FORMTEKNIK
Your Solution Partner

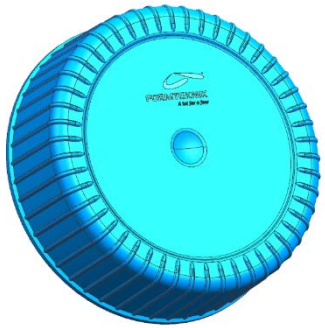
ESI Report XL

Content

Scope

- 1: This report scope is to provide alternative ideas to optimise the part quality and archive lowest possible cycle time, by optimizing the part thickness.

- 2: Scope is also to evaluate cooling optimization in steel core.

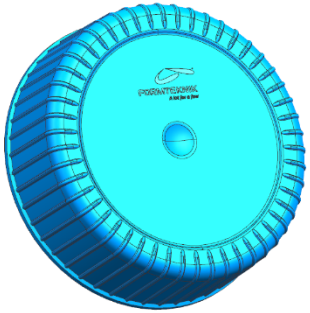


General Parameters

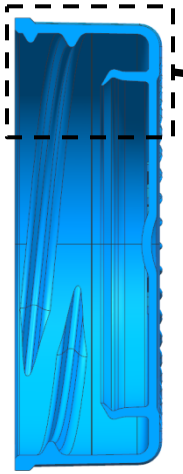
Project Name:		Tool Concept:	2 plate – Single face
Part Name:		Number of cavities:	72 cavities
Version / Model:	???	Injection Concept:	Direct
Design – Status:	Production	Number of drops:	72 drops
Resin:	Specified Material Eltex B4020N1331	Material use in moldflow Eltex B4020N1343	
Shrinkage:	N/A	Texture (VDI) Cavity:	N/A
Part Volume:	1,51 cm^3	Texture (VDI) Core:	N/A
Part Weight:	1,43 gram	Special area texture:	N/A
Runner weight:	0 gram	Shot Weight:	103 gram – 109 cm^3
Moulding Machine:	N/A	Nozzle Type:	Hot tip
Total Projected area:	8,5 cm^2 pr. part	Requirements:	245 Ton (400 Bar holding pressure.)
		Optimal IMM Screw size.	Ø45 (1,5XD)

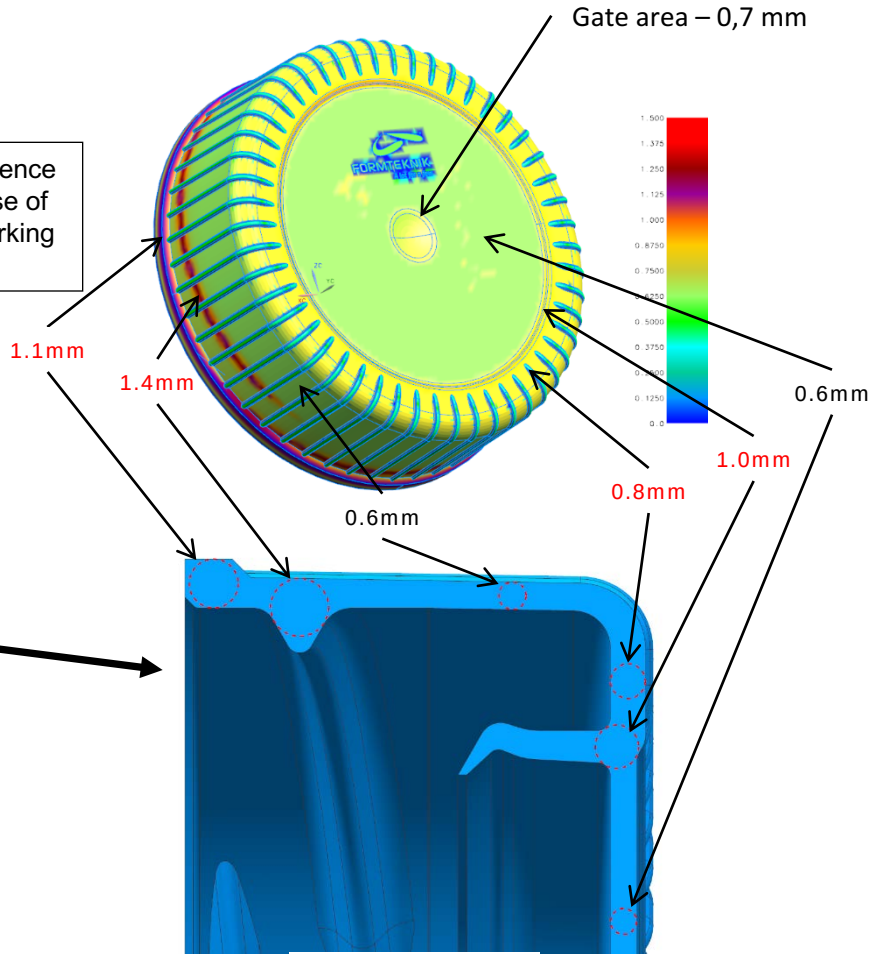
Wall Thickness Analysis

ORIGINAL PART



Not uniform section thickness can influence part quality and part distortion, because of local rest shrinkage and not proper working holding pressure.

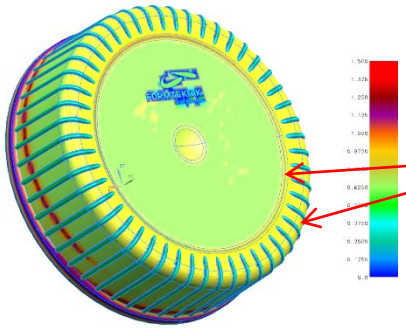




Section view

Wall Thickness Analysis

ORIGINAL PART

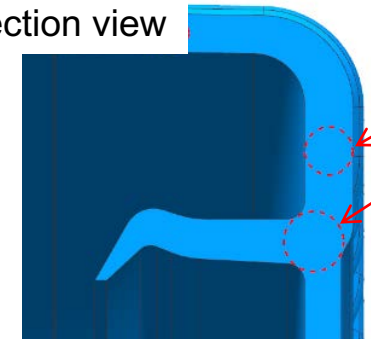


Suggestion to change part to have more uniformed part section thickness.

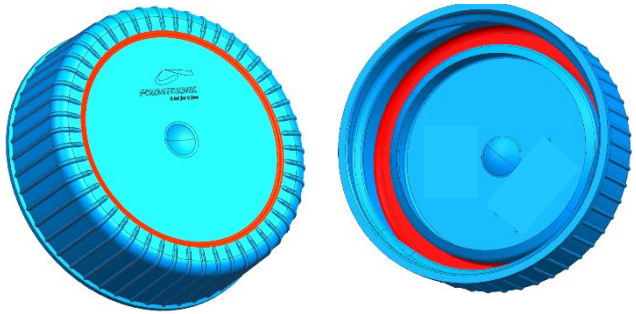
See also 3D file.

ORIGINAL PARTS

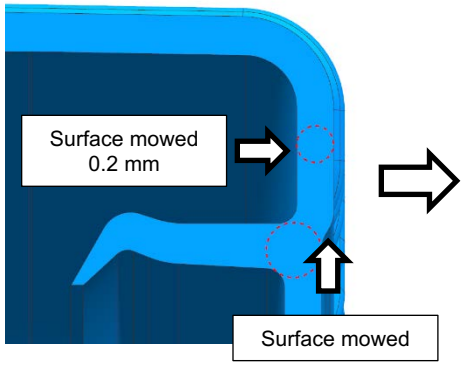
Section view



Red surfaces **MODIFIED**.



MODIFIED PART



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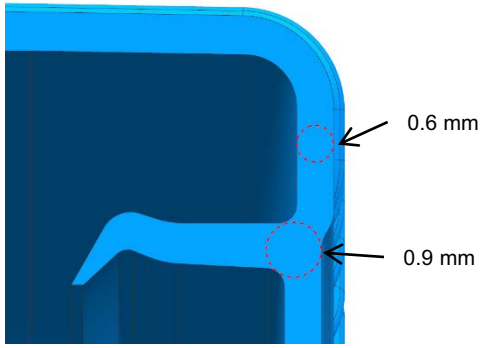
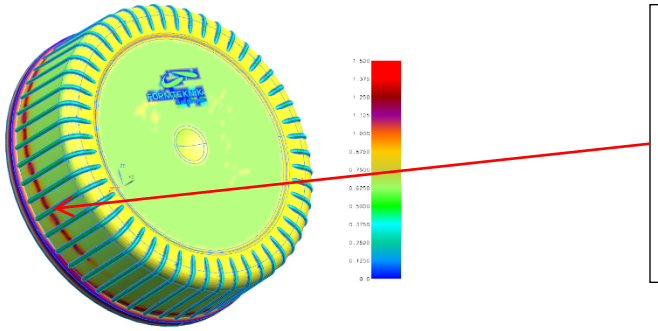


Section view

Wall Thickness Analysis

ORIGINAL PART

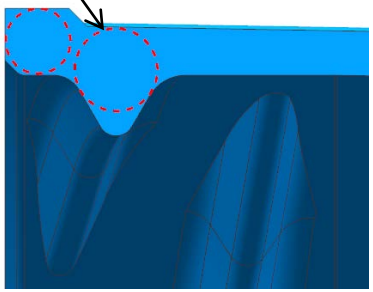


Marked thick area can result in sink marks and also influence cycle time.

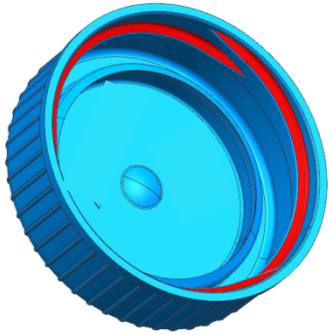
Suggest to reduce thickness in thick area To obtain homogenies wall thickness.

ORIGINAL PART Section view

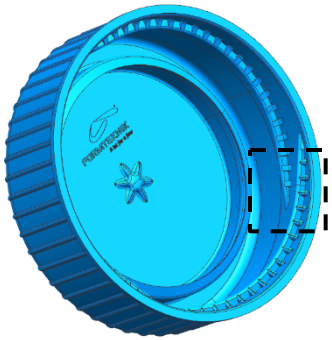
1.4 mm

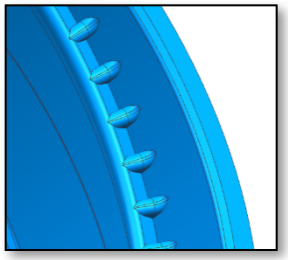


Red surfaces **MODIFIED**



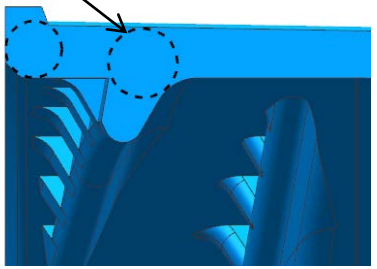
MODIFIED PART





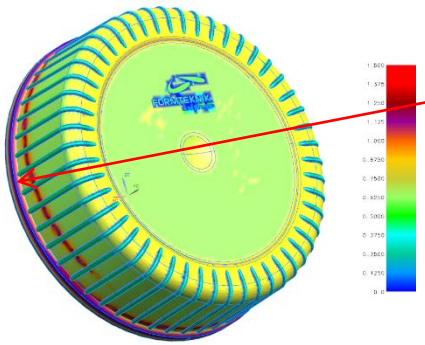
MODIFIED PART Section view

1.1 mm



Wall Thickness Analysis

ORIGINAL PART

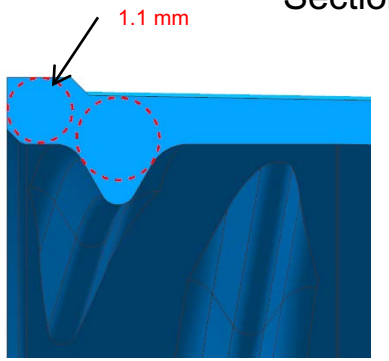


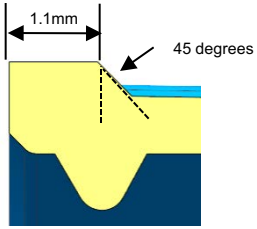
Marked thick area can result in sink marks and also influence cycle time and form stability.

Suggest to reduce thickness in thick area To obtain homogenies wall thickness. To reach faster cycle time.

ORIGINAL PART

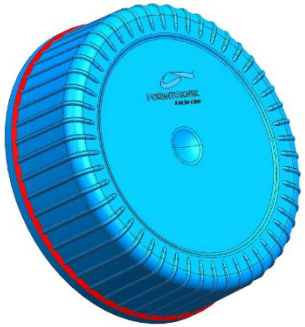
Section view



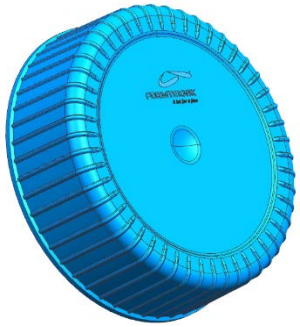


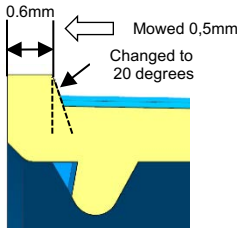
Original part

Red surfaces **MODIFIED**



MODIFIED PART

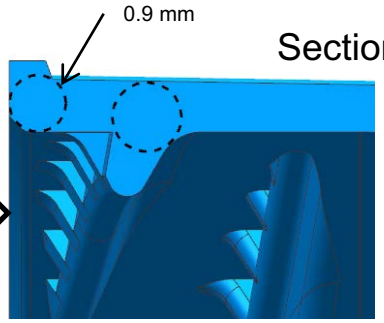




Modified part

MODIFIED PART

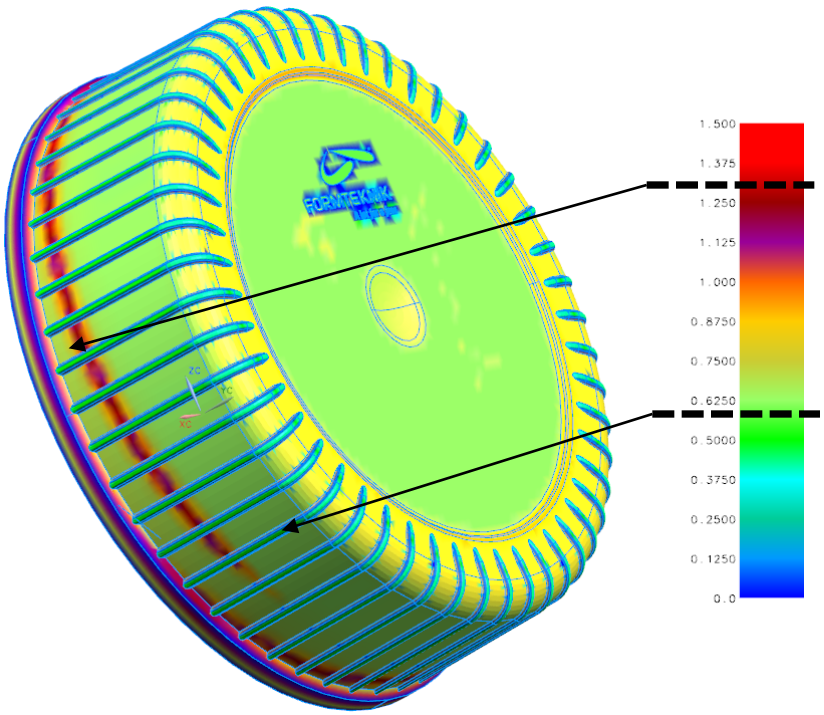
Section view



Analysis result

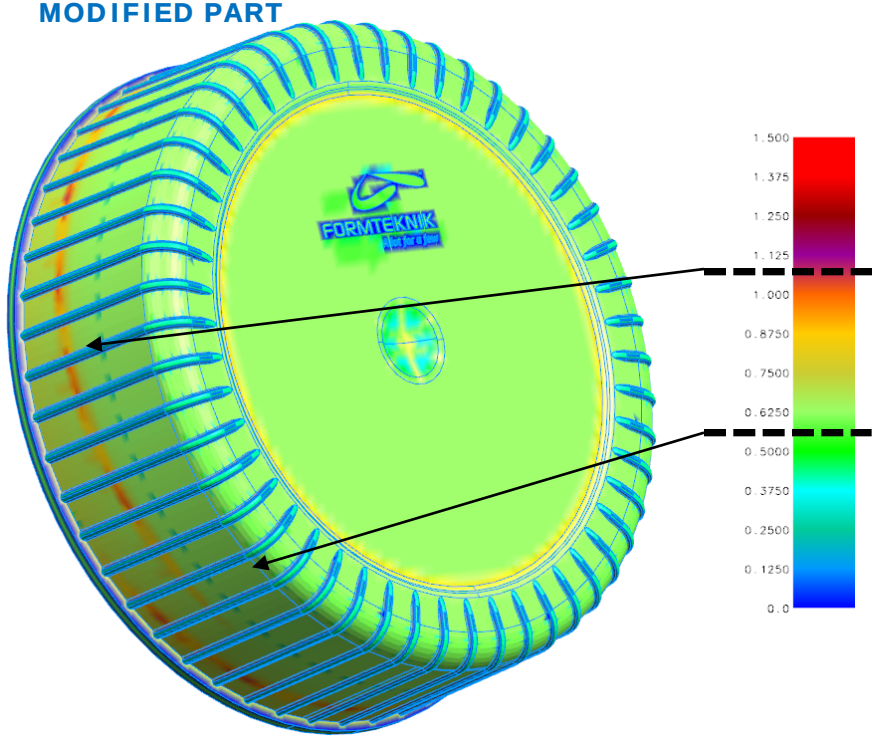
Advantage thickness is reduces with 0,24 mm

ORIGINAL PART



Average Thickness: 0.629188
Maximum Thickness: 1.35486

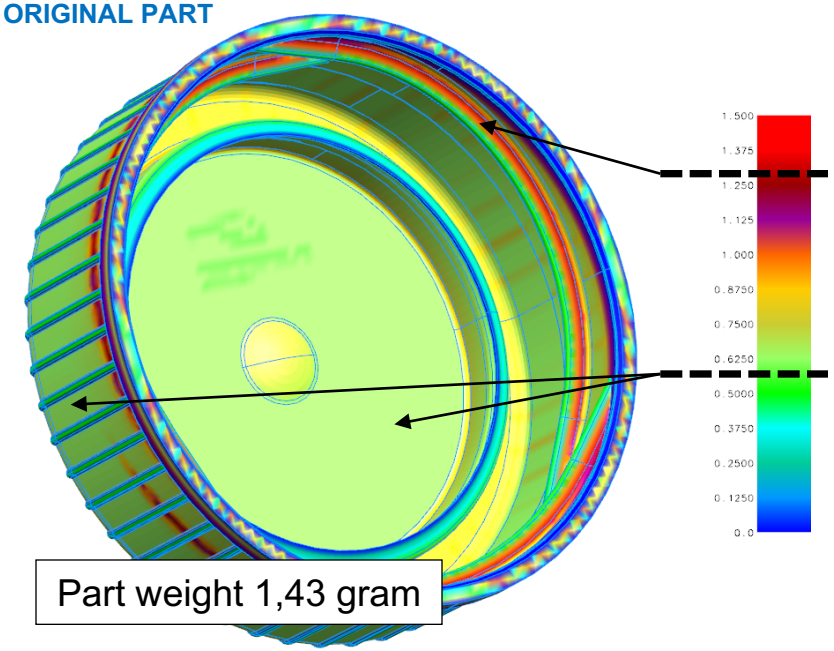
MODIFIED PART



Average Thickness: 0.566488
Maximum Thickness: 1.11057

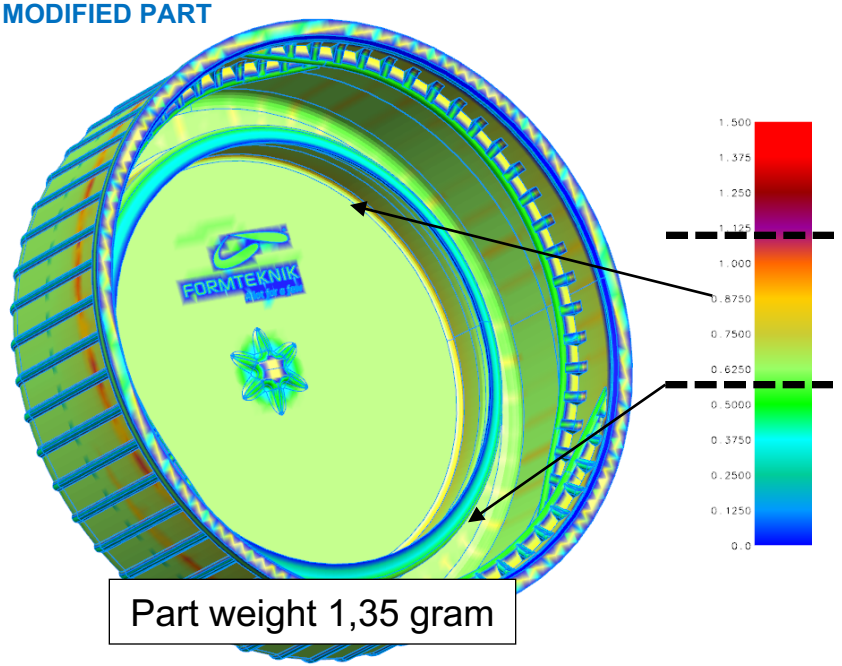
Analysis result

ORIGINAL PART



Part weight 1,43 gram

MODIFIED PART

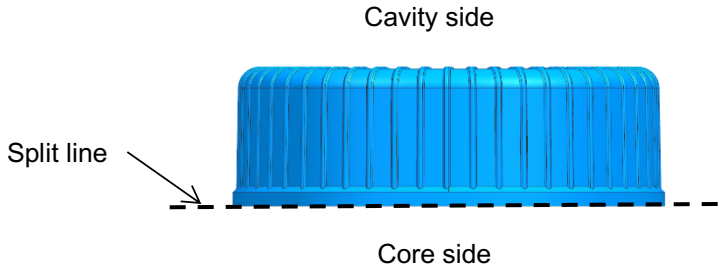


Part weight 1,35 gram

- Theoretical cycle time reduction based on part thickness optimization is app. 0,5 sec. see Mold flow results. (next 3 slides).
- 0,08 gram less material used for the modified part. 80 Ton material saved on 1.000.000.000 parts !

Draft Analysis Cavity Side

Blue surfaces = cavity side
Yellow surfaces = No draft or below 0,5 degrees

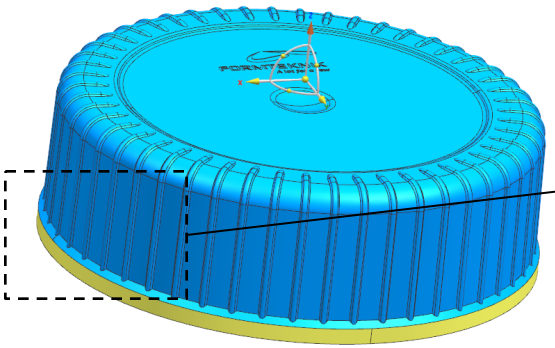


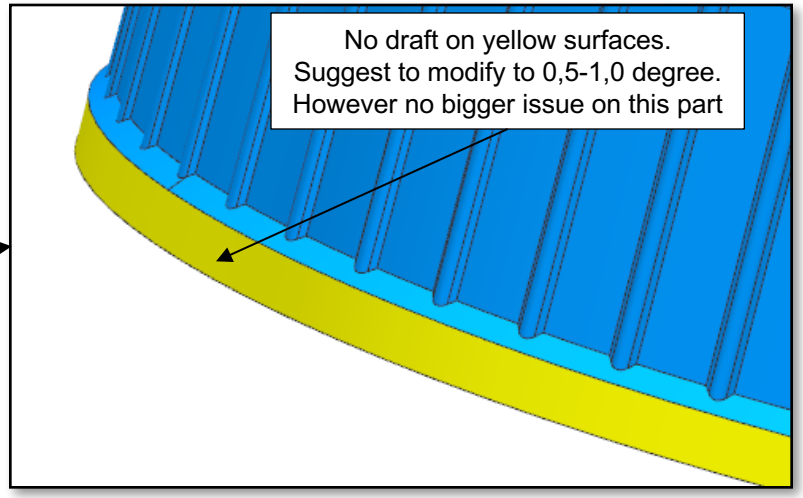
Scratch marks could occur on yellow surfaces.

If surface texture is >VDI 12 then we Suggest to add 0,5-1,0 degree draft toward Z+ on these yellow surfaces.

This will optimize visual quality.

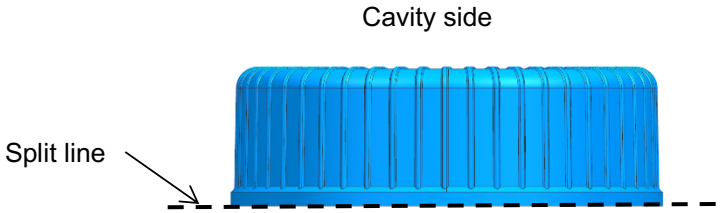
ORIGINAL PART



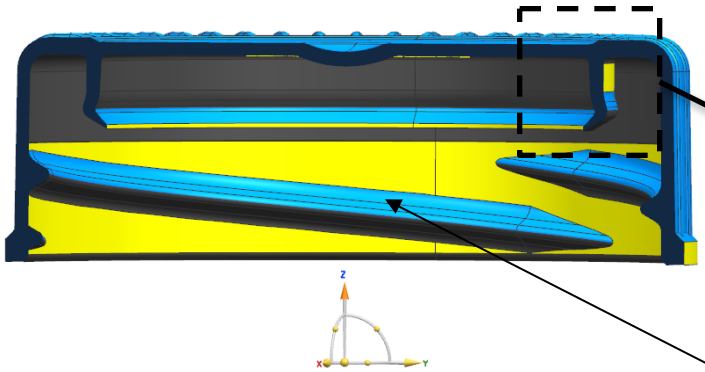


Draft Analysis Core Side

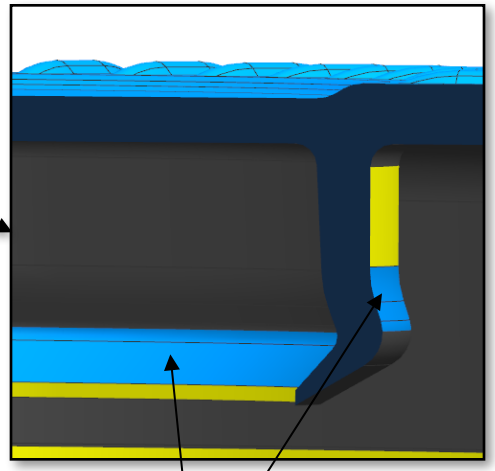
Blue surfaces = cavity side
Grey surfaces = Core side.
Yellow surfaces = No draft.



Original part



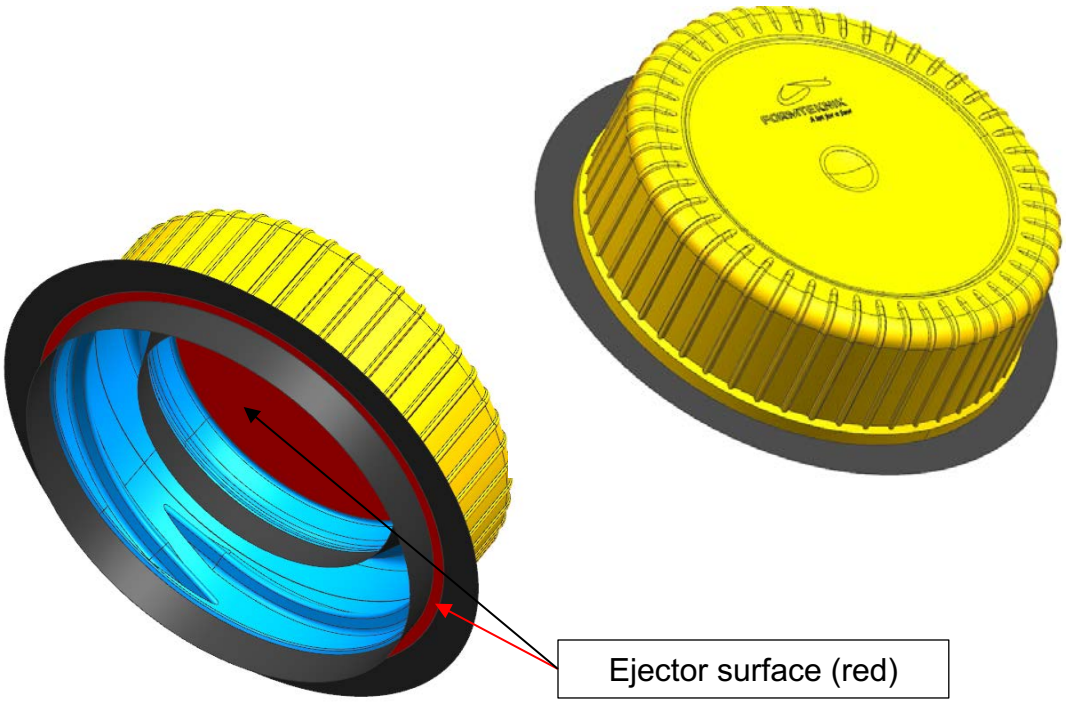
Core side

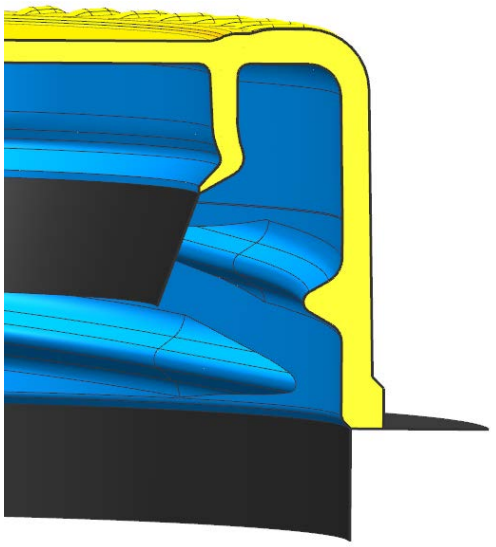


Scratch marks can occur on the blue surfaces on these 3 features because of the undercut.
However because of expansion in demould process – Not a major issue.

Detail Parting Line

Black Surfaces indicate the flash direction.
Blue is MH, yellow is FH.





Section view

Gate location used in MoldFlow

Scope:

1.To calculate the water flow liters/min to obtain recommend Reynolds number of minimum “4000” for each cooling string in mould

2.To calculated the temp. in part and in the inserts
a

Gate: Option

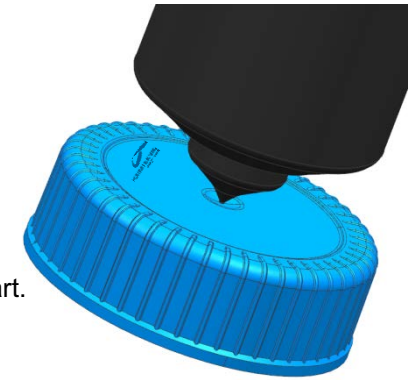
1 gate

Specifieded:

Hot gate

Ø 0,8 mm

Direct Gate located on part.



Hotrunner supplier recommend to use Ø0,7 in gate size.
In Mold flow calculation we have used Ø0,8

Material Specifications

We don't have the original material specification in our mold flow data base, we have used material as shown in scheme below.

Both material have a MFR on 2.2g / 10min

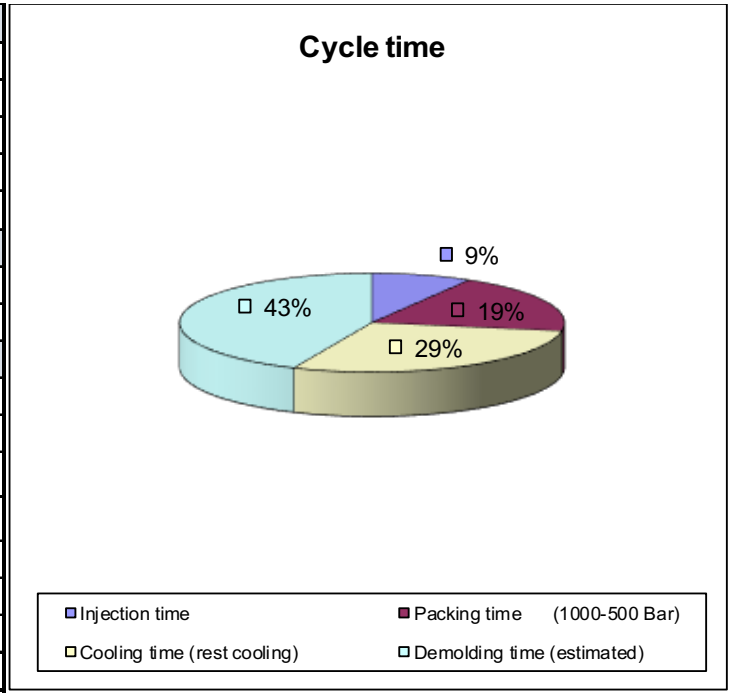
Customer Specified material in mold flow

Description: 1st shot				
Trade Name	Eltex B4020N 1343			
Supplier				
Type	HDPE			
Recommended Processing:		**Nom.**	**Min.**	**Max.**
Melt temperature	°C	**188**	**120**	**255**
Mold temperature	°C	**40**	**20**	**60**
T-tranz temperature	°C	**110**		
Ejection temperature	°C	**85**		
Maximum shear stress	Mpa	**0,2**		
Maximum shear rate	1/s	**40.000**		
Rheological Properties:				
MoldFlow Viscosity Index				
MFR	g/10min	**2.2**	**190°C / 2,16 Kg**	

Material used in all calculations.

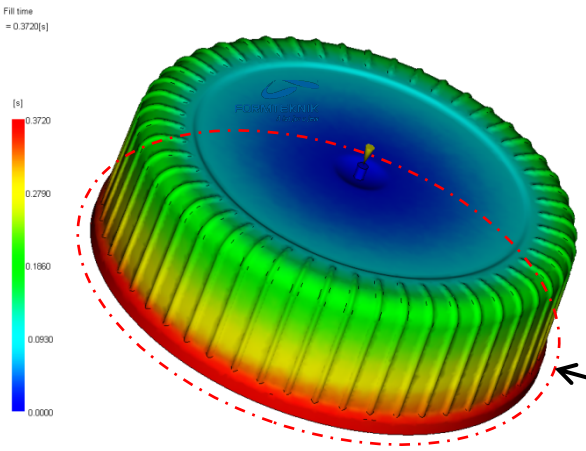
Used Process Data for Simulation

Process Conditions:		
Injection time	0,35	sec.
Packing time (1000-500 Bar)	0,80	sec.
Cooling time (rest cooling)	1,20	sec.
Demolding time (estimated)	1,80	sec.
Cycle time	**4,15**	**sec.**
Melt temperature	220	°C
Mold temperature	13	°C
Clamp Tonnage (estimated)	300	ton
Clamp Tonnage, Safety factor 25%	375	ton
Shot Volume (one cavity)	1,5	cm^3
Injection Rate (one cavity)	4,3	cm^3/sec
Injection Pressure (estimated)	400	bar
Switch over point	99	%
Part weight	1,43	g



Analysis Results, Filling (Venting area):

ORIGINAL PART

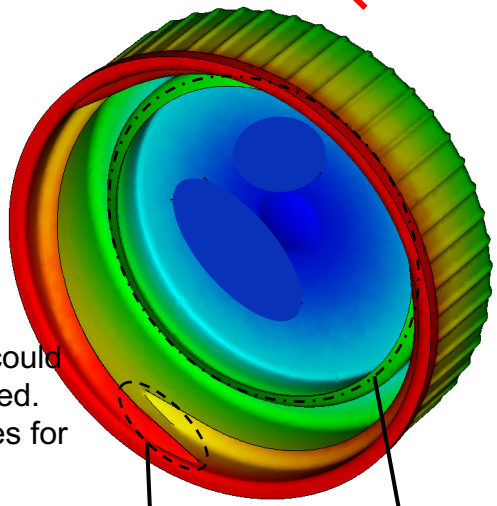


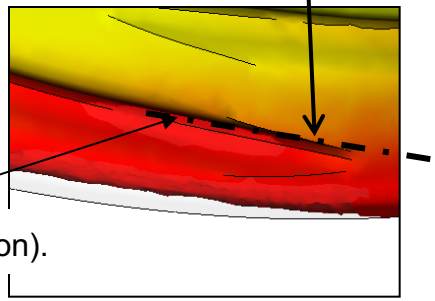
Weld lines and air traps could occur, so venting is needed. However good possibilities for venting in those areas.

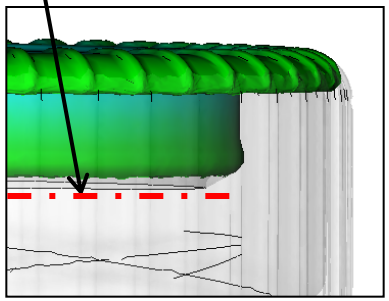
Weld line

Venting (beside parting plane)

ORIGINAL PART







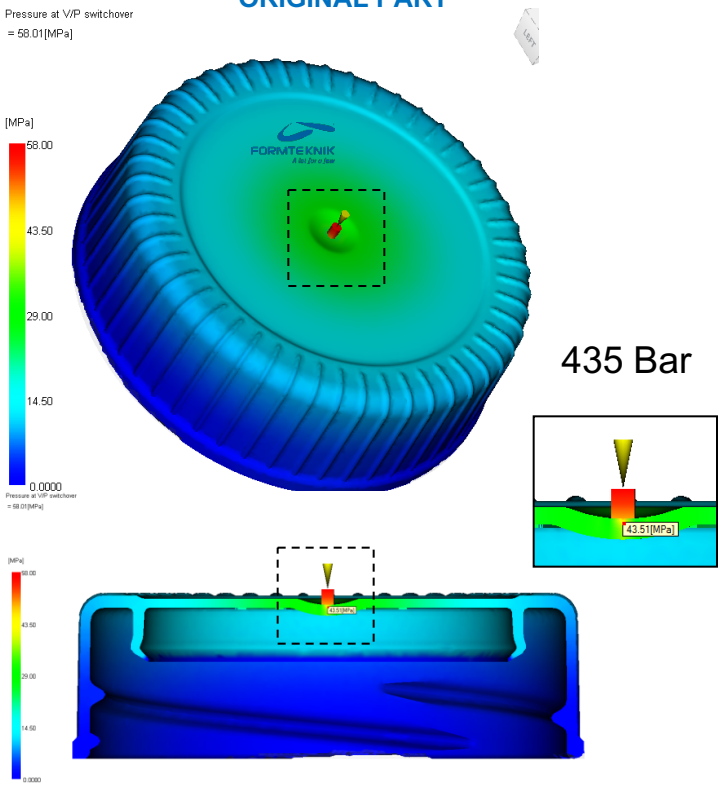
Venting (will not be possible in this location).

MoldFlow Analysis

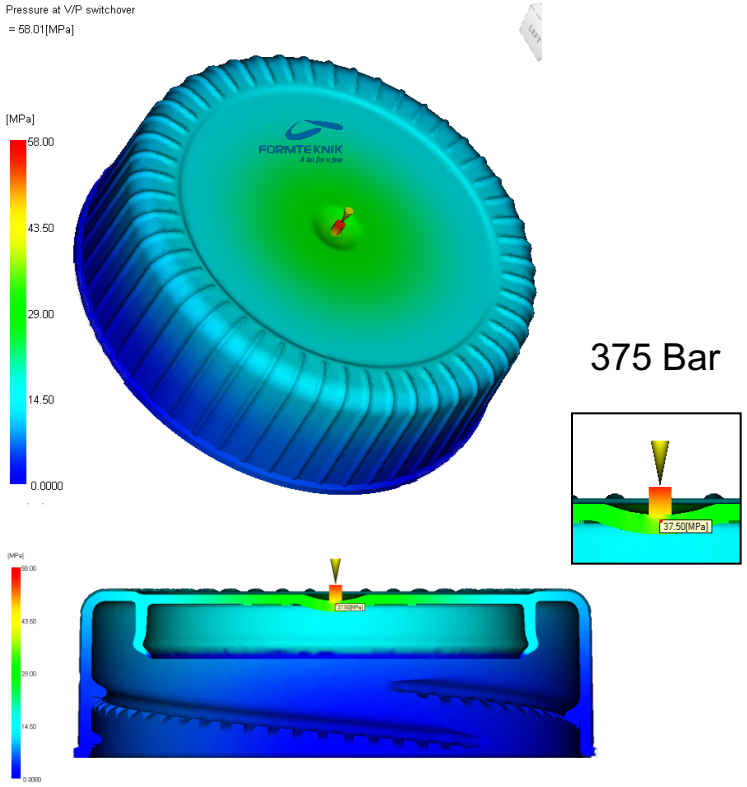
Cavity pressure check - Original part VS modified part

Cavity pressure:

ORIGINAL PART



MODIFIED PART

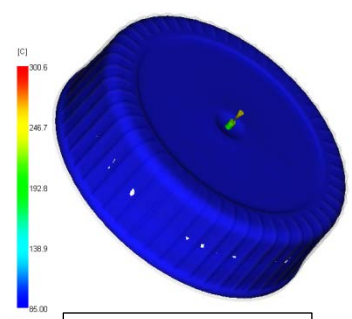


Cavity pressure is still well inside an acceptable process.

MoldFlow Analysis

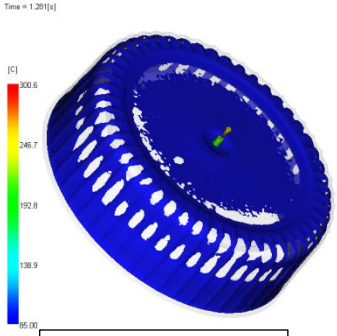
Ejection temp VS time = 85 degrees:

ORIGINAL PART



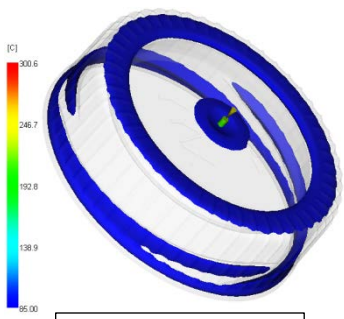
Cooling. time 1,3 sec.

MODIFIED PART



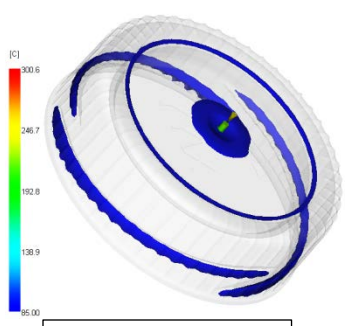
Cooling. time 1,3 sec.

ORIGINAL PART



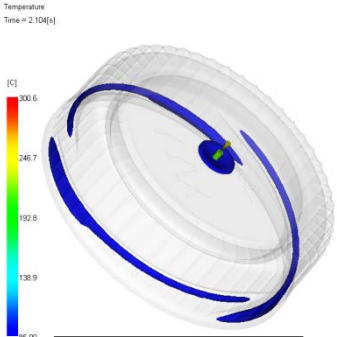
Cooling. time 1,6 sec.

MODIFIED PART



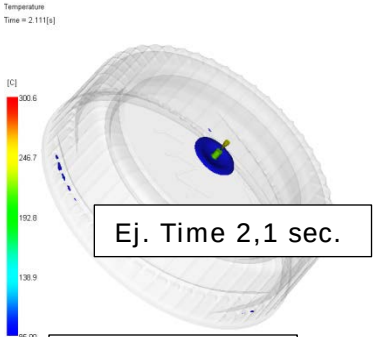
Cooling. time 1,6 sec.

ORIGINAL PART



Cooling. time 2,1 sec.

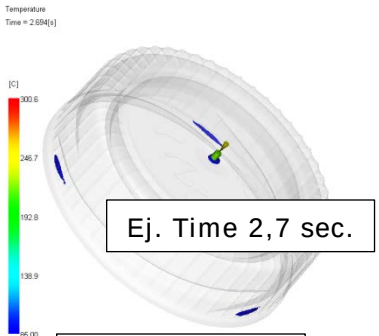
MODIFIED PART



Ej. Time 2,1 sec.

Cooling. time 2,1 sec.

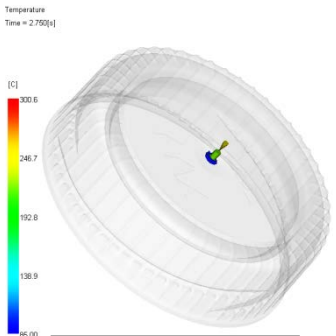
ORIGINAL PART



Ej. Time 2,7 sec.

Cooling. time 2,7 sec.

MODIFIED PART



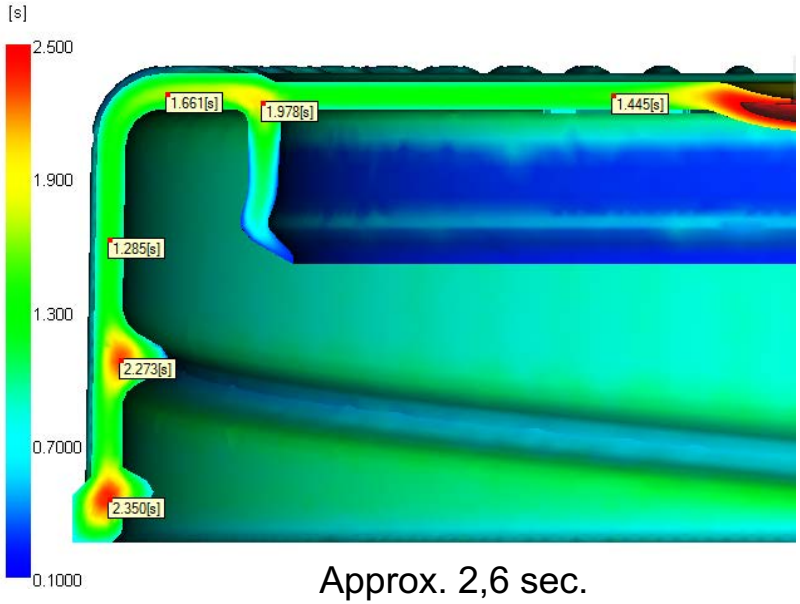
Cooling. time 2,7 sec.

MoldFlow Analysis

Time to reach eject temp.

Time to reach ejection temperature
= 2.500[s]

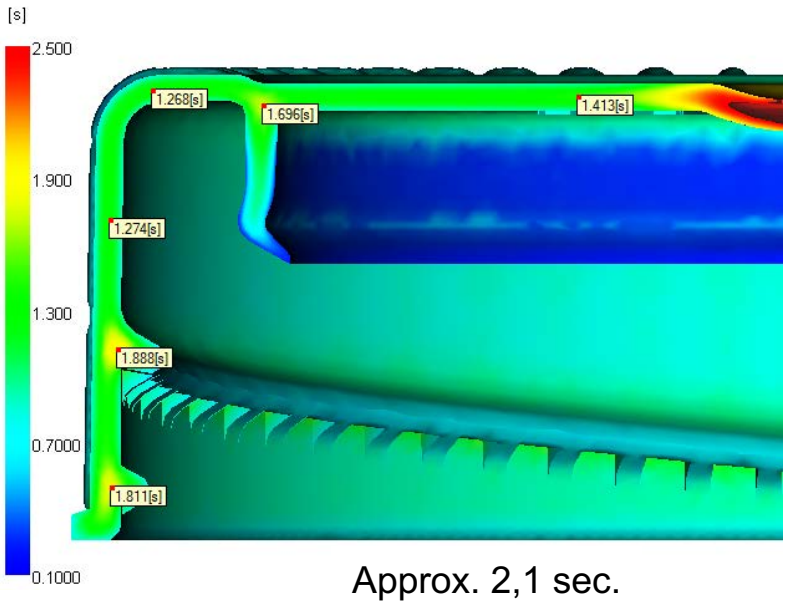
ORIGINAL PART



Approx. 2,6 sec.

Time to reach ejection temperature
= 2.500[s]

MODIFIED PART

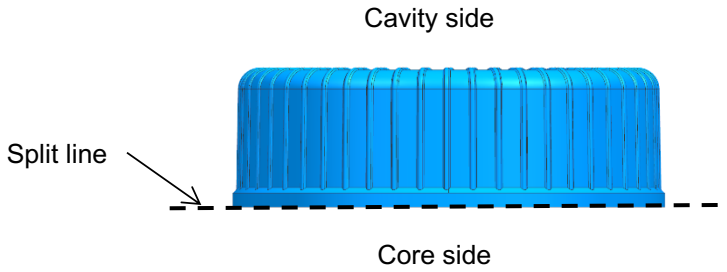


Approx. 2,1 sec.

Theoretical cycle time reduction based on part thickness optimization app. 0,5 sec.

Draft Analysis Cavity Side

Blue surfaces = cavity side
Yellow surfaces = No draft or below 0,5 degrees

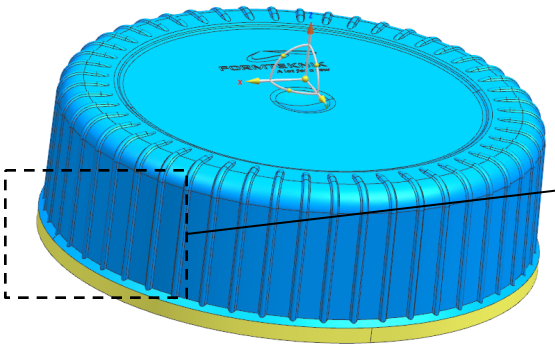


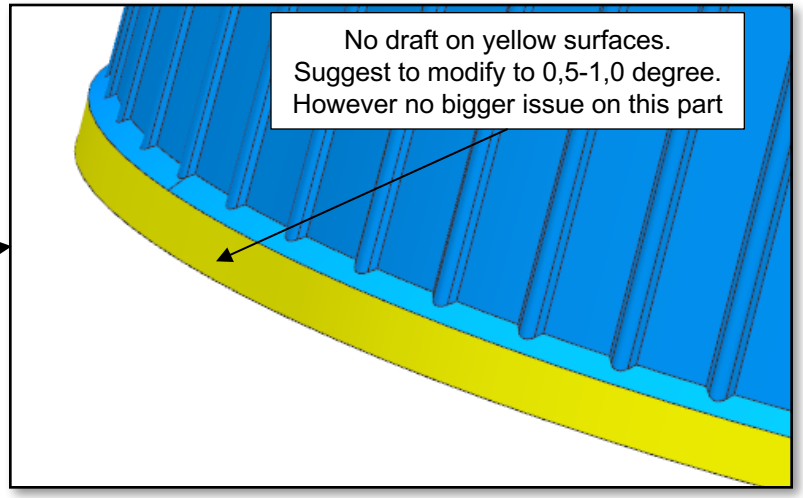
Scratch marks could occur on yellow surfaces.

If surface texture is >VDI 12 then we Suggest to add 0,5-1,0 degree draft toward Z+ on these yellow surfaces.

This will optimize visual quality.

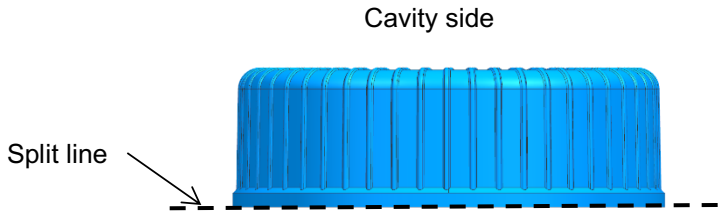
ORIGINAL PART



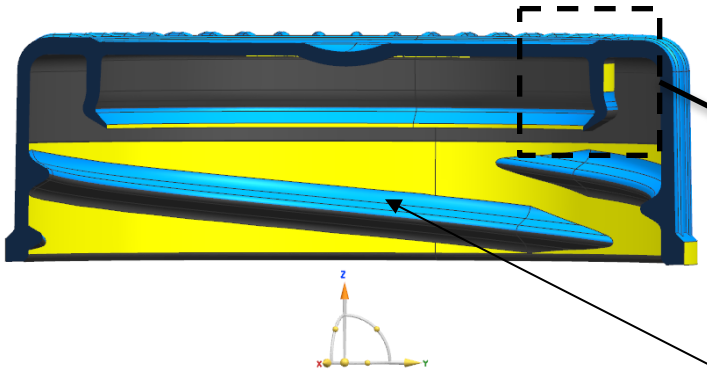


Draft Analysis Core Side

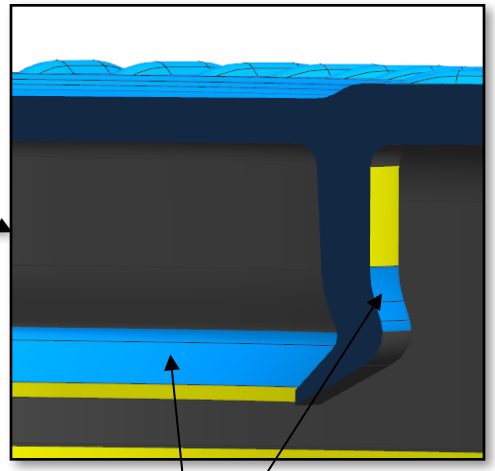
Blue surfaces = cavity side
Grey surfaces = Core side.
Yellow surfaces = No draft.



ORIGINAL PART



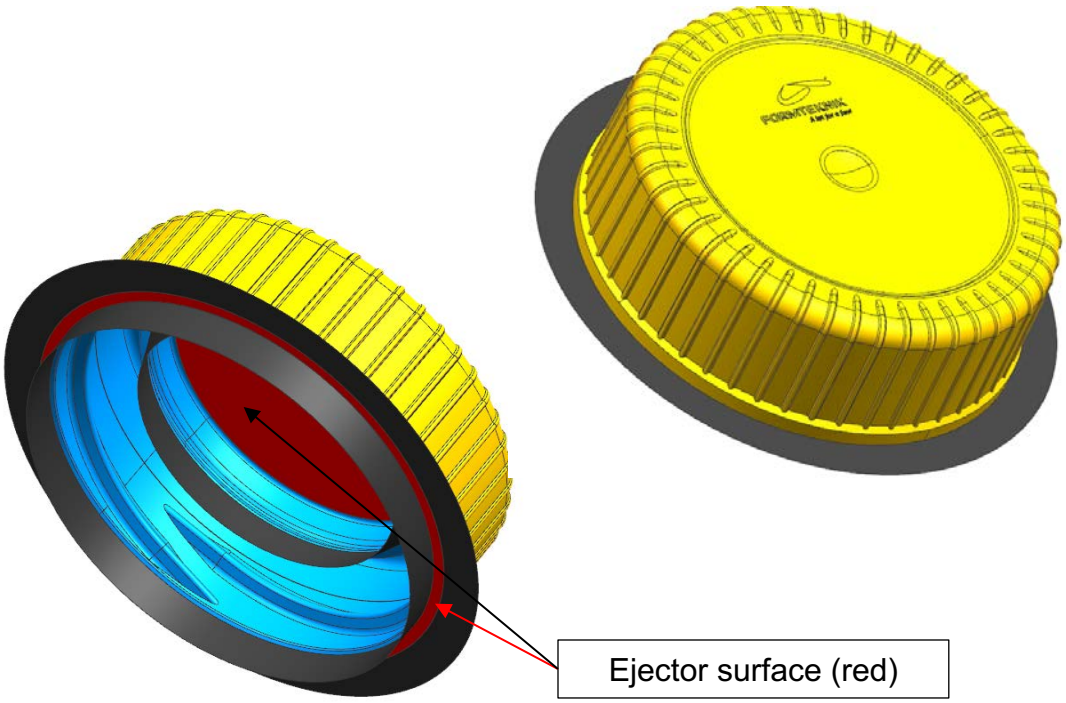
Core side



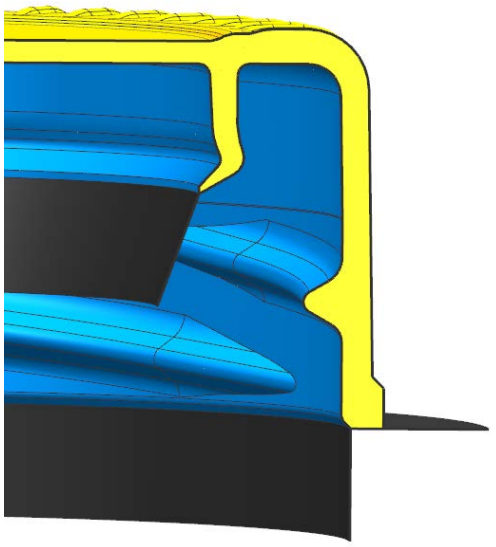
Scratch marks can occur on the blue surfaces on these 3 features because of the undercut.
However because of expansion in demould process – Not a major issue.

Parting Line

Black Surfaces indicate the flash direction.
Blue is MH, yellow is FH.

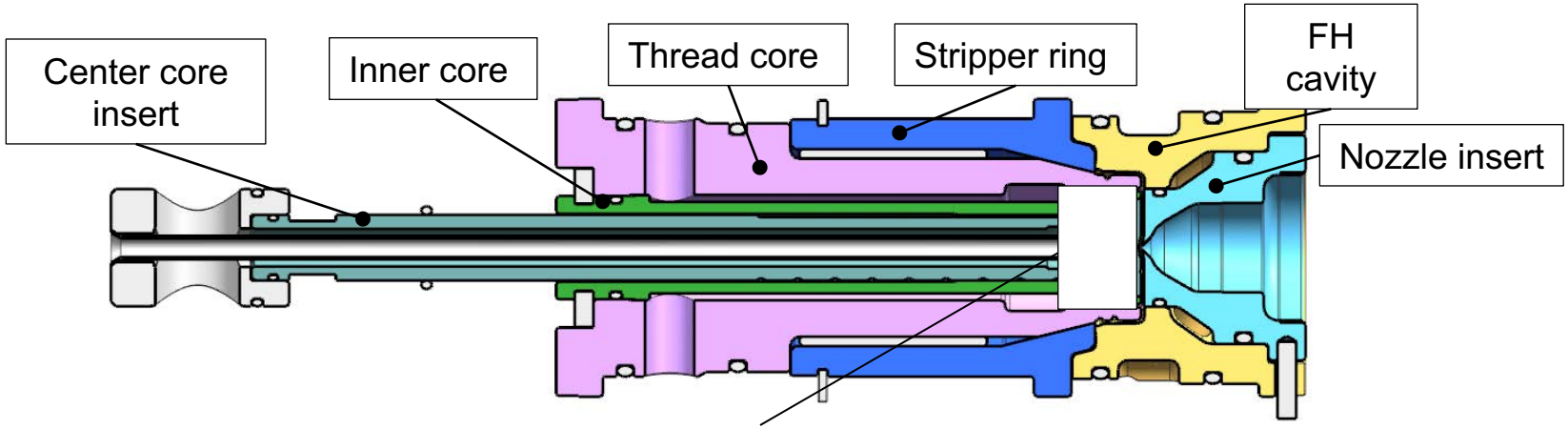


Ejector surface (red)

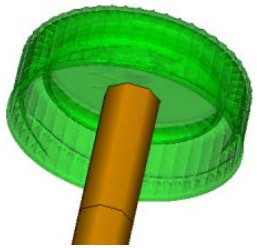


Section view

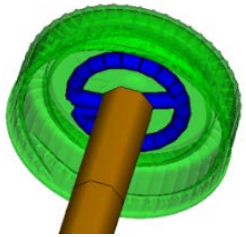
Modified Stack



In optimization of cooling layout we have only optimized cooling area in center core insert – see view below how the added components are located and how it function.



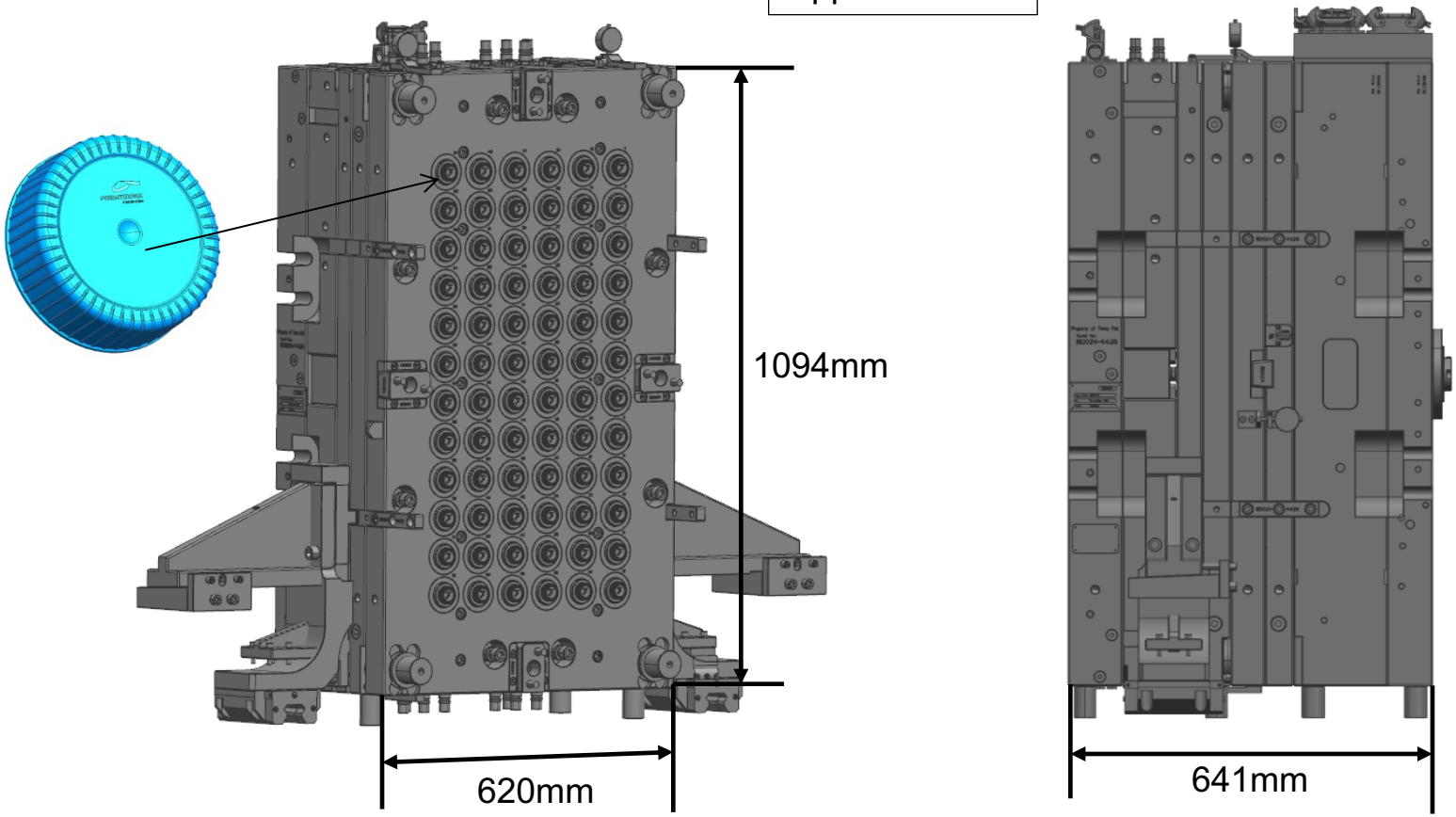
ORIGINAL center cooling



MODIFIED center cooling

Tool Layout 72 cavity Production Mould

App. mold size



Gate Location used in MoldFlow

Scope:

1.To calculate the water flow liters/min to obtain recommend Reynolds number of minimum “4000” for each cooling string in mould

2.To calculated the temp. in part and in the inserts

Gate: Option

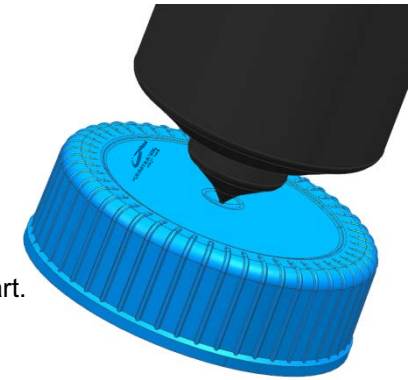
1 gate

Specifieded:

Hot gate

Ø 0,8 mm

Direct Gate located on part.



Hotrunner supplier recommend to use Ø0,7 in gate size.
In Mold flow calculation we have used Ø0,8

Material Specifications

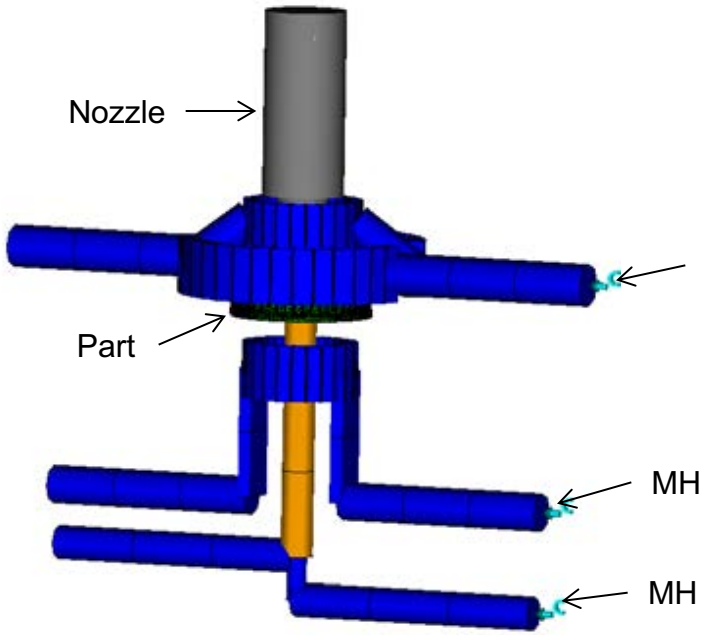
Customer Specified material in mold flow

Description: 1st shot				
Trade Name	Eltex B4020N 1343			
Supplier				
Type	HDPE			
Recommended Processing:		**Nom.**	**Min.**	**Max.**
Melt temperature	°C	**188**	**120**	**255**
Mold temperature	°C	**40**	**20**	**60**
T-tranz temperature	°C	**110**		
Ejection temperature	°C	**85**		
Maximum shear stress	Mpa	**0,2**		
Maximum shear rate	1/s	**40.000**		
Rheological Properties:				
MoldFlow Viscosity Index				
MFR	g/10min	**2.2**	**190°C / 2,16 Kg**	

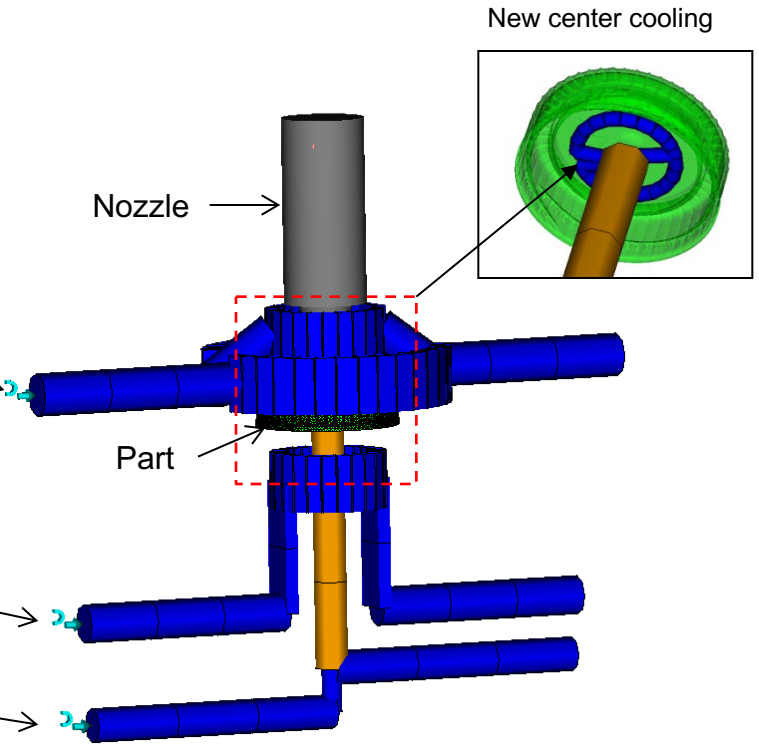
Material used in all calculations.

Cooling option

ORIGINAL cooling layout:



MODIFIED cooling layout:

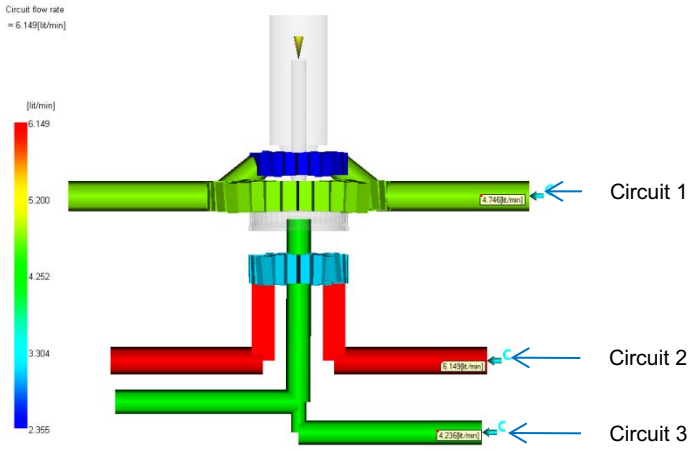


Only the center insert are changed in cooling layout

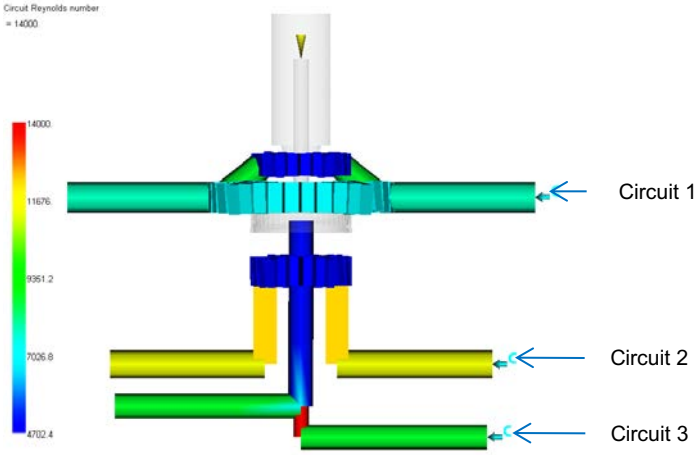
Calculated Flow Result - Two Cooling Options

To archive a turbulent flow in the cooling channel near the part arear 4000 Reynolds is needed. In the analyze we have calculated with Reynolds number of minimum 5000 in each channel.
Scheme shows the flow l/min water which is needed in each string.

ORIGINAL cooling
Circuit flow rate



ORIGINAL cooling
Circuit Reynolds number

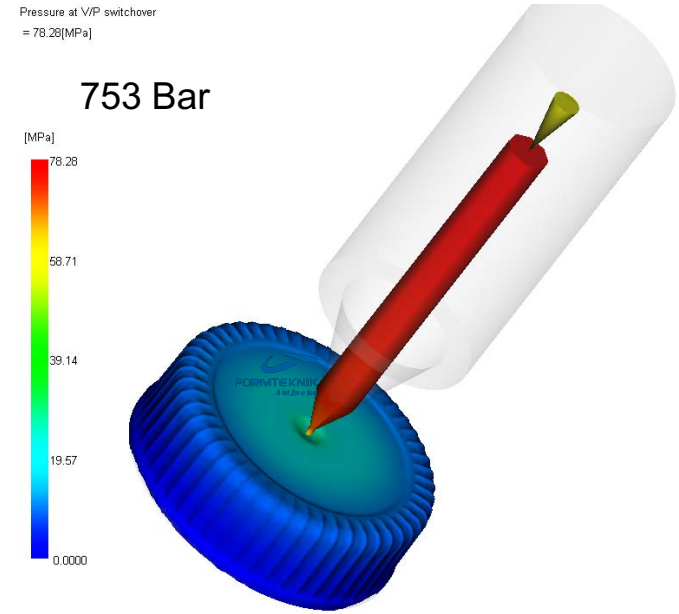


Stack cooling Option1	Reynolds number in each channel	Current flow rate
Circuit 1. nozzle insert	5000	4.7 l/min
Circuit 2. outer insert	5000	6.1 l/min
Circuit 3. inner insert	5000	4.2 l/min
Flow rate for each stack in mould		**15. l/min**

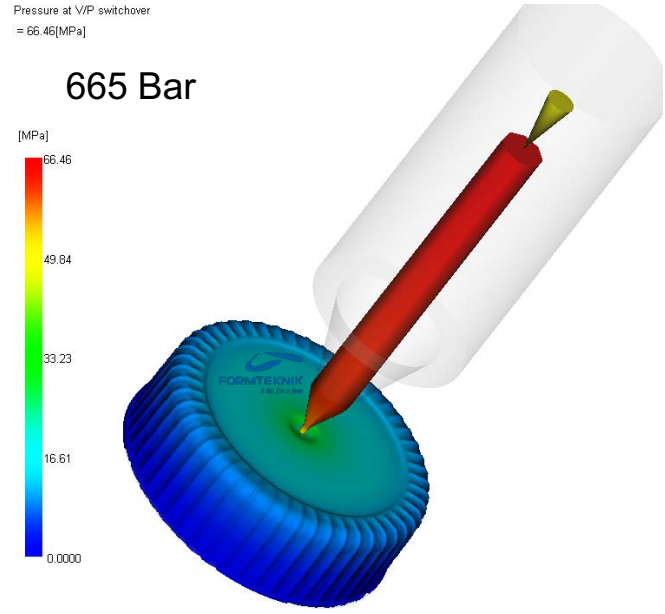
Analysis Result in MoldFlow

Cavity pressure:

ORIGINAL option



MODIFIED option

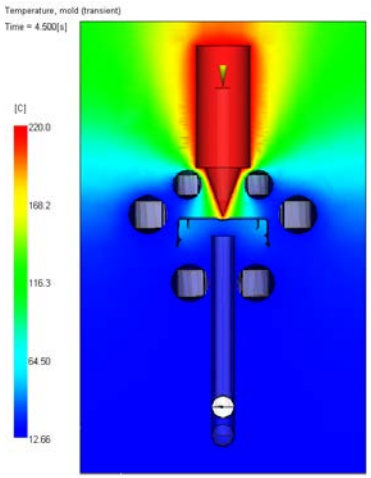


The cavity pressure is inside a acceptable level.
Pressure is a bit higher than earlier in the ppt. as the pressure in the hotrunner system is include in this calculation

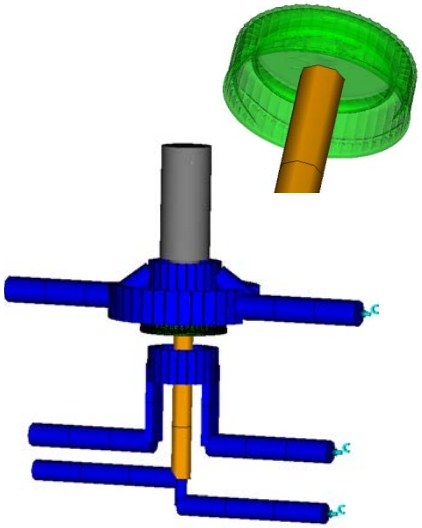
Analysis result

Temperatur, mold transient.

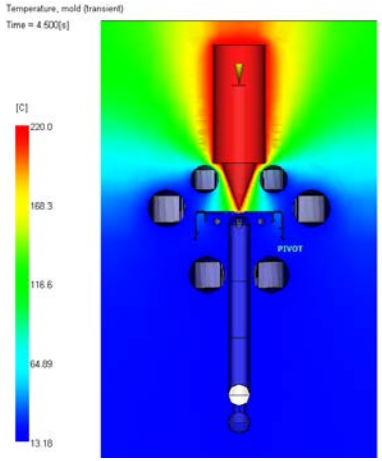
ORIGINAL option



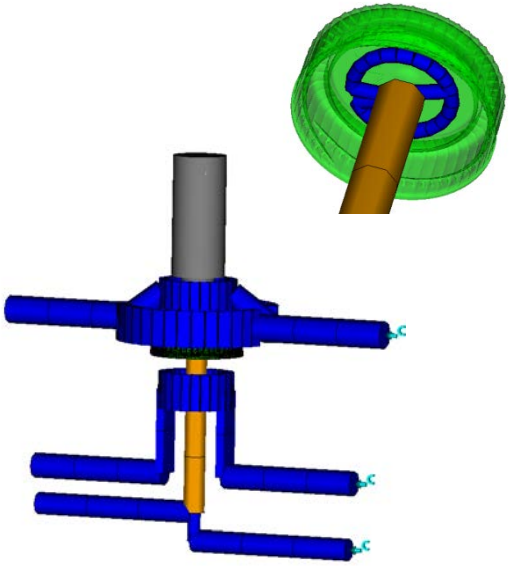
Original inner cooling



MODIFIED option



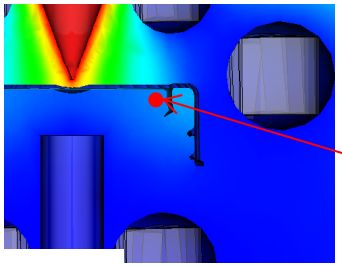
Modified inner cooling



Pictures showing the heat distribution from the nozzle.
Next 2 slides will show temp in steel measure points.

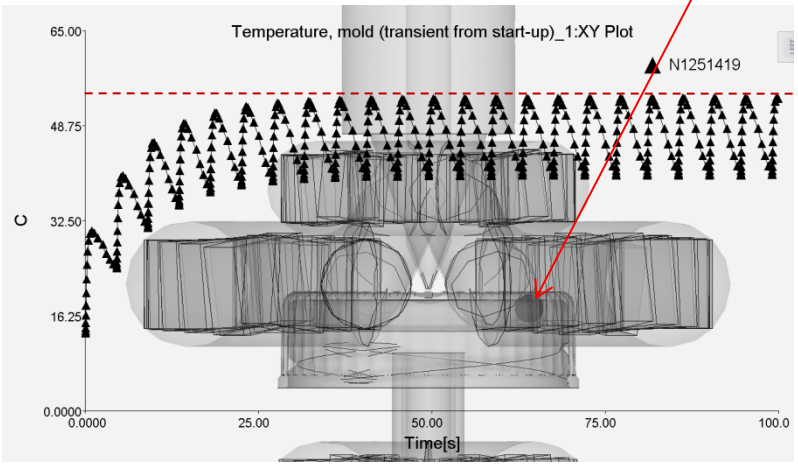
Analysis Result

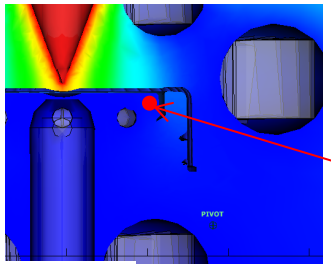
Transient temp. from start up in XY Plot 1.



Calculation point

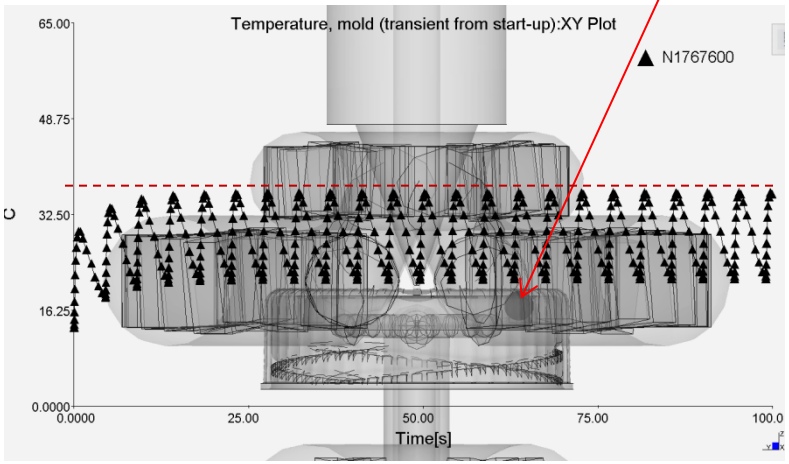
ORIGINAL option





Calculation point

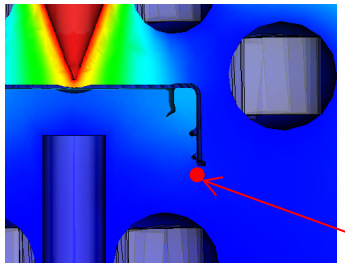
MODIFIED option



The center core temp measure is app. 16 degrees lower in the modified option

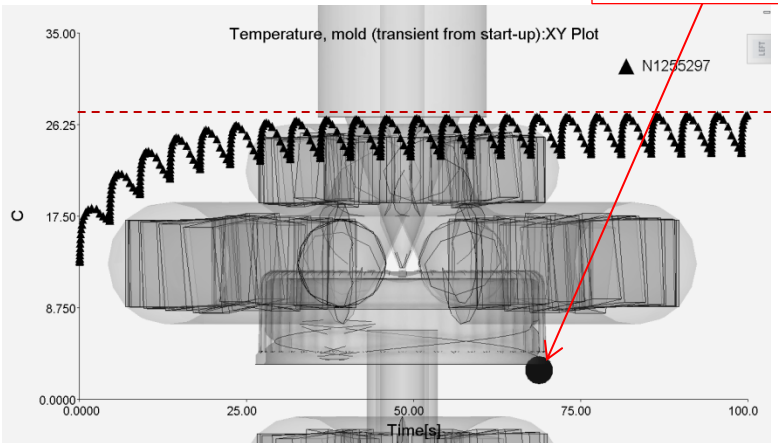
Analysis result

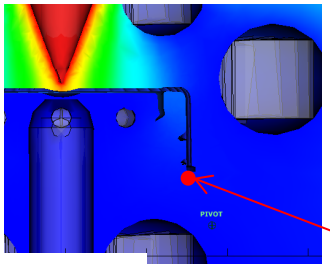
Temperature, mold (transient from start up) XY Plot 2.



Original Option

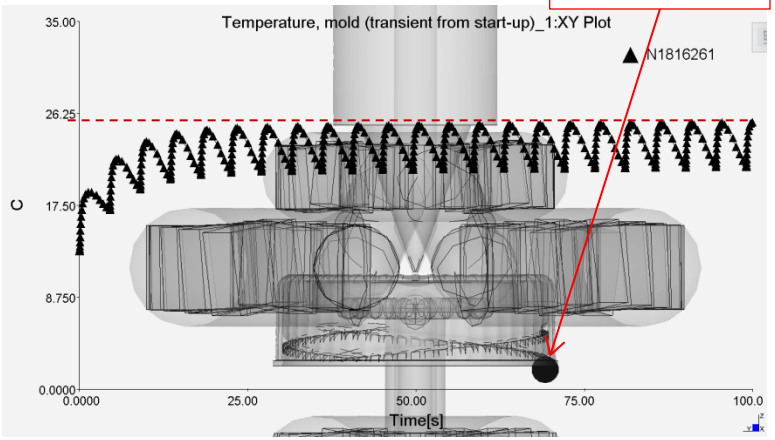
Calculation point





Modified Option

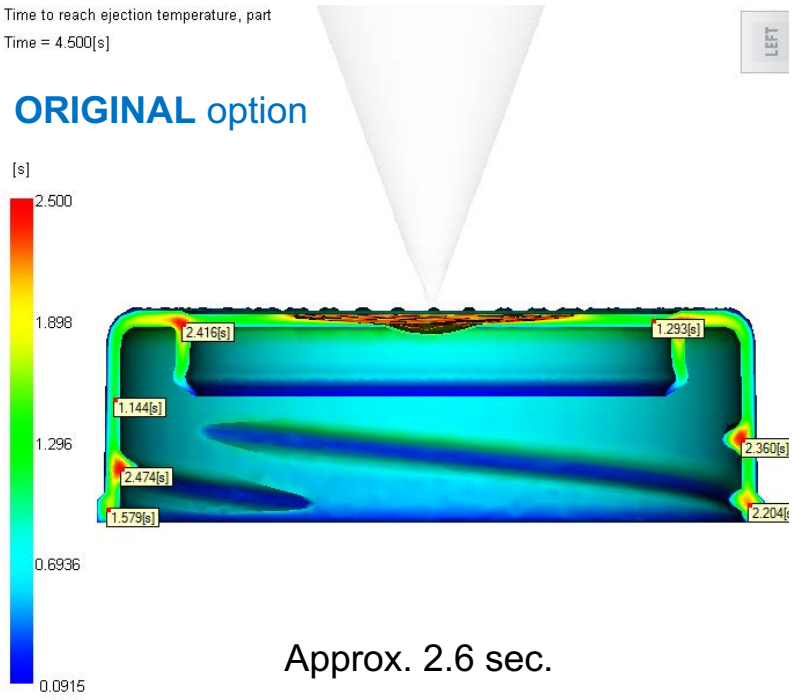
Calculation point



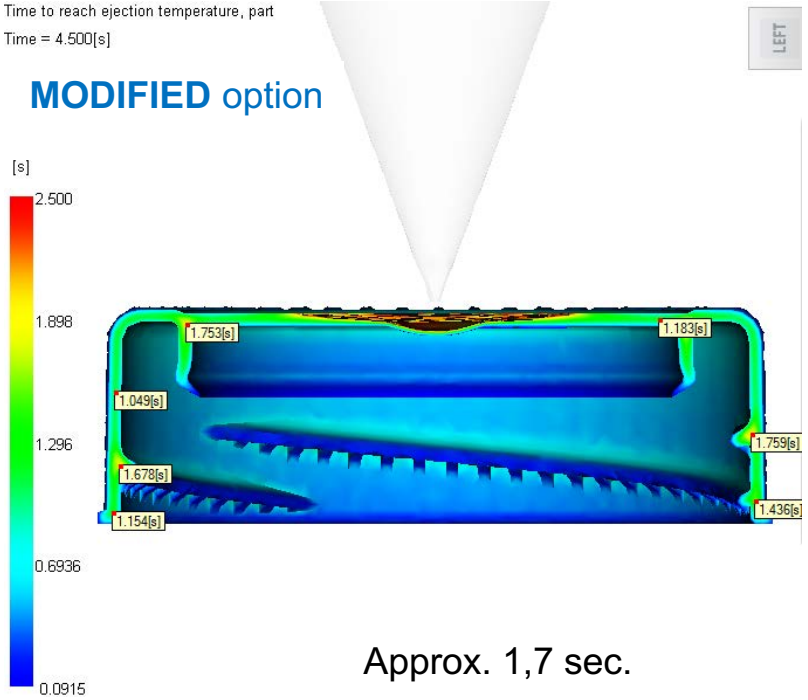
The steel temp. in the red point is close to be the same in the two options

Analysis Result

Time to reach ejection temperature (including cooling options)



Approx. 2.6 sec.



Approx. 1,7 sec.

Theoretic cycle time reduction in matter of time to ejection will be app. 0,9 sec.

Conclusion

Part optimizing: Theoretical cycle time reduction with reference in 13 degrees surface temp. based ***only*** on part optimization shows “only” app. 0,5 sec. plus a material saving of 0,08 gram. 80 Ton material saved on 1.000.000.000 parts

Changing cooling layout : It has a positive effect to change cooling layout in the center core. Max steel temp lowered from 51 degrees in measure point on core to be app. 35 degrees. This together with the cooling layout and part optimization will lower the cycle time with app. 0,7 -> 1,0 sec.

Part ejection/Part fall: Real life observations has shown that number of air blow grooves in the ejector valve has a huge impact on the part fall. Only one air grove will disturb the part fall. 3 air groves show a better picture on how the parts fall. This can have a big impact on the total cycle time (up to 0,3 sec.). On a big mould (ex. 72 cav.) an accumulate air tank should be considered. The air circuit could also be divided into a higher number of circuits to minimize air pressure drop.