.99013	3.25253	1.37795	3.67716	0.11811	3234.39	55	15	1.31	1.72	3.02
15	459.32	99.5	2.6423	2.94741	1.37795	2.75984	0.07874	5671.06	25	10	1.31	1.58	2.65
16	465.98	104.72	2.58738	1.41573	1.37795	2.71653	0.043307	12284.9	20	10	1.24	1.17	1.81
17	460.22	98.6	2.60568	2.72163	1.37795	2.76377	0.07874	8078.73	25	10	1.2	1.39	1.71
18	460.22	116.78	0.402752	2.85588	1.37795	2.74409	0.07874	10863.5	25	10	1.01	1.25	0.912
19	461.84	100.94	0.970266	2.97182	1.37795	2.77952	0.07874	10907	25	10	1.03	1.23	0.841
20	461.84	99.5	0.170864	1.64762	1.37795	2.81102	0.07874	10907	25	10	1.04	1.24	0.828
21	484.88	97.16	0.195274	2.85588	1.37795	2.76377	0.07874	10820	25	10	0.938	1.21	0.827
22	460.94	99.5	3.25863	4.2533	1.37795	2.76771	0.07874	10921.5	25	10	1.02	1.24	0.819
23	460.94	99.5	4.18618	5.25408	1.37795	2.7874	0.07874	10892.5	25	10	1.01	1.22	0.818
24	432.14	98.06	0.591923	2.97182	1.37795	2.74015	0.07874	10892.5	25	10	1.06	1.24	0.813

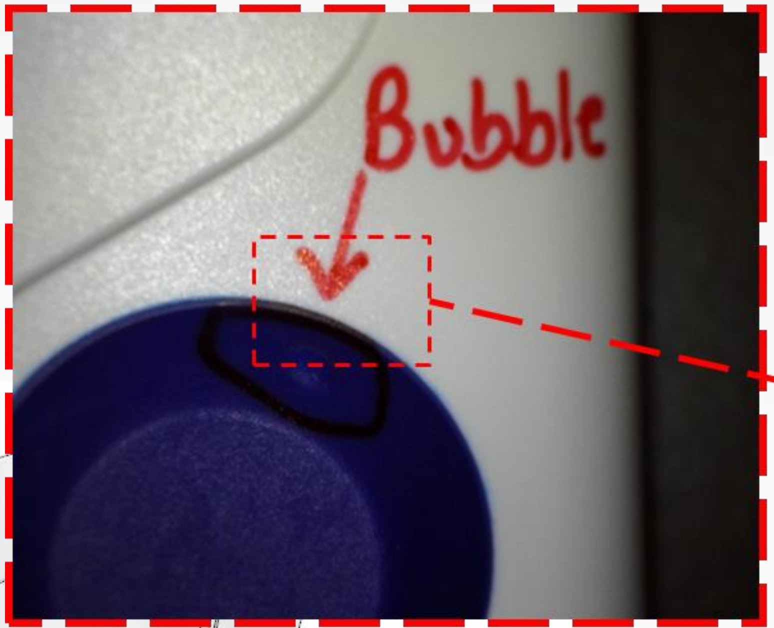
Name: Moplen HP500N : Basell Polyolefins Europe

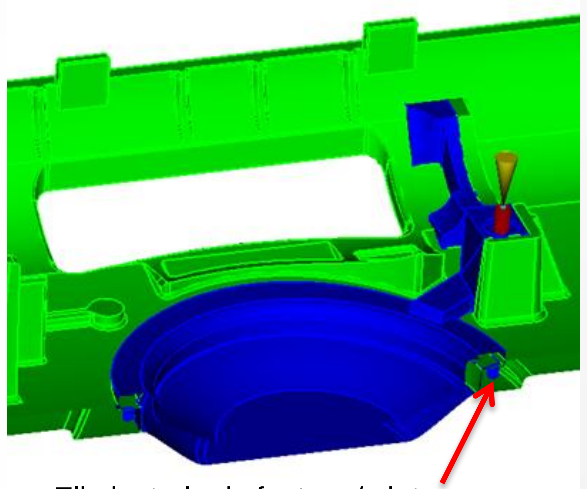
Case Study
Secondary Issue
Material Change

Surface Defect



Jetting & Bubbles





Eliminated grip feature / air trap

✓ Modeling Jetting Check List

- ❑ Mesh Type 3D
  - ❑ 3D mesh for part
  - ❑ 3D Gates and feed systems will improve predicted shear history
  - ❑ No less than 10 tetra through thickness
  - ❑ May need to refine *Ratio of maximum tetra edge length in thickness
- ❑ Advanced Setting
  - ❑ Inertia effects on
  - ❑ Gravity effects should be on if applicable (Large volume, low viscosity etc..)
  - ❑ Intermediate results setting 50-250 or set manually based on quick fill (could be in region of 0.001s)
  - ❑ Time steps may help improve resolution
- ❑ Results
  - ❑ When viewing the results, the "Polymer fill region" plot will display jetting best.
  - ❑ Jetting will stop as soon as the flow front touches the wall so slippage unless using the Scandium Lab

✓ Modeling Venting Check List

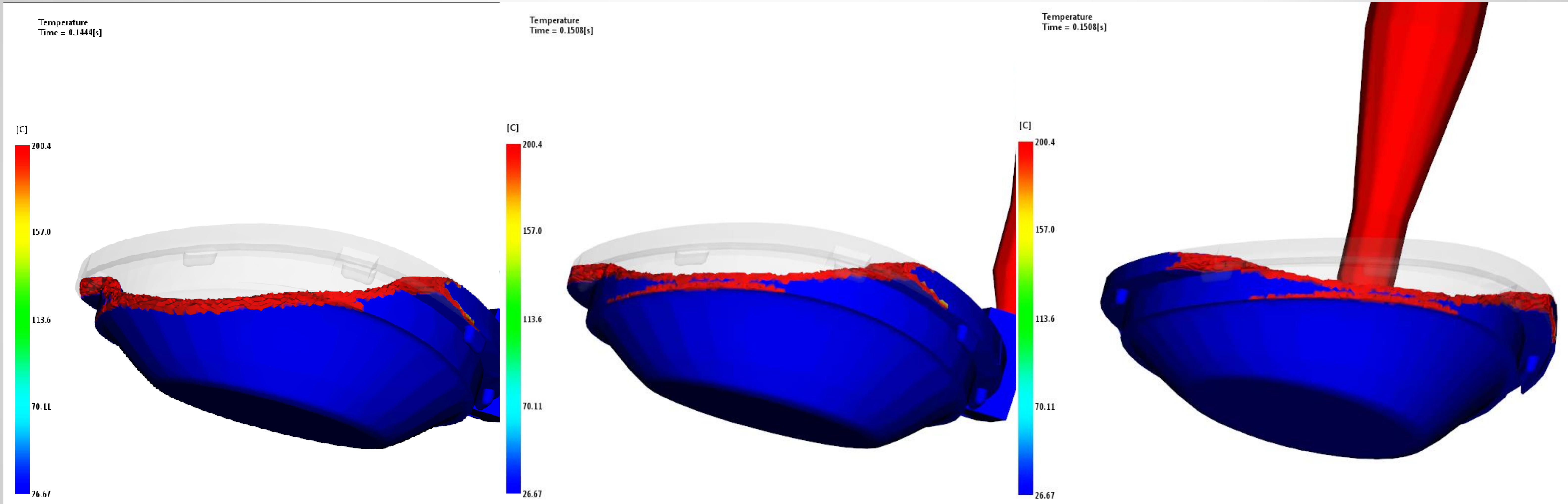
- ❑ Mesh Type 3D
  - ❑ 3D mesh for part
  - ❑ Mesh refinement near vent locations
- ❑ Boundary Conditions
  - ❑ Assigned Vent Locations
  - ❑ Apply actual dimensions
  - ❑ Grouping Conditions set if applicable
- ❑ Advanced Setting
  - ❑ Perform Venting Analysis “Checked”
  - ❑ Time steps refined if needed
  - ❑ Intermediate results refined if needed

Predicting Cosmetic Defects

Methods to Evaluate Cosmetic Defects

- Temperature
- Velocity
- Shear Rate
- Interia - Jetting
- Pathlines

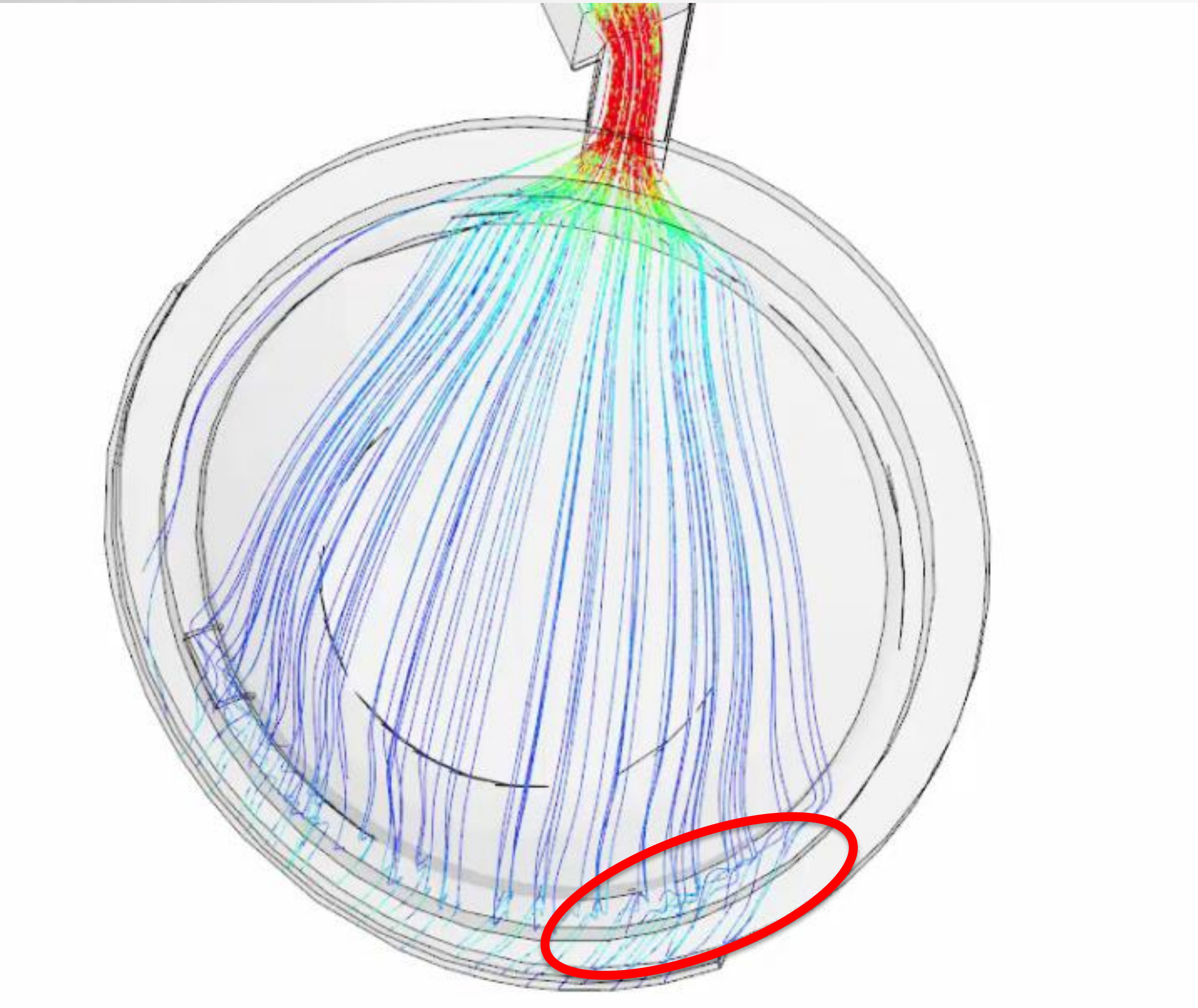
Temperature

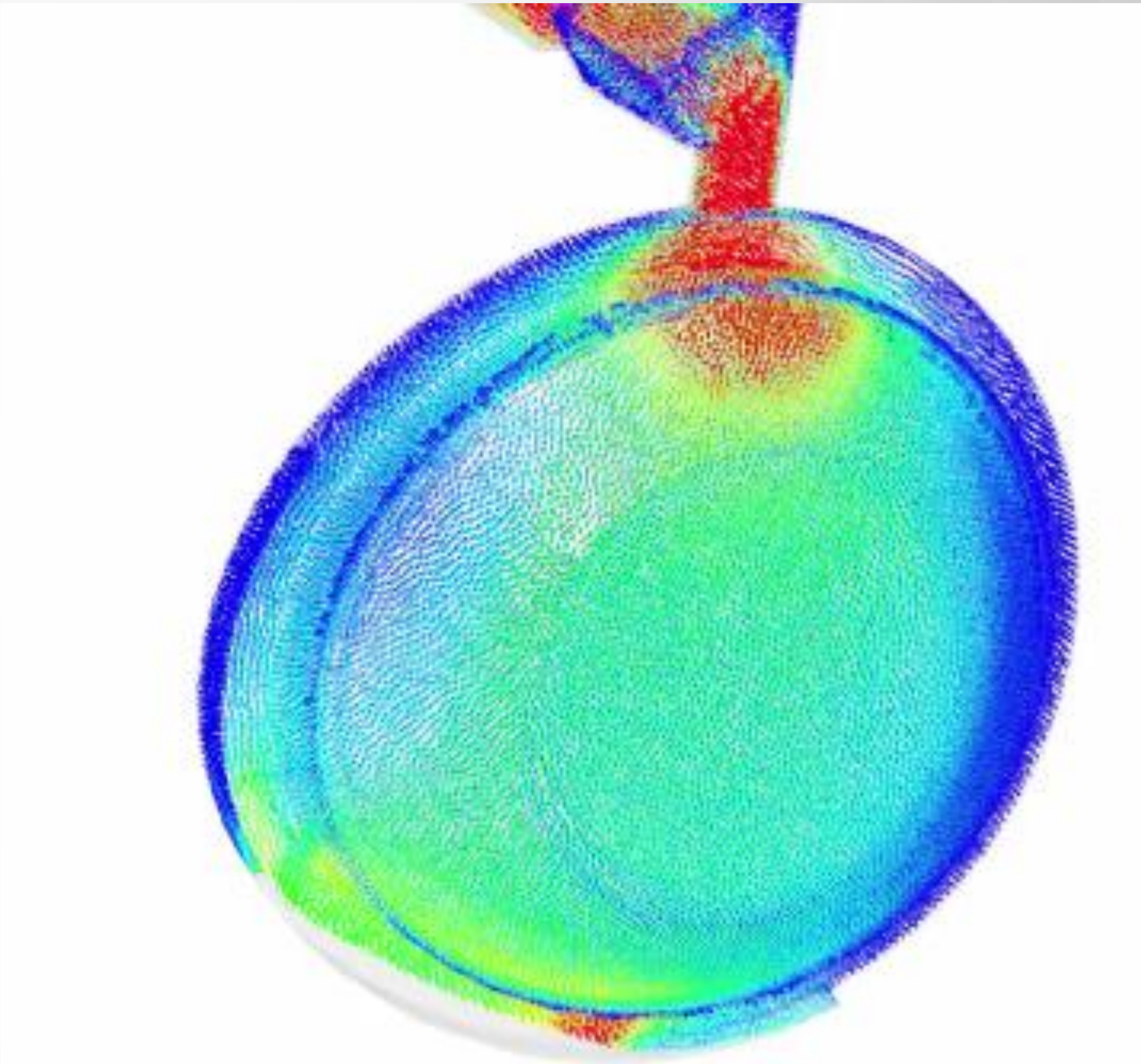


Material
Dynaflex G7940
Unfilled TPE + PP196C

Pathlines

Speed, Temperature, Time, Shear Rate, Pressure





✓ Pathline Check List

- ❑ Mesh Type 3D
  - ❑ 3D mesh for part
  - ❑ Mesh refinement
- ❑ Molding Process Types (Min. Fill Analysis)
  - ❑ Thermoplastic Injection Molding
  - ❑ Thermoplastic Overmolding (2-Shot)
  - ❑ Reactive Molding
- ❑ Advanced Setting
  - ❑ Increased intermediate result intervals
- ❑ Result Highlights
  - ❑ Speed, Temperature, Time, Shear Rate, Pressure

Takeaways

Resolving Cosmetic Defects

- Direct Cause vs. Root Cause
- Geometry?
- Process settings?
- Material?