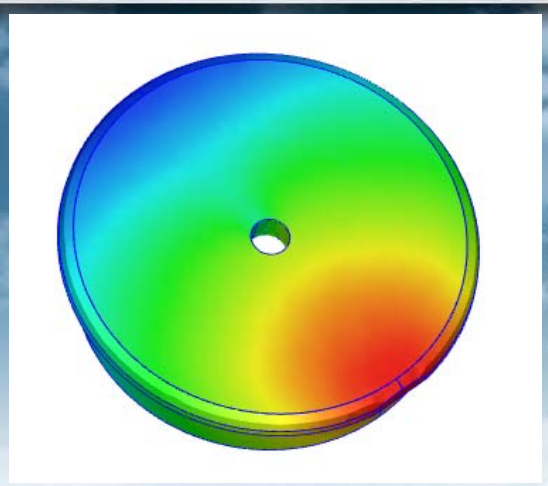
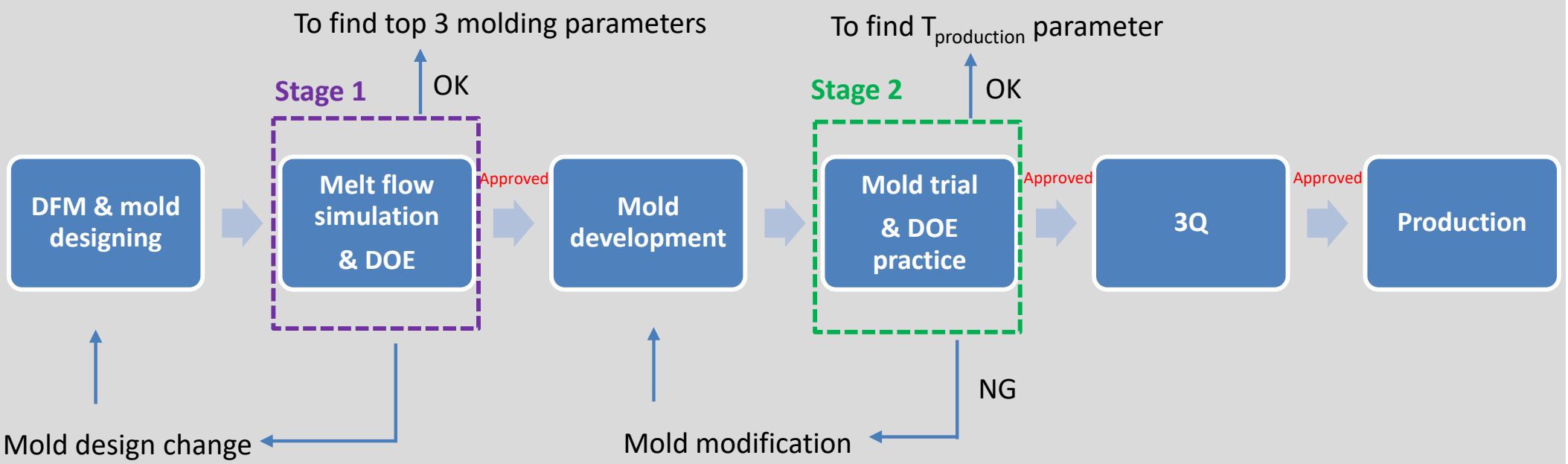
# PYRAMIDS TECHNOLOGY

**Process and Quality Control by DOE + Molding Window Method**

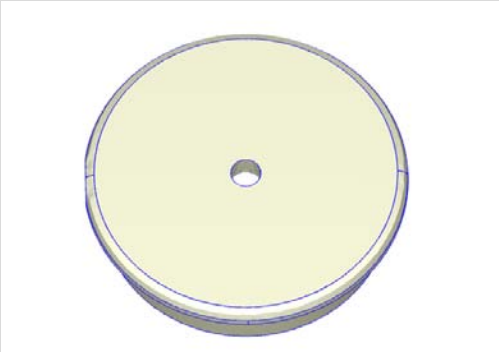


# DOE + Molding Window Method



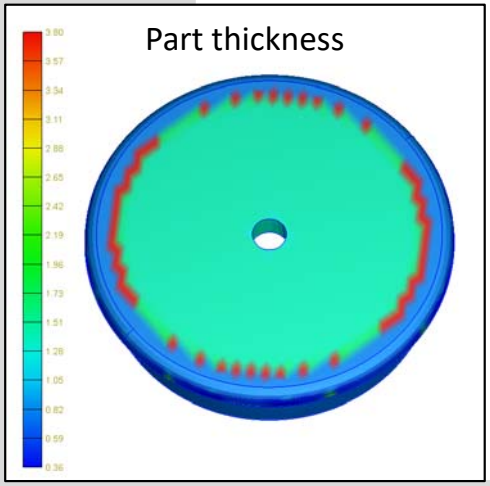

1. Melt flow simulation includes the **Full analysis** and **DOE analysis** :
   - **Full analysis** helps mold design and reduces risk of molding process.
   - **DOE analysis** is to find top 3 molding parameters and do risk assessment of OQ process.
2. Mold trial & DOE practice are Full Factorial Experiments with top 3 molding parameters(analyzed by melt flow DOE analysis) when mold trial(Total 27 groups, each group includes 10 shots), will define $T_{production}$ parameter which have best control of molding process and lowest process risk.

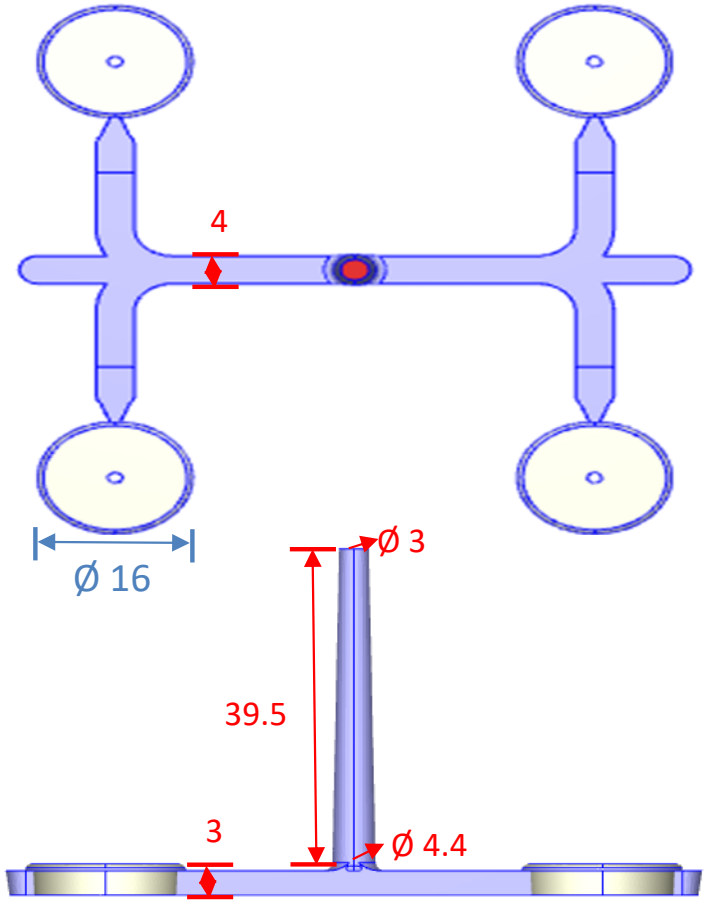
# Project Information



| Material properties | |
|---|---|
| Material | POLYLAC® ABS PA765 |
| Mold Temperature (°C) | 40~70 |
| Melt Temperature (°C) | 180~220 |
| Molding Shrinkage (%) | 0.3~0.6 |
| Density (g/cm$^3$) | 1.19 |
| MFI (200°C/5kg) | 5 g/10min |

# Model Information – Runner & Part

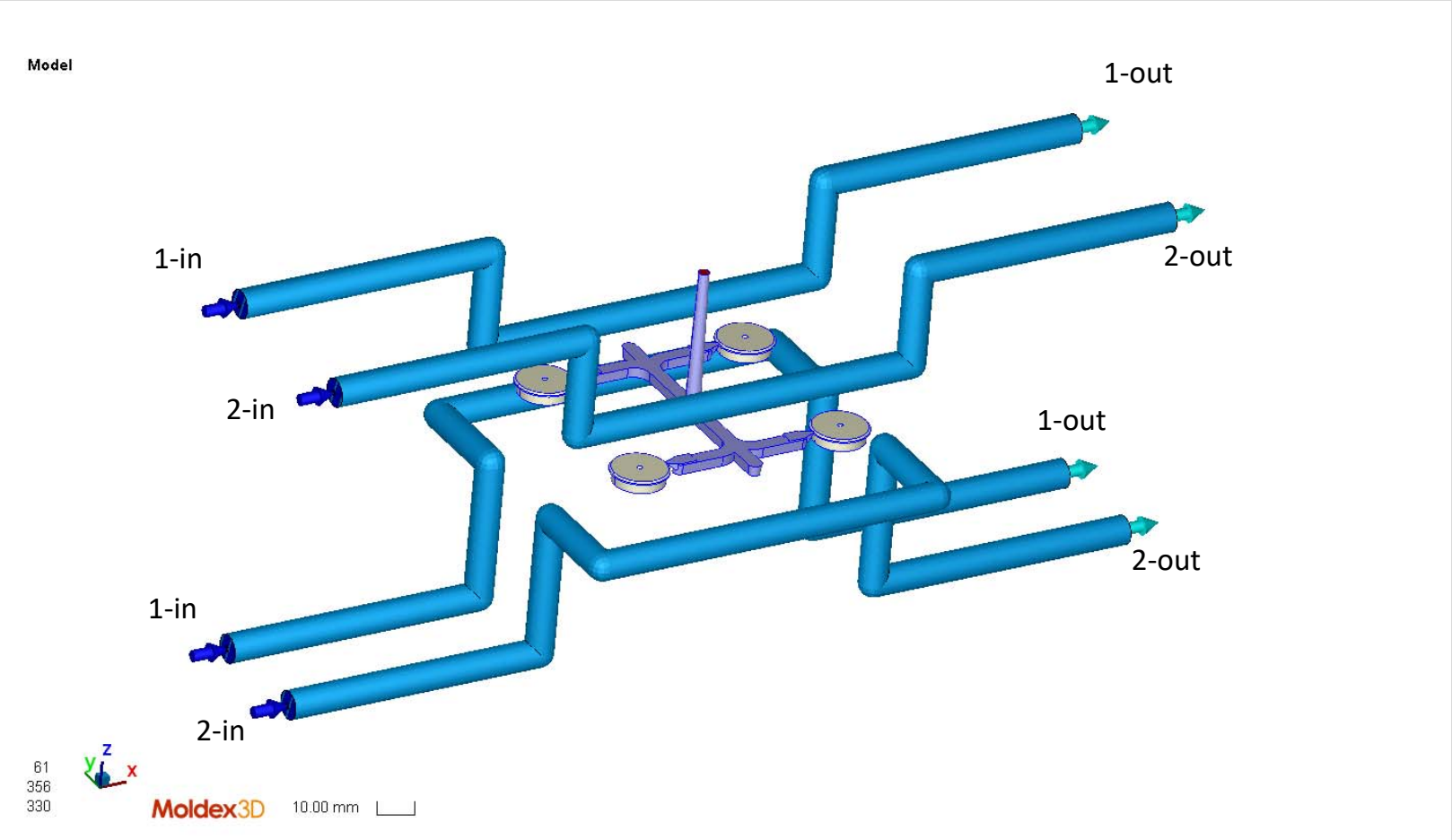



The gate size is 1X0.5
One shot volume (runner: 2.03 + cavity: 1.35) = 3.38 (cc)
One shot weight (runner: 2.736+ cavity: 1.212) = 3.948 (g)

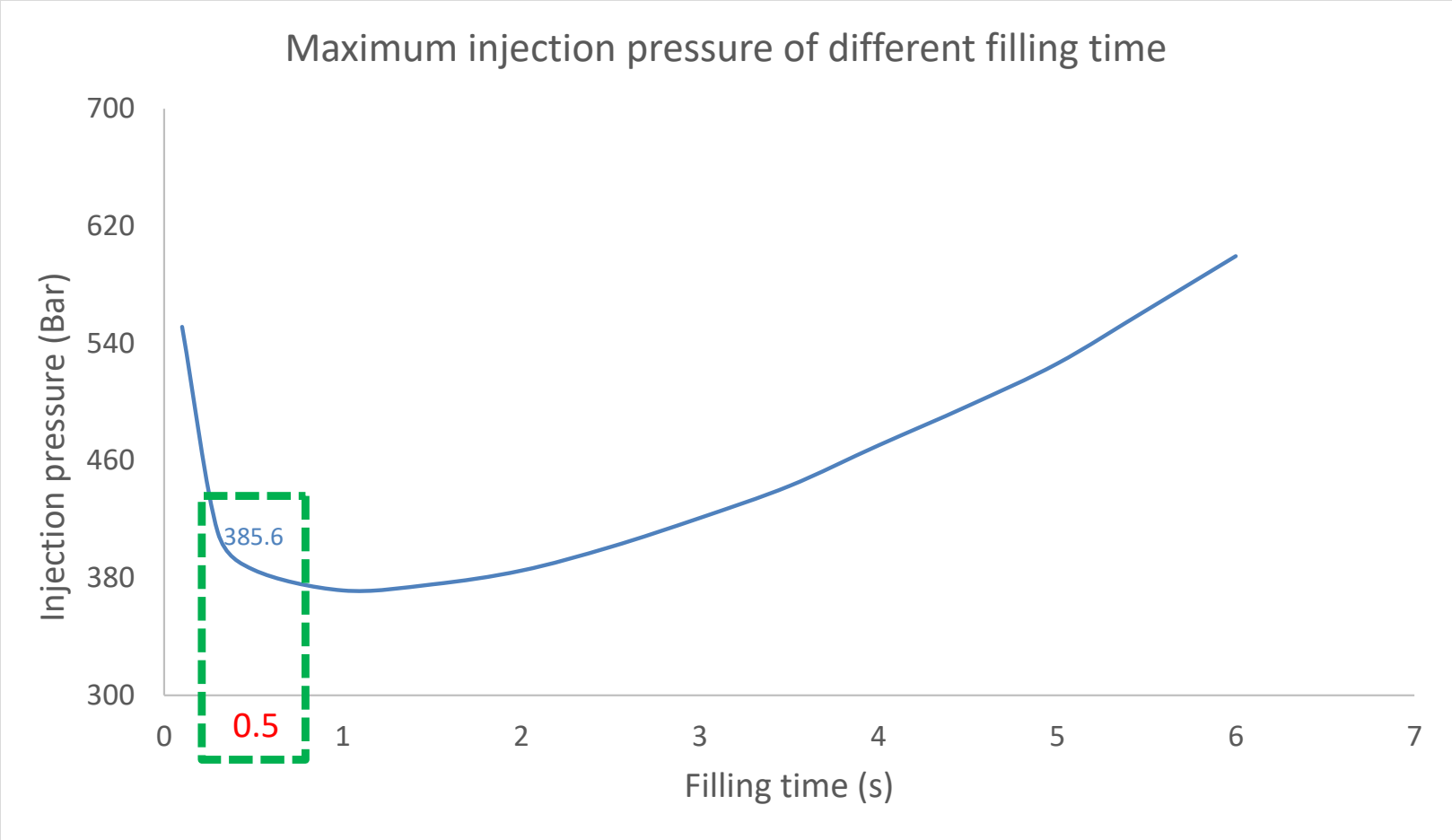
Unit : mm

# Model Information – Cooling System




Both Cavity and Core side are 2 input/ 2 output .

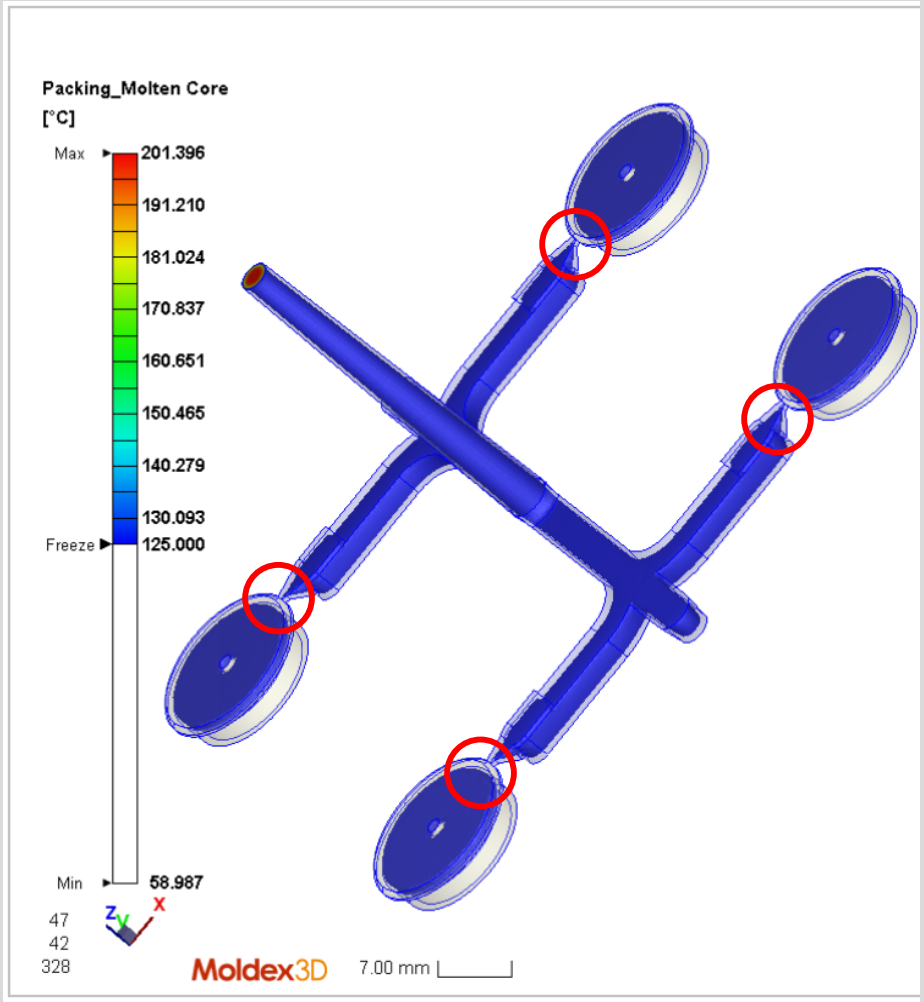
# The Filling Time Determination




Determined the filling time parameter as 0.5s.(In page.10)

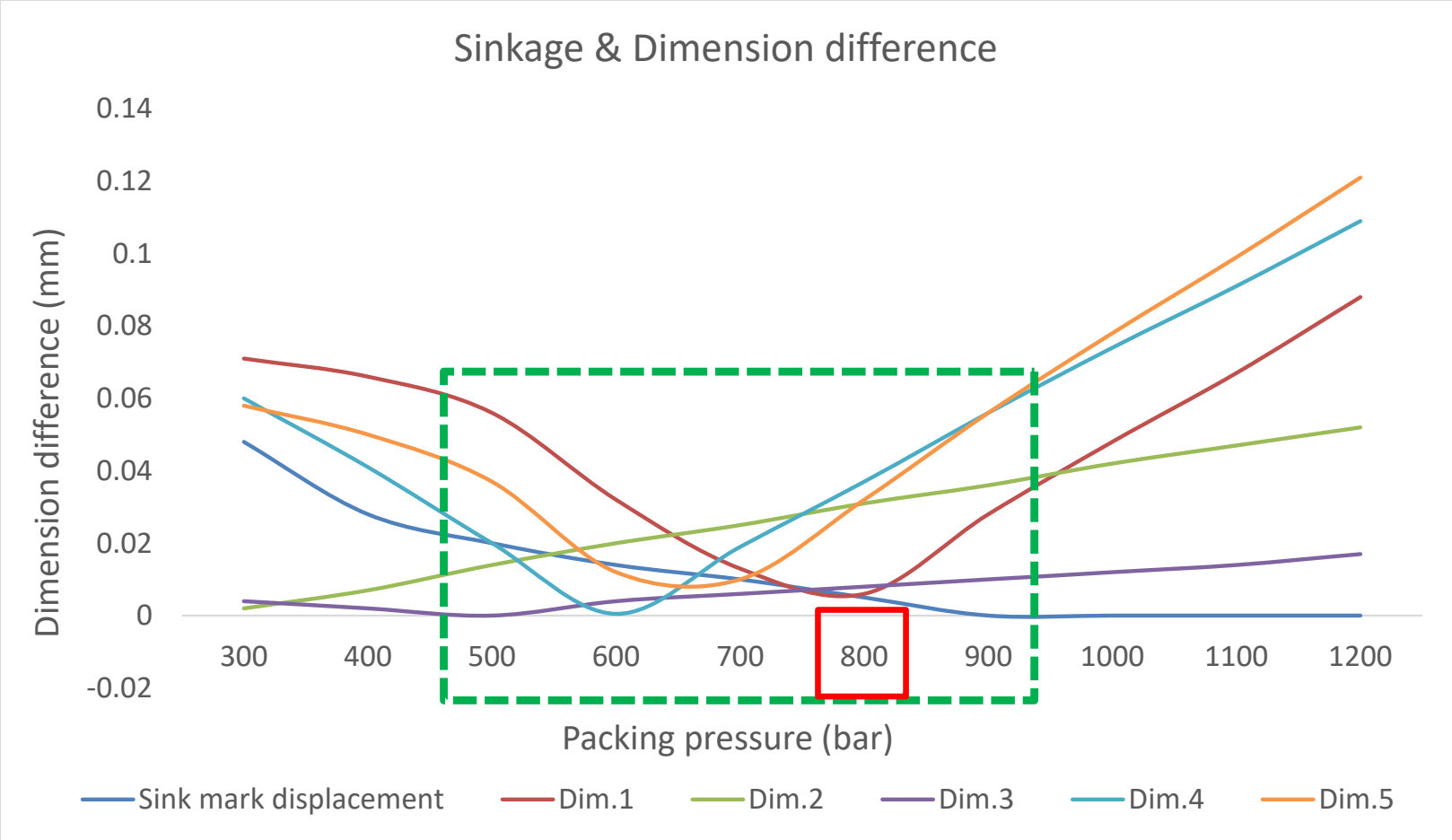
# The Packing Time Determination

## Molten Core Temperature



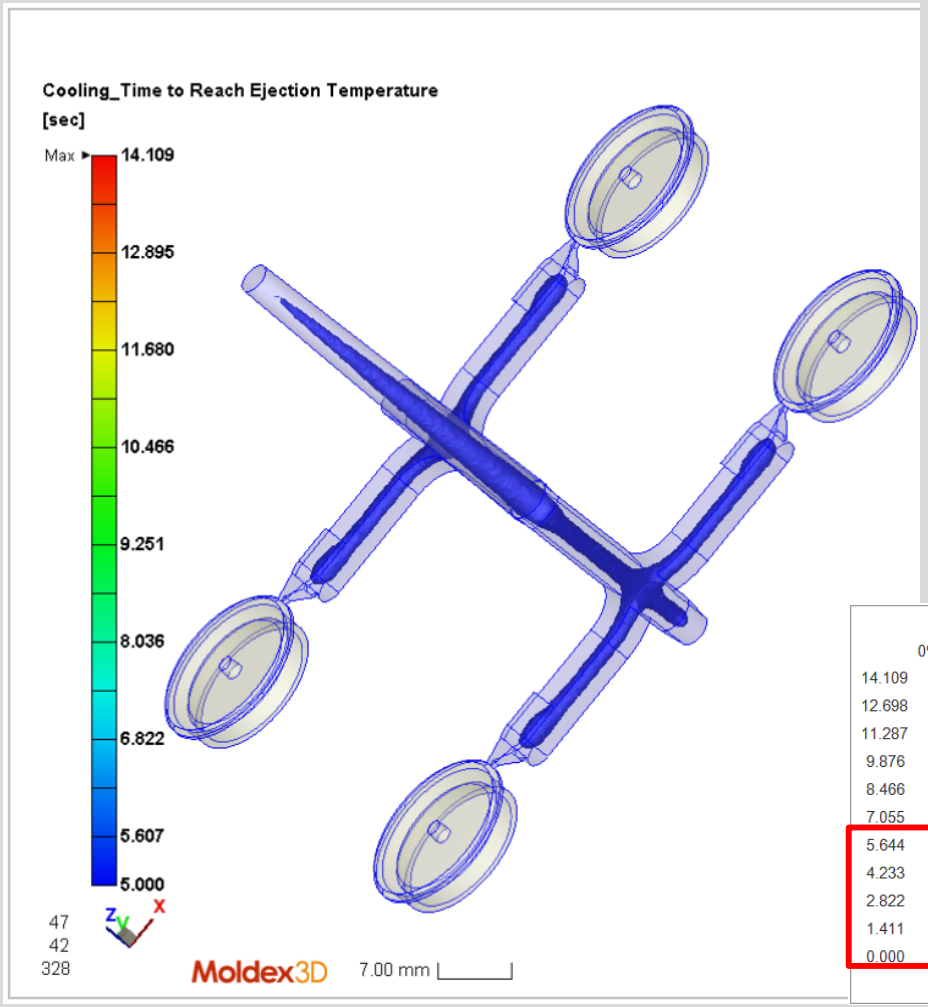

The effective packing time will be equal to the gate frozen time and the gate frozen time is 1s.
Determined the packing time parameters as gate frozen time.(In page.10)

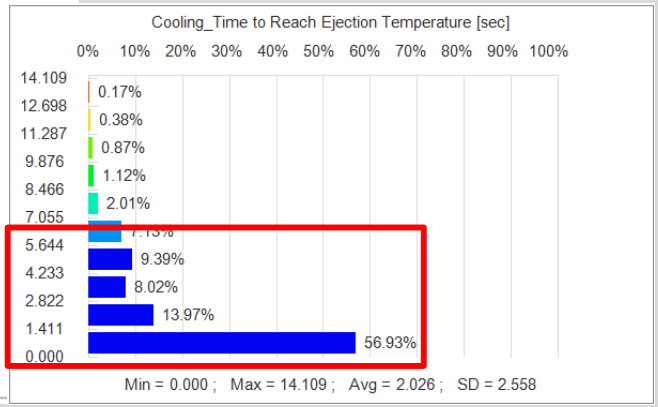
# The Packing Pressure Determination




In this case, higher packing pressure can improve the sinkage, but the dimensions may out of tolerance if packing pressure is not in the range of 500~900 bar.
The best packing pressure may be 800 bar (In page.10)

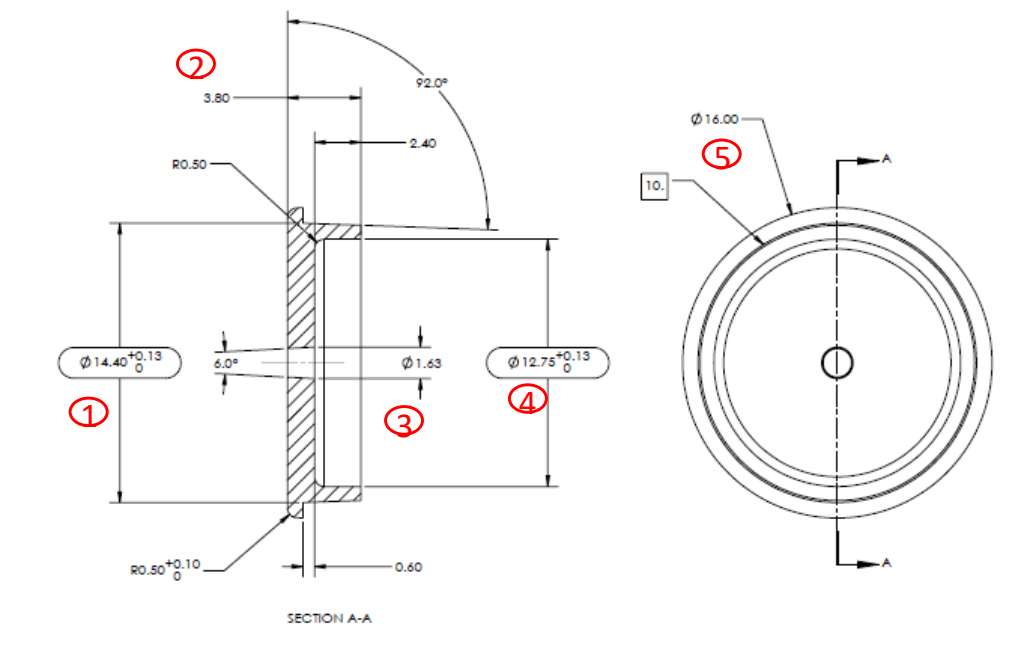
# The Cooling Time Determination

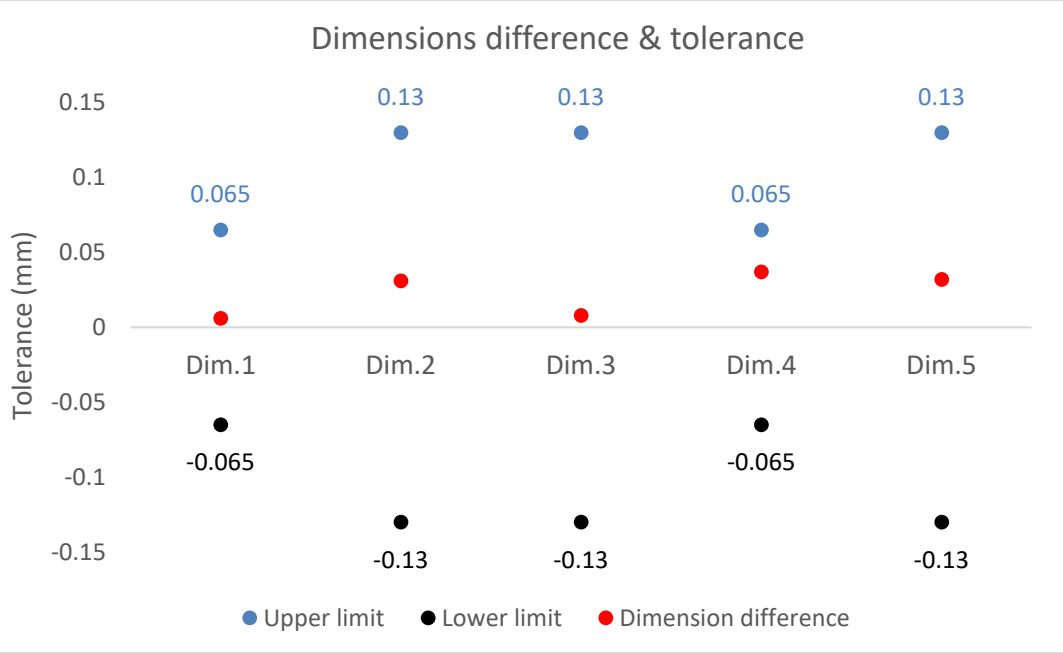



It can be ejected after 80% cooling, and the cooling time is about 5s.
*Due to the runner thickness issue may require more than 5s to cool down.
Determined / Preset the cooling time parameters as 5s.(In page.10)

# Part Dimension



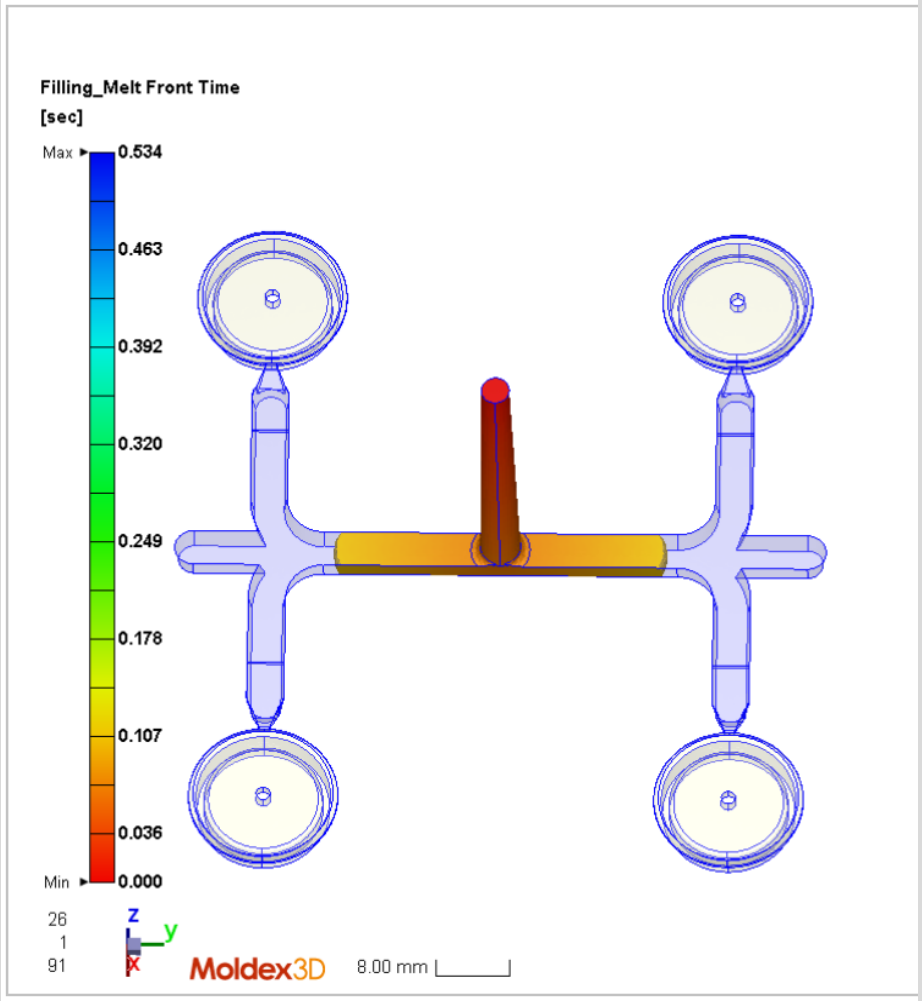




| Dimensions and tolerance | Dim.1 | Dim.2 | Dim.3 | Dim.4 | Dim.5 |
|---|---|---|---|---|---|
| | Ø 14.40 +0.13/-0 | 3.80 ± 0.13 | Ø 1.63 ± 0.13 | Ø 12.75 +0.13/-0 | Ø 16.00 ± 0.13 |
| Actual dimension (mm) | 14.471 | 3.831 | 1.638 | 12.852 | 16.032 |
| Dimension difference | 0.006 | 0.031 | 0.008 | 0.037 | 0.032 |

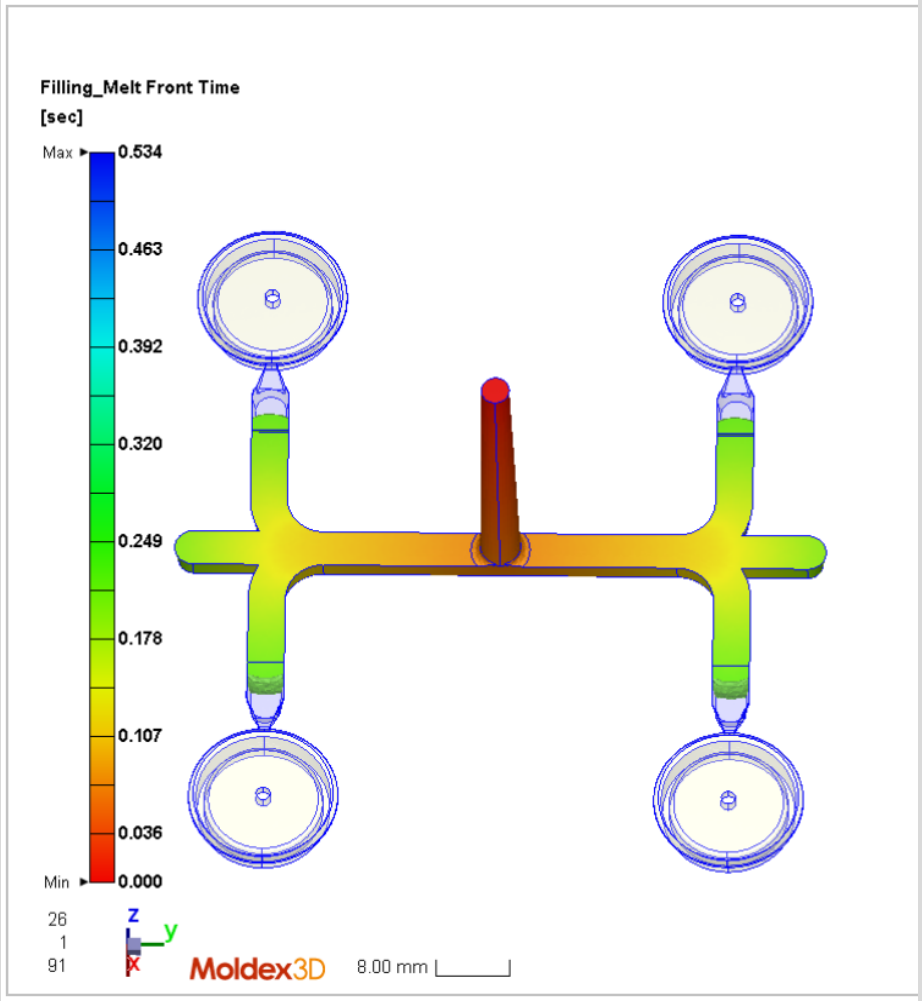
For all cavities, all the dimensions are in tolerance and the risk of dimension issue is low.

# Filling Stage

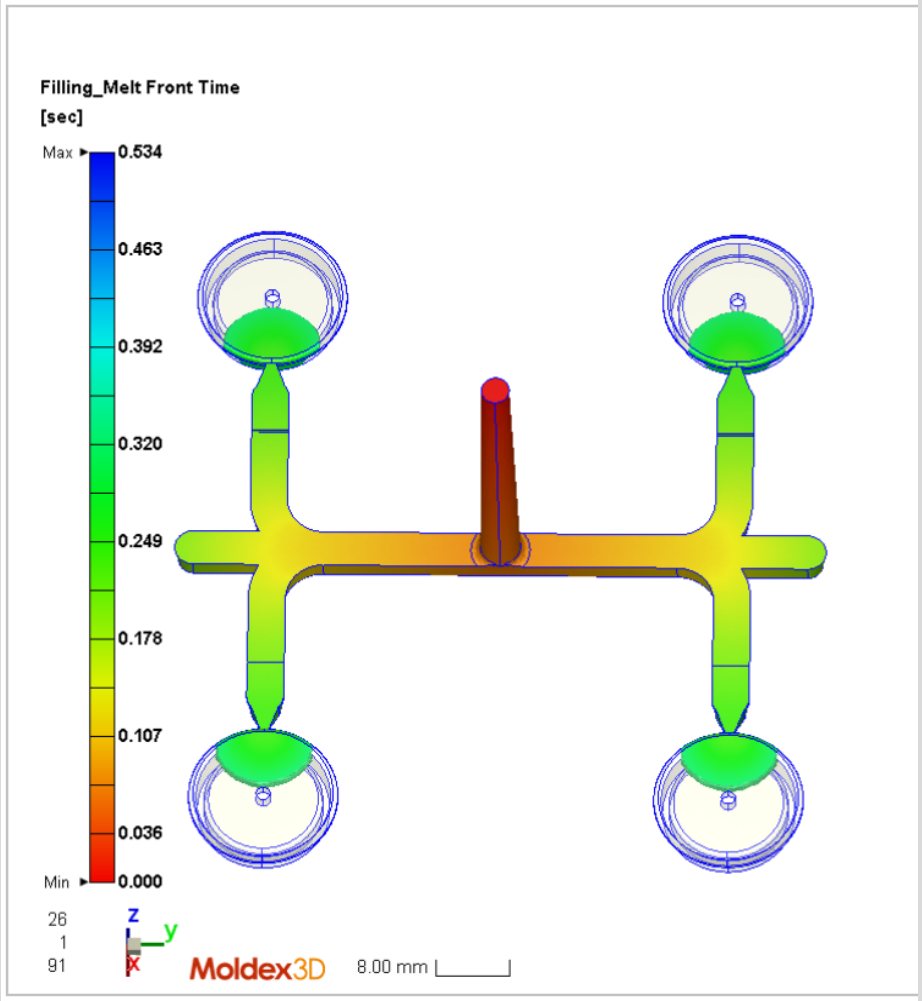
# Melt Front Time 20%



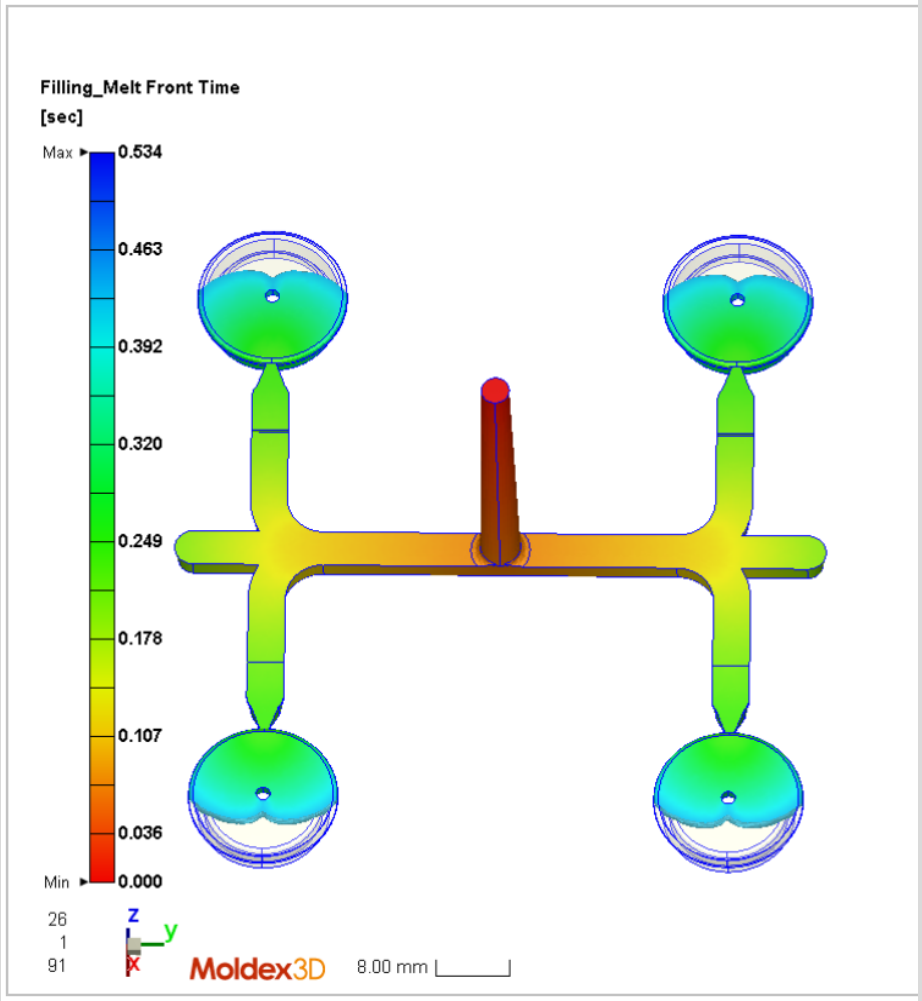
# Melt Front Time 40%



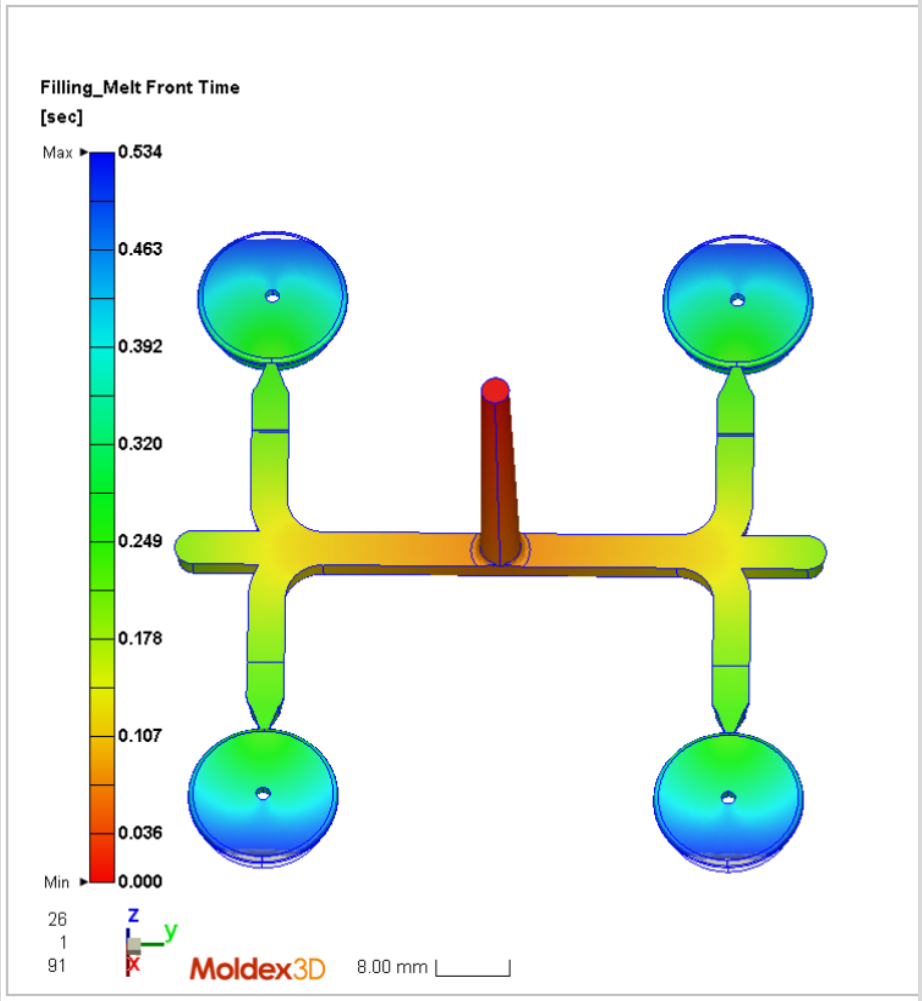
# Melt Front Time 60%



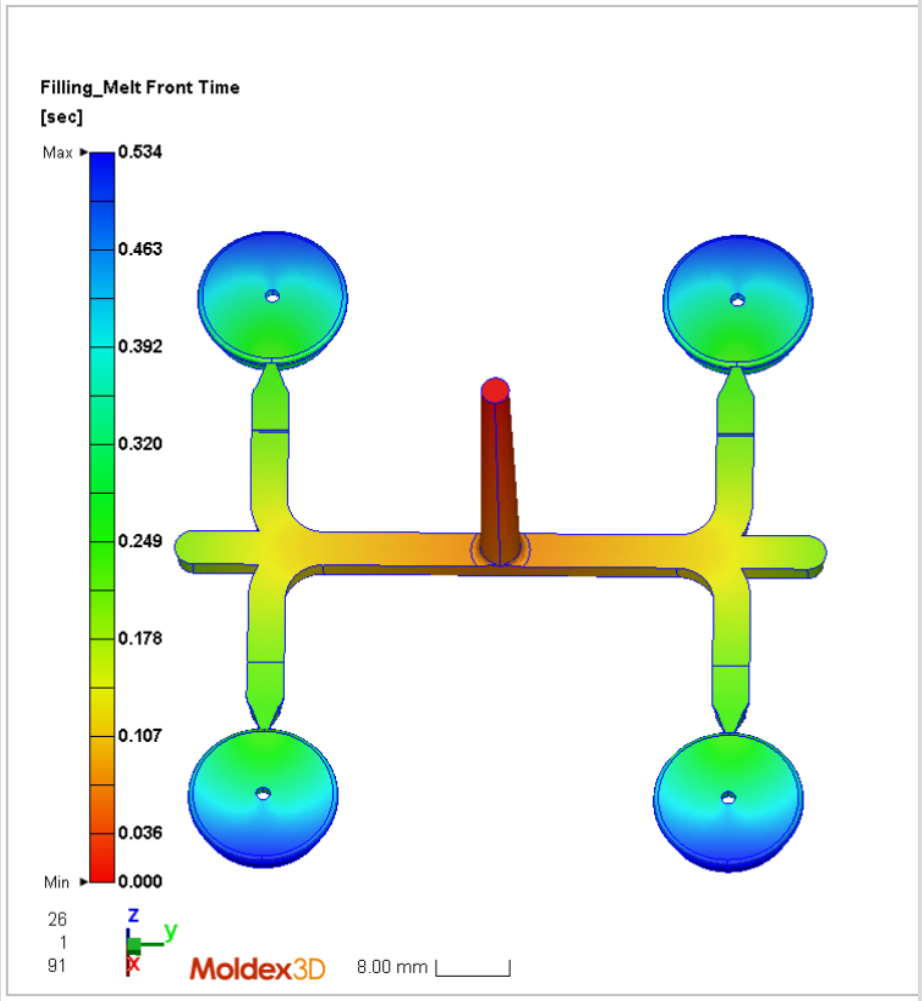
# Melt Front Time 80%



# Melt Front Time 95%

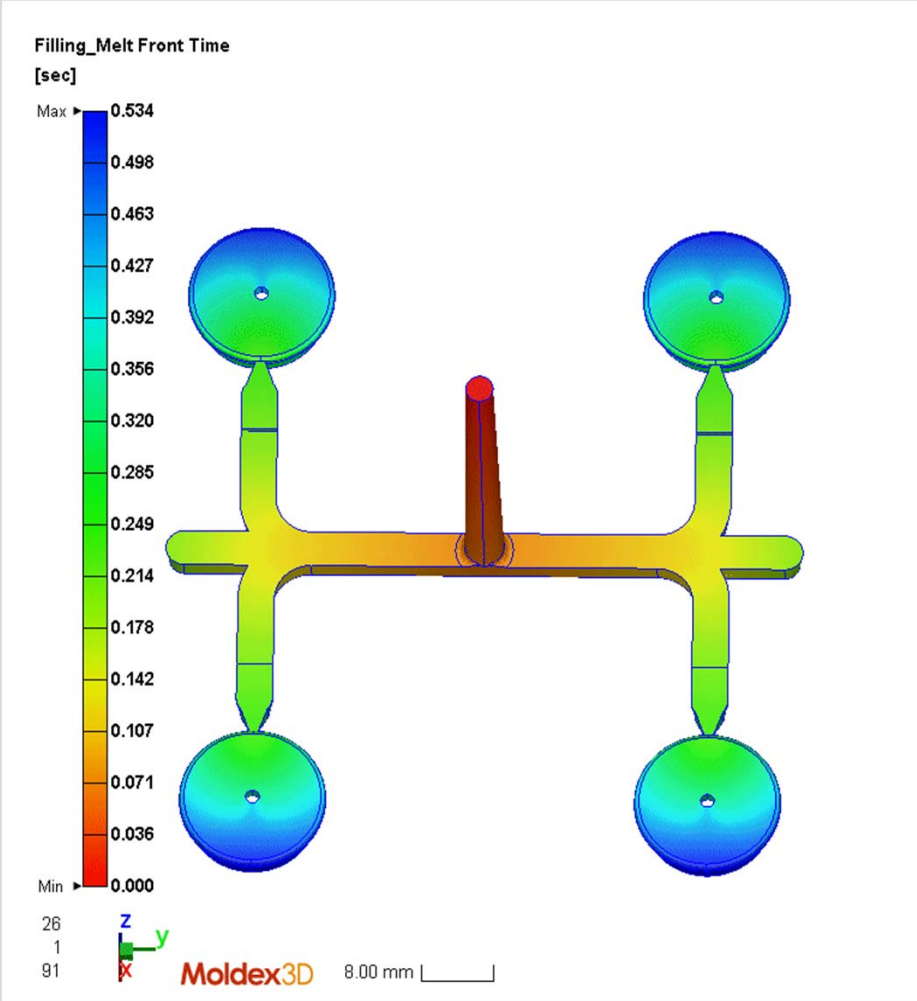


# Melt Front Time 100%

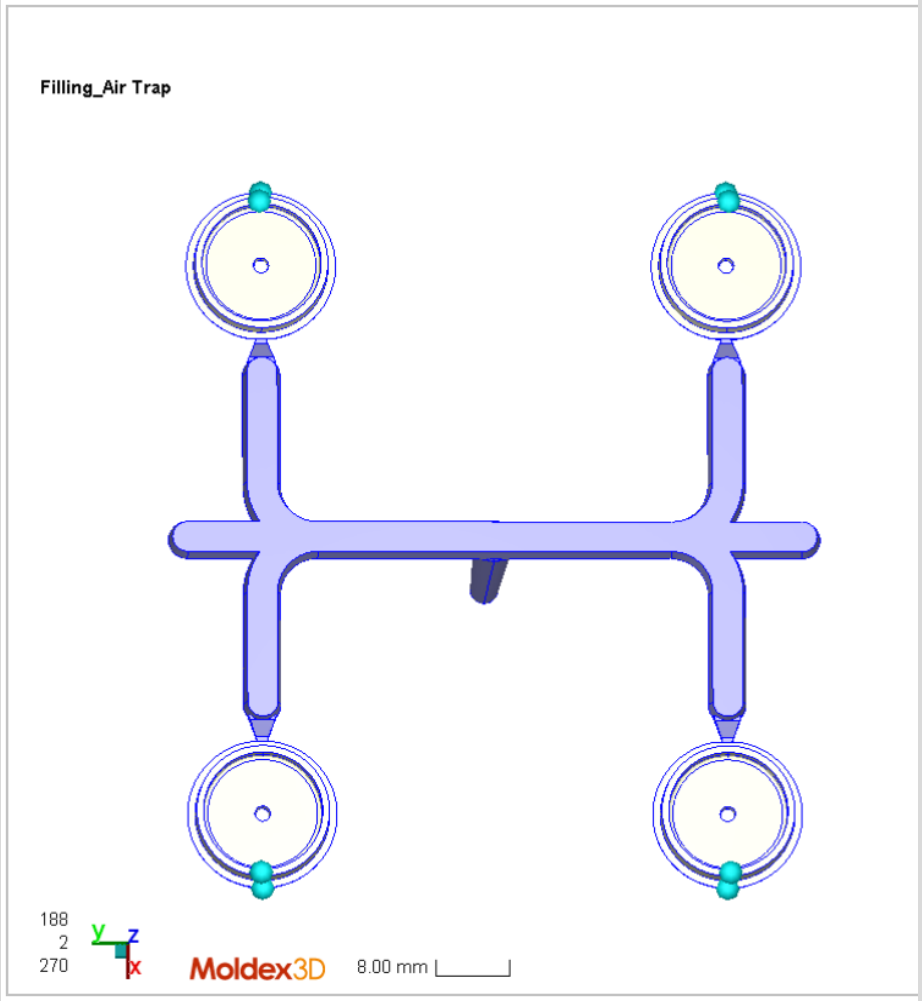



No short shot happened.

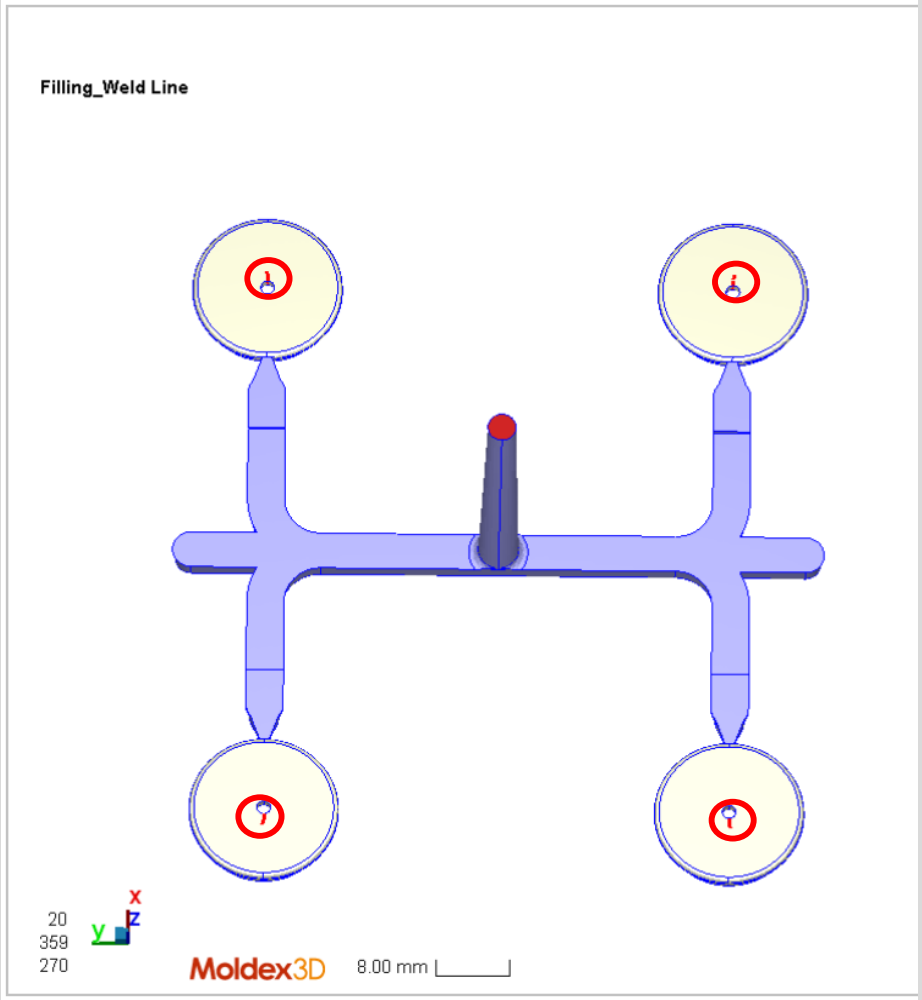
# Melt Front Time



# Air Trap



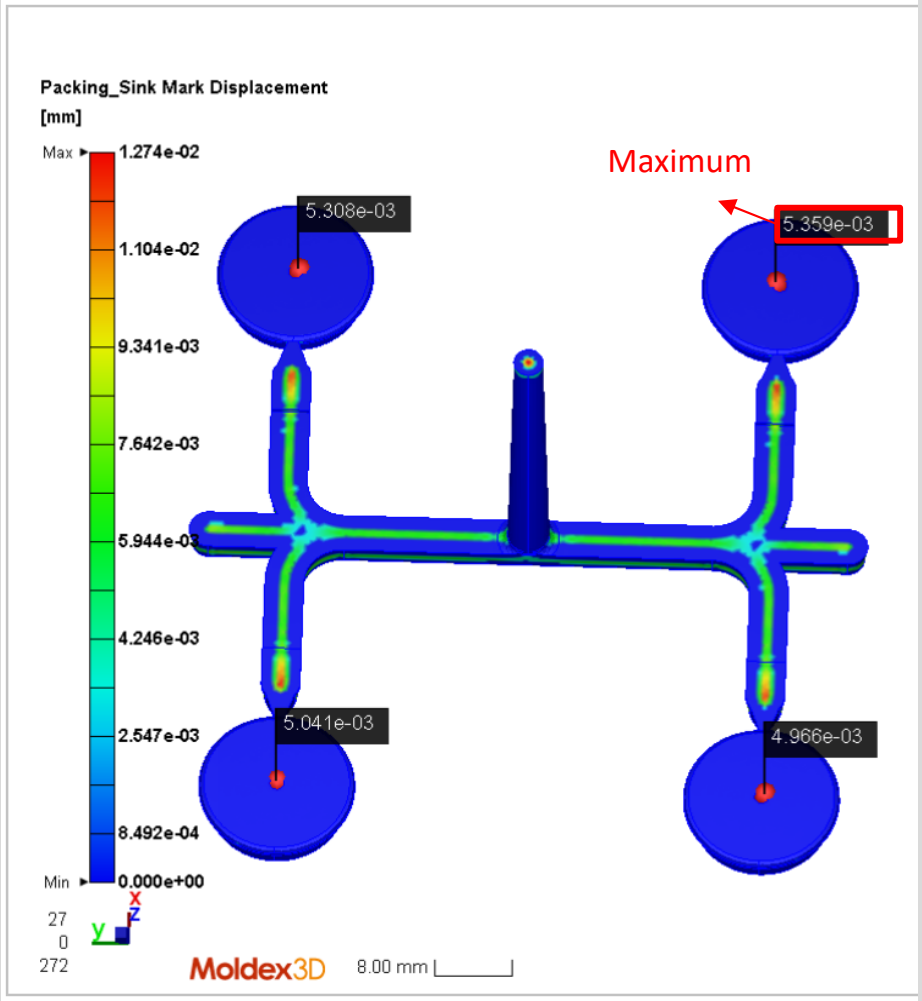
# Weld Line



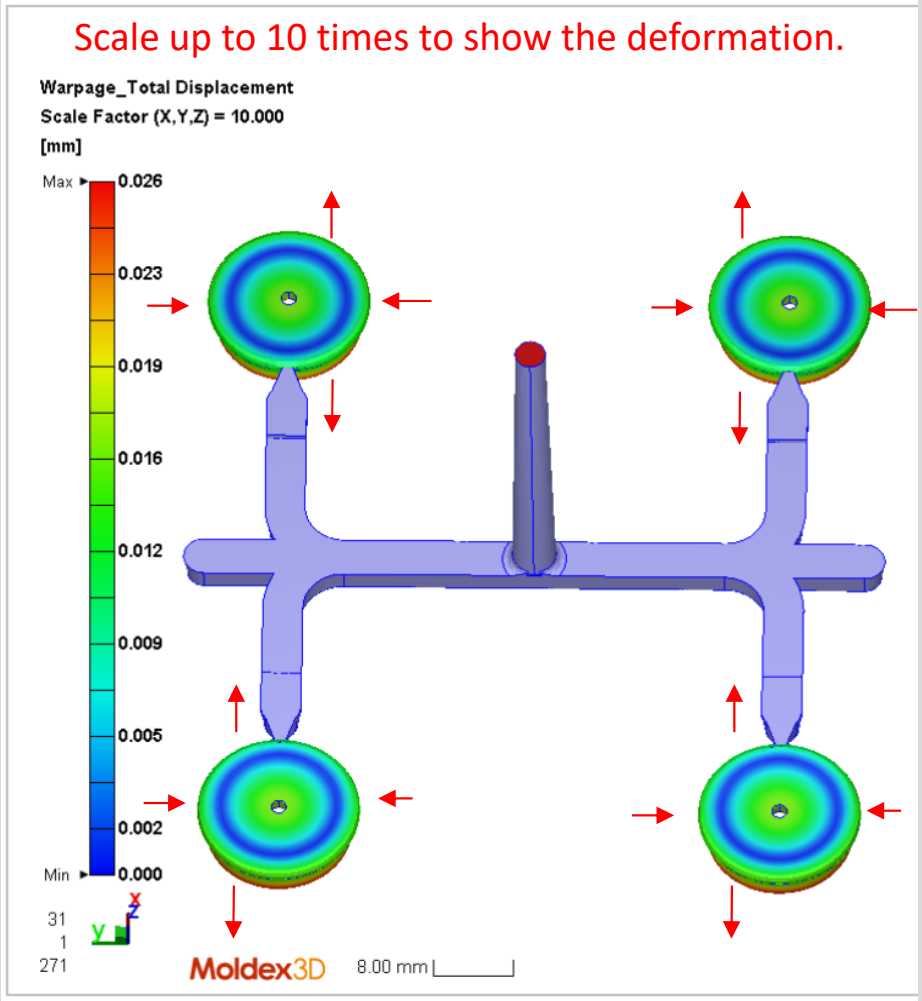

Weld line may appear at appearance and may need to increase the melt/mold temperature to improve the weld line quality.

# Sinkage & Warpage

# Sink Mark Displacement



# Warpage Behavior

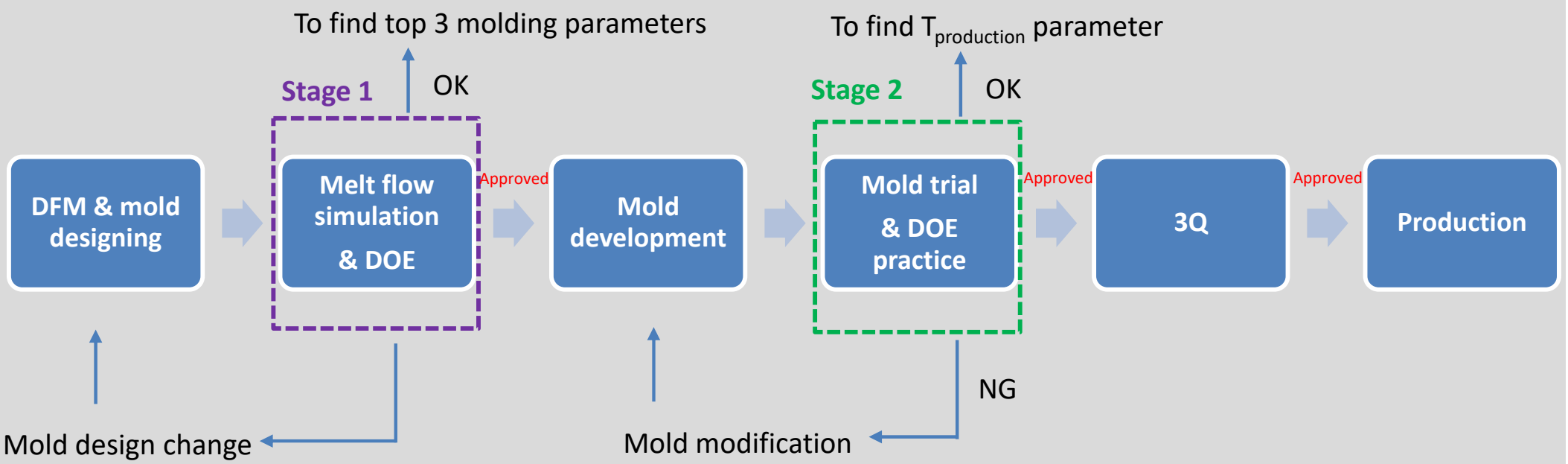


# The Injection Parameters (By Melt Flow Simulation)

| Parameters | |
|---|---|
| Simulation Setting Model | Machine model – Arburg PYA3 Ø25 |
| Mold Temperature (˚C) | Core: 55, Cavity: 55 |
| Melt Temperature (˚C) | 200 |
| **Filling** | |
| Filling Time (s) – Actual value | 0.515 |
| Section Number of injection velocity Profile | 3 |
| Initial Ram position (mm) | 14 |
| Section-1 Screw position, injection velocity (mm/s) | 10 , 20 |
| Section-2 Screw position, injection velocity (mm/s) | 7 , 10 |
| Section-3 Screw position, injection velocity (mm/s) | 5 , 5 |
| Actual injection pressure (bar) | 366.6 (5320 psi) |
| **Packing** | |
| Packing Time (s) | 1 |
| Section Number of Packing Pressure Profile | 1 |
| Section-1 Time 0s - 1s , Packing Pressure (bar) | 800 (11605 psi) |
| **Cooling** | |
| Cooling Time (s) | 5 |

Max Injection Pressure of machine (spec.) : 2500 bar (36260 psi)

# Melt flow DOE Analysis

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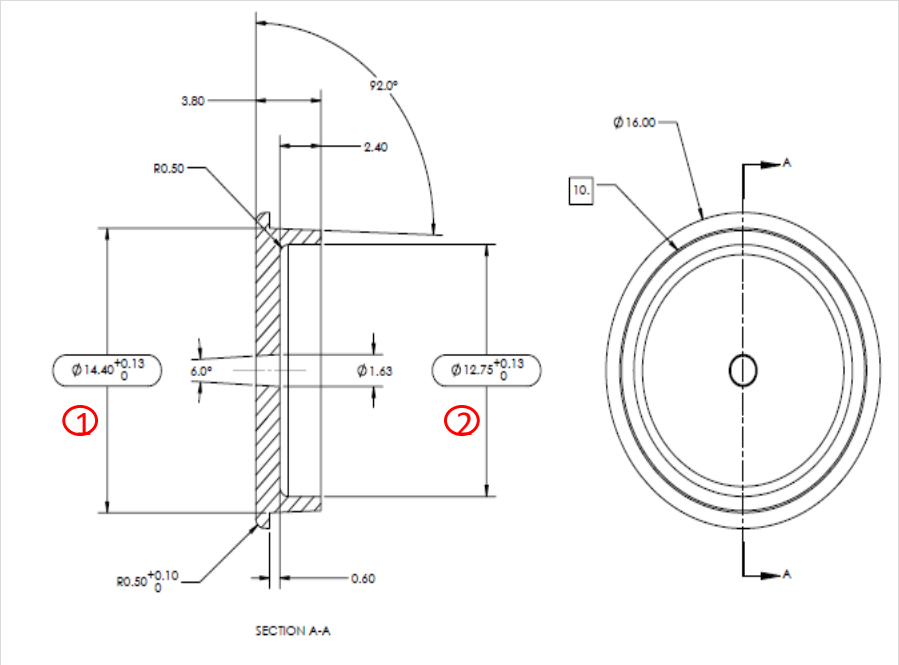
2. Mold trial & DOE practice are Full Factorial Experiments with top 3 molding parameters(analyzed by melt flow DOE analysis) when mold trial(Total 27 groups, each group includes 10 shots), will define $T_{production}$ parameter which have best control of molding process and lowest process risk.

# The DOE Method - Full Factorial Experiments By Simulation

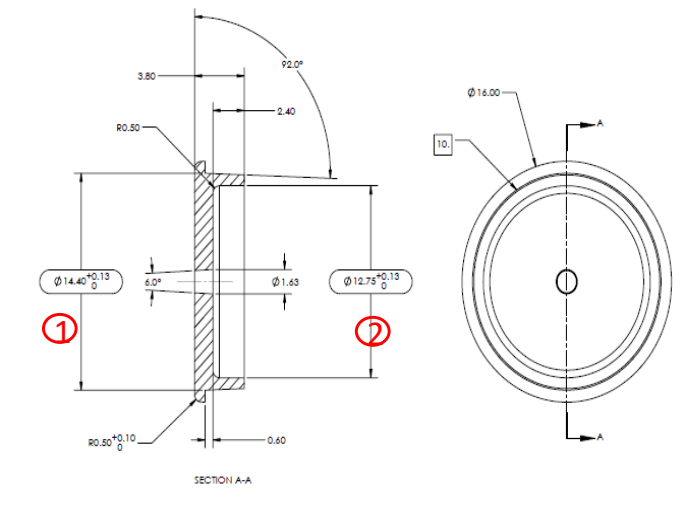
| Control Factor | | Level 1 | Level 2 | Level 3 |
|---|---|---|---|---|
| 1 | Melt temperature (˚C) | 50 | 55 | 60 |
| 2 | Mold temperature (˚C) | 190 | 200 | 210 |
| 3 | Injection velocity (mm/s) | 5 | 10 | 15 |
| 4 | Packing pressure (Bar) | 700 | 800 | 900 |

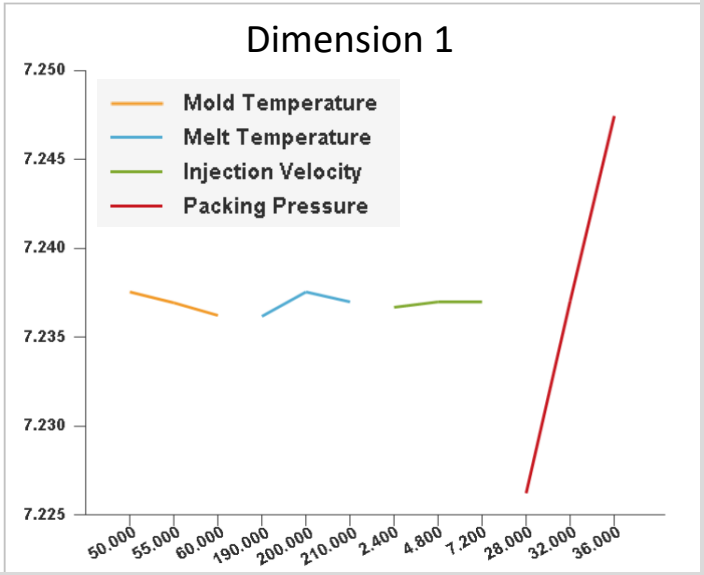
*Total number of experimental groups : 81 sets

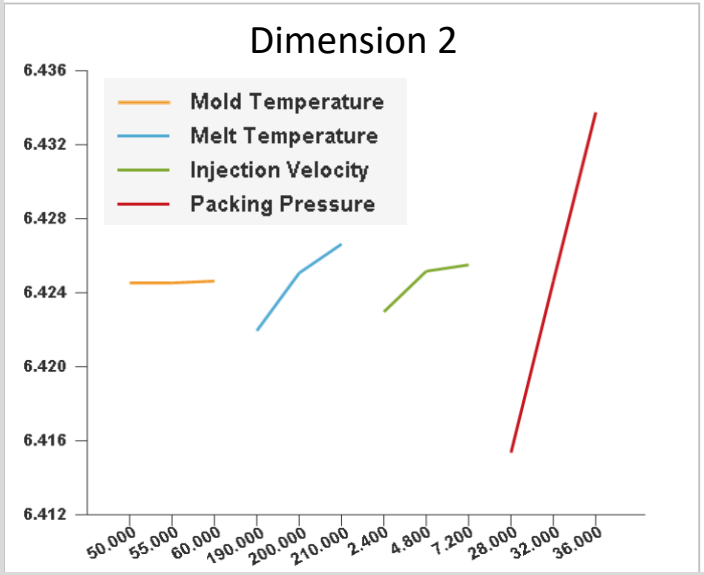
| Quality Factor | | Weighting (%) |
|---|---|---|
| 1 | Dim. 1 : 14.40 mm | 50 |
| 2 | Dim. 2 : 12.75 mm | 50 |



# The DOE Results – Quality Response



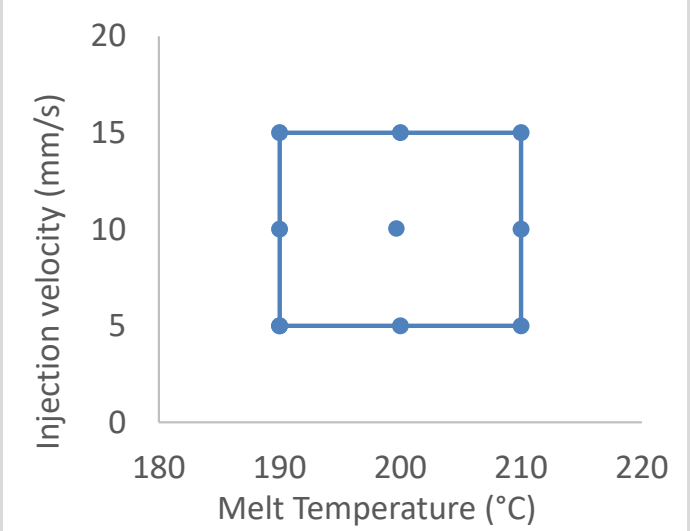




*__Packing pressure__ has the greatest impact on dimensions quality, then the second and third are __melt temperature__ and __injection velocity.__ They are the top 3 critical parameters of this project.

# Reference Molding Windows By Melt Flow Simulation

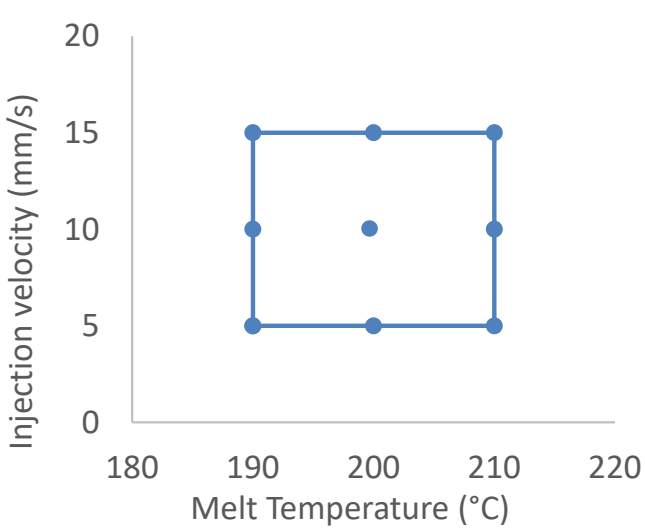
## Packing Pressure : 700 bar




| Melt Temp. (˚C) | Injection velocity (mm/s) | Dim. Qualities |
|---|---|---|
| 190 | 5 | OK |
| 190 | 10 | OK |
| 190 | 15 | OK |
| 200 | 5 | OK |
| 200 | 10 | OK |
| 200 | 15 | OK |
| 210 | 5 | OK |
| 210 | 10 | OK |
| 210 | 15 | OK |

When setting lower packing pressure, the risk of dimension issues is low.

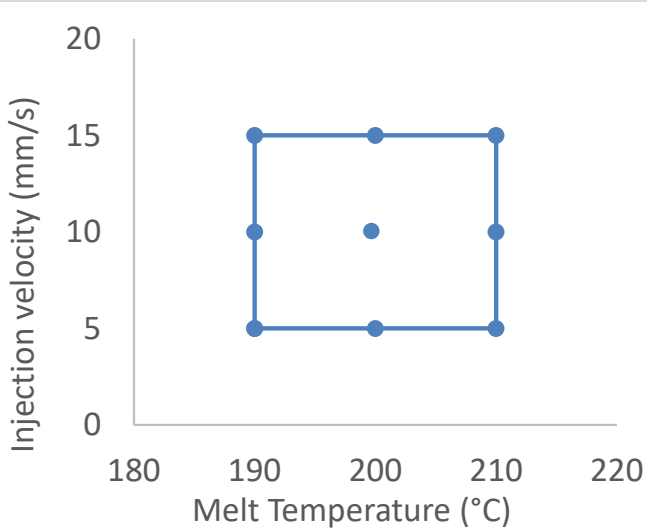
## Packing Pressure : 800 bar




| Melt Temp. (˚C) | Injection velocity (mm/s) | Dim. Qualities |
|---|---|---|
| 190 | 5 | OK |
| 190 | 10 | OK |
| 190 | 15 | OK |
| 200 | 5 | OK |
| 200 | 10 | OK |
| 200 | 15 | OK |
| 210 | 5 | OK |
| 210 | 10 | OK |
| 210 | 15 | OK |

When setting medium packing pressure, the risk of dimension issues is low.

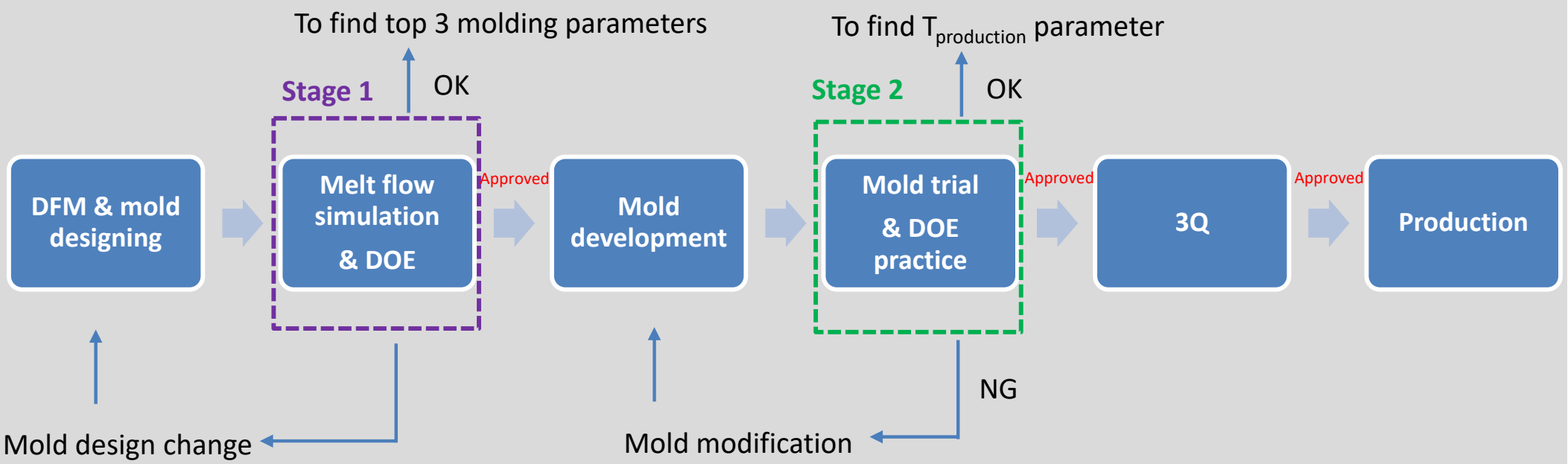
## Packing Pressure : 900 bar




| Melt Temp. (˚C) | Injection velocity (mm/s) | Dim. Qualities |
|---|---|---|
| 190 | 5 | OK |
| 190 | 10 | OK |
| 190 | 15 | OK |
| 200 | 5 | OK |
| 200 | 10 | OK |
| 200 | 15 | OK |
| 210 | 5 | OK |
| 210 | 10 | OK |
| 210 | 15 | OK |

When setting higher packing pressure, the risk of dimension issues is low.

# Mold Trial & DOE practice

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   - **Full analysis** helps mold design and reduces risk of molding process.
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2. Mold trial & DOE practice are Full Factorial Experiments with top 3 molding parameters(analyzed by melt flow DOE analysis) when mold trial(Total 27 groups, each group includes 10 shots), will define $T_{production}$ parameter which have best control of molding process and lowest process risk.

# The Molding Parameters From Mold Trial Results That Have Been Adjusted To Eliminate The Flow Mark And Sink Mark

| Parameters | | | | | | | |
|---|---|---|---|---|---|---|---|
| Mold Temperature (˚C) | Core: 55 , Cavity: 55 | | | | | | |
| Melt Temperature (˚C) | 200 | 205 | 200 | 190 | 180 | 170 | 40 |
| **Filling** | | | | | | | |
| Filling Time (s) – Actual value | 0.16 | | | | | | |
| Initial Ram position (mm) | 20 | | | | | | |
| Section-1 Screw position, injection velocity (mm/s) | 18.7 , 80 | | | | | | |
| Section-2 Screw position, injection velocity (mm/s) | 14.5 , 60 | | | | | | |
| Section-3 Screw position, injection velocity (mm/s) | 13 , 30 | | | | | | |
| Actual injection pressure (bar) | 630 | | | | | | |
| Screw speed (mm/s) | 100 | | | | | | |
| Back pressure (bar) | 150 | | | | | | |
| Metering delay time(s) | 6 | | | | | | |
| Suck back (mm / mm/s) | 2 , 30 | | | | | | |
| **Packing** | | | | | | | |
| Packing speed (mm/s) | 10 | | | | | | |
| Time(s) / Packing Pressure (bar) | 0.5/900~2/900 | | | | | | |
| **Cooling** | | | | | | | |
| Cooling Time (s) | 10 | | | | | | |
| Cycle Time (s) | 16 | | | | | | |

Max Injection Pressure of machine (spec.) : 2500 bar

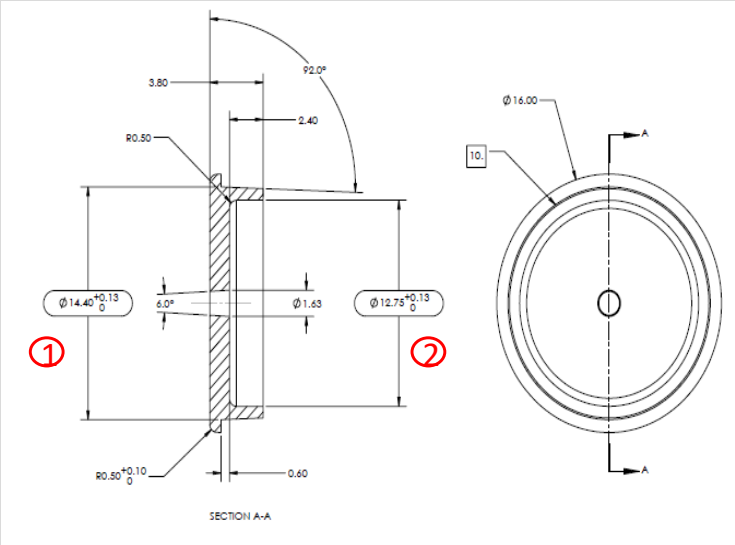
# The DOE Method - Full Factorial Experiments By Real Molding

*Total number of experimental groups : 27 sets

| Control Factor | | Level 1 | Level 2 | Level 3 |
|---|---|---|---|---|
| 1 | Injection velocity (mm/s) | 55 | 60 | 65 |
| 2 | Melt temperature (˚C) | 195 | 200 | 205 |
| 3 | Packing pressure (Bar) | 800 | 900 | 1000 |

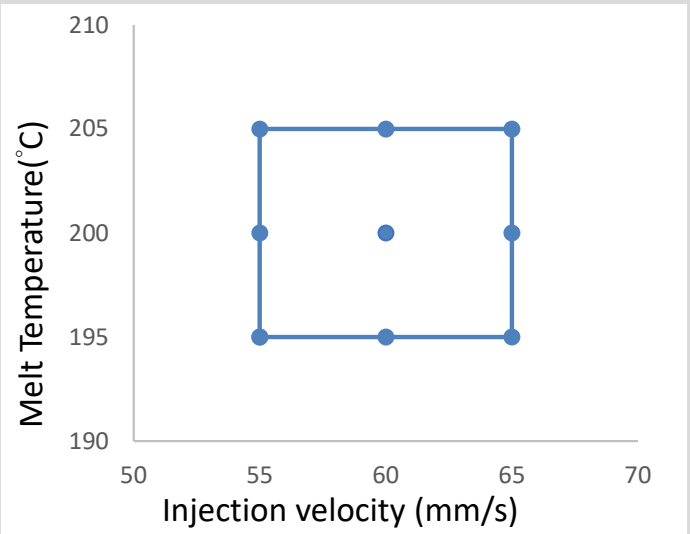
***Packing pressure** has the greatest impact on dimensions quality, then the second and third are **injection velocity** and **melt temperature.** They are the top 3 critical parameters of this project.

| Quality Factor | |
|---|---|
| 1 | Dim. 1 : 14.40 mm |
| 2 | Dim. 2 : 12.75 mm |



# The Molding Windows Resulted By Mold Trial

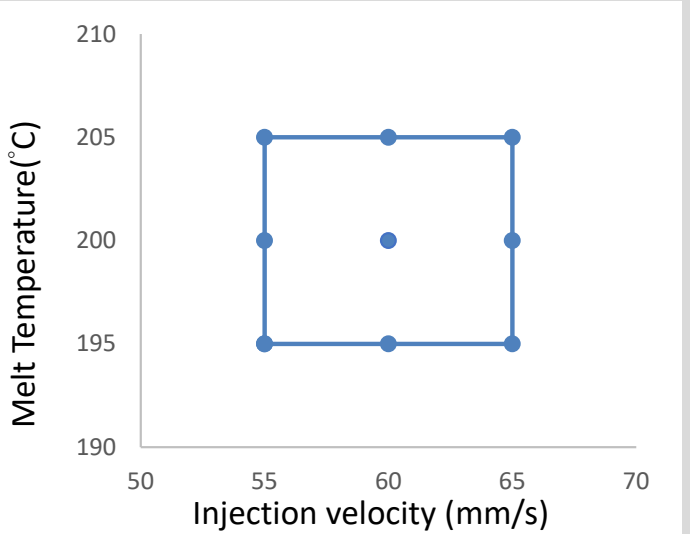
## Packing Pressure : 800 bar




| Injection velocity (mm/s) | Melt Temp. (˚C) | Dim. Qualities |
|---|---|---|
| 55 | 195 | OK |
| 55 | 200 | OK |
| 55 | 205 | OK |
| 60 | 195 | OK |
| 60 | 200 | OK |
| 60 | 205 | OK |
| 65 | 195 | OK |
| 65 | 200 | OK |
| 65 | 205 | OK |

When setting lower packing pressure, the risk of dimension issues is low.

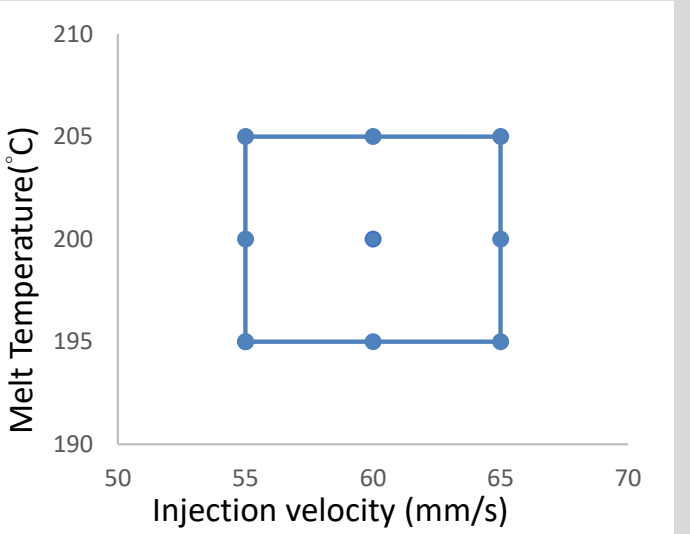
## Packing Pressure : 900 bar




| Injection velocity (mm/s) | Melt Temp. (˚C) | Dim. Qualities |
|---|---|---|
| 55 | 195 | OK |
| 55 | 200 | OK |
| 55 | 205 | OK |
| 60 | 195 | OK |
| 60 | 200 | OK |
| 60 | 205 | OK |
| 65 | 195 | OK |
| 65 | 200 | OK |
| 65 | 205 | OK |

When setting medium packing pressure, the risk of dimension issues is low.

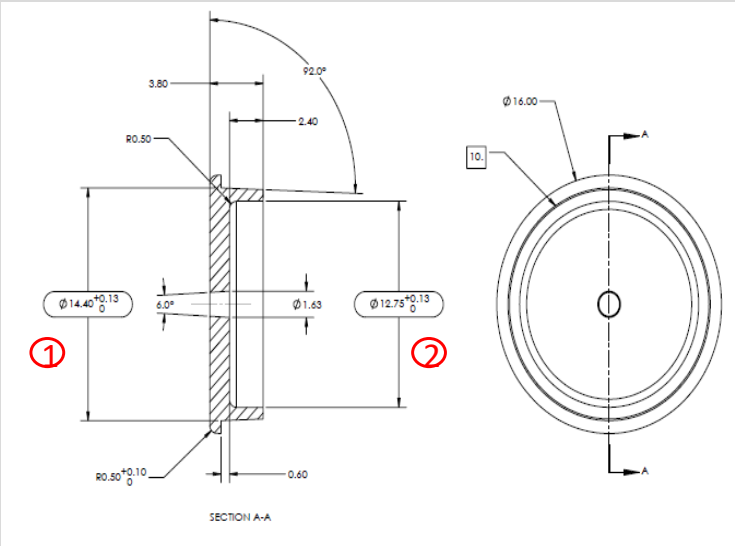
## Packing Pressure : 1000 bar




| Injection velocity (mm/s) | Melt Temp. (˚C) | Dim. Qualities |
|---|---|---|
| 55 | 195 | OK |
| 55 | 200 | OK |
| 55 | 205 | OK |
| 60 | 195 | OK |
| 60 | 200 | OK |
| 60 | 205 | OK |
| 65 | 195 | OK |
| 65 | 200 | OK |
| 65 | 205 | OK |

When setting higher packing pressure, the risk of dimension issues is low.

# Dimension And Appearance Results From The Molding Windows-Cav 1



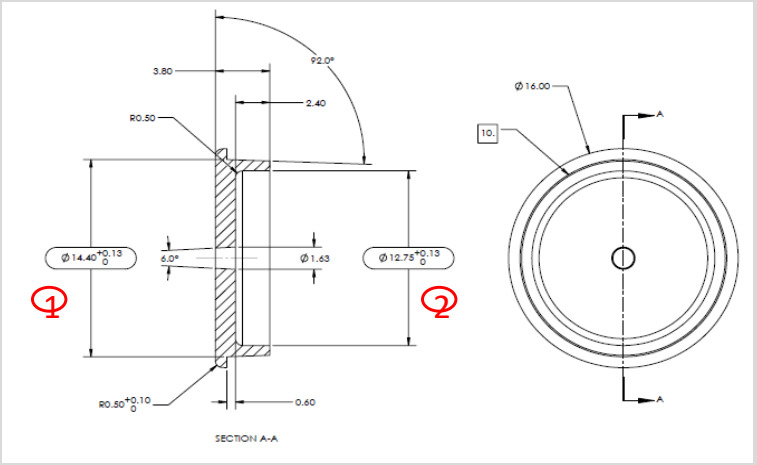

| Appearance grade | |
|---|---|
| Perfect | 0 |
| Minor | 1 |
| Limit sample | 2 |

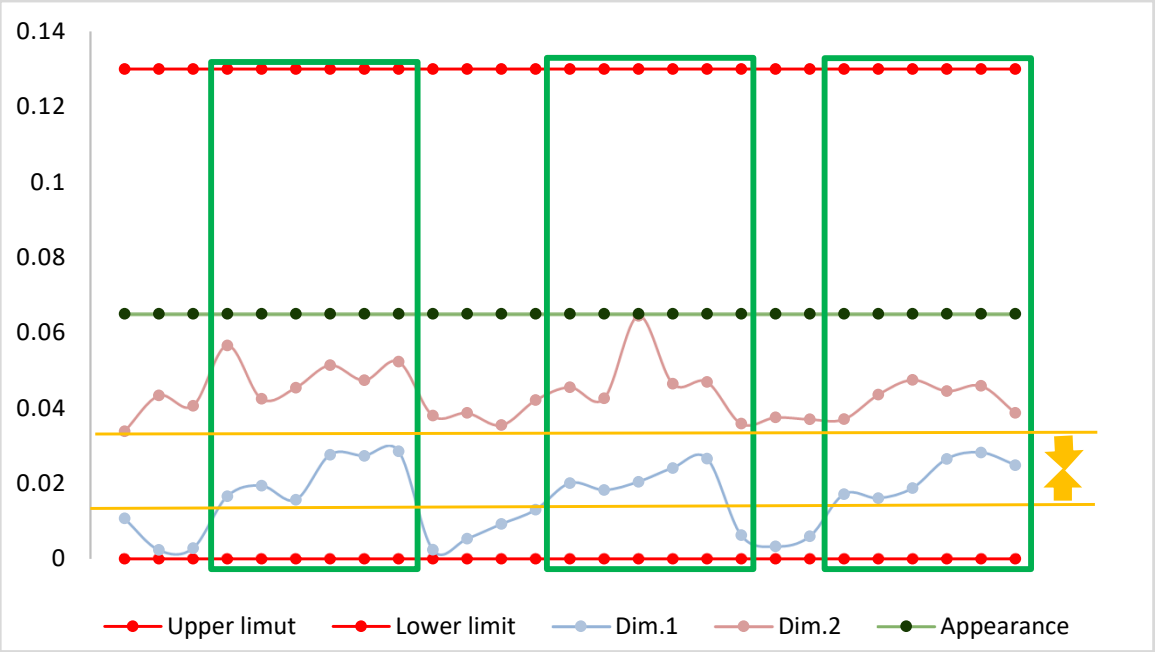
| Injection velocity | Melt Temp. | Packing pressure | Appearance | CPK | |
|---|---|---|---|---|---|
| | | | | 1.05 | 2.56 |
| | | | | Dim.1 | Dim.2 |
| 55 | 195 | 800 | 1 | 14.411 | 12.784 |
| 55 | 200 | 800 | 1 | 14.402 | 12.793 |
| 55 | 205 | 800 | 1 | 14.403 | 12.791 |
| 55 | 195 | 900 | 1 | 14.417 | 12.807 |
| 55 | 200 | 900 | 1 | 14.419 | 12.792 |
| 55 | 205 | 900 | 1 | 14.416 | 12.795 |
| 55 | 195 | 1000 | 1 | 14.428 | 12.801 |
| 55 | 200 | 1000 | 1 | 14.427 | 12.797 |
| 55 | 205 | 1000 | 1 | 14.429 | 12.802 |
| 60 | 195 | 800 | 1 | 14.402 | 12.788 |
| 60 | 200 | 800 | 1 | 14.405 | 12.789 |
| 60 | 205 | 800 | 1 | 14.409 | 12.785 |
| 60 | 195 | 900 | 1 | 14.413 | 12.792 |
| 60 | 200 | 900 | 1 | 14.420 | 12.796 |
| 60 | 205 | 900 | 1 | 14.418 | 12.793 |
| 60 | 195 | 1000 | 1 | 14.420 | 12.814 |
| 60 | 200 | 1000 | 1 | 14.424 | 12.796 |
| 60 | 205 | 1000 | 1 | 14.427 | 12.797 |
| 65 | 195 | 800 | 1 | 14.406 | 12.786 |
| 65 | 200 | 800 | 1 | 14.403 | 12.788 |
| 65 | 205 | 800 | 1 | 14.406 | 12.787 |
| 65 | 195 | 900 | 1 | 14.417 | 12.787 |
| 65 | 200 | 900 | 1 | 14.416 | 12.794 |
| 65 | 205 | 900 | 1 | 14.419 | 12.797 |
| 65 | 195 | 1000 | 1 | 14.426 | 12.795 |
| 65 | 200 | 1000 | 1 | 14.428 | 12.796 |
| 65 | 205 | 1000 | 1 | 14.425 | 12.789 |

*The CPK of Dim.1 is the lowest, will pay attention to it in every production.

# Dimension And Appearance Results From The Molding Windows-Cav 1

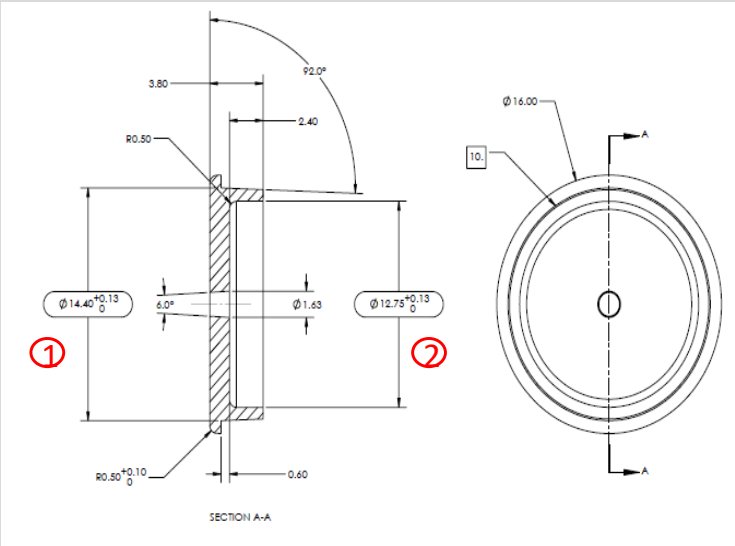
| | Injection velocity (mm/s) | Melt Temp. (°C) | Packing Pressure(Bar) |
|---|---|---|---|
| 1 | 55 | 195 | 800 |
| 2 | 55 | 200 | 800 |
| 3 | 55 | 205 | 800 |
| 4 | 55 | 195 | 900 |
| 5 | 55 | 200 | 900 |
| 6 | 55 | 205 | 900 |
| 7 | 55 | 195 | 1000 |
| 8 | 55 | 200 | 1000 |
| 9 | 55 | 205 | 1000 |
| 10 | 60 | 195 | 800 |
| 11 | 60 | 200 | 800 |
| 12 | 60 | 205 | 800 |
| 13 | 60 | 195 | 900 |
| 14 | 60 | 200 | 900 |
| 15 | 60 | 205 | 900 |
| 16 | 60 | 195 | 1000 |
| 17 | 60 | 200 | 1000 |
| 18 | 60 | 205 | 1000 |
| 19 | 65 | 195 | 800 |
| 20 | 65 | 200 | 800 |
| 21 | 65 | 205 | 800 |
| 22 | 65 | 195 | 900 |
| 23 | 65 | 200 | 900 |
| 24 | 65 | 205 | 900 |
| 25 | 65 | 195 | 1000 |
| 26 | 65 | 200 | 1000 |
| 27 | 65 | 205 | 1000 |




*The suitable molding parameters are group 4~9, 14~18,22~27 (green area).

# Dimension And Appearance Results From The Molding Windows-Cav 2



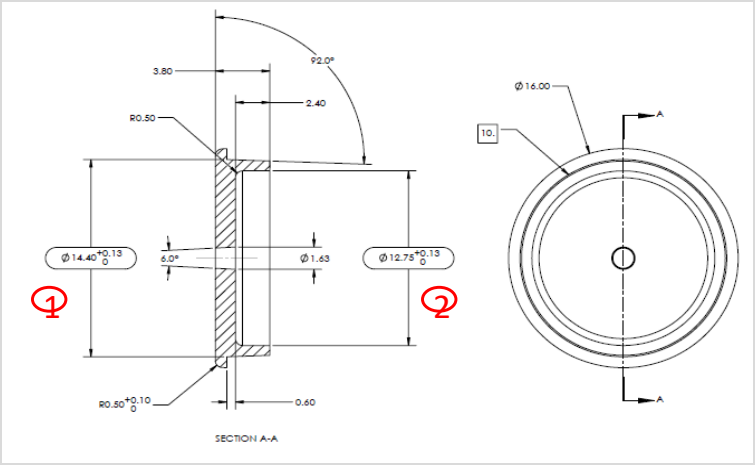

| Appearance grade | |
|---|---|
| Perfect | 0 |
| Minor | 1 |
| Limit sample | 2 |

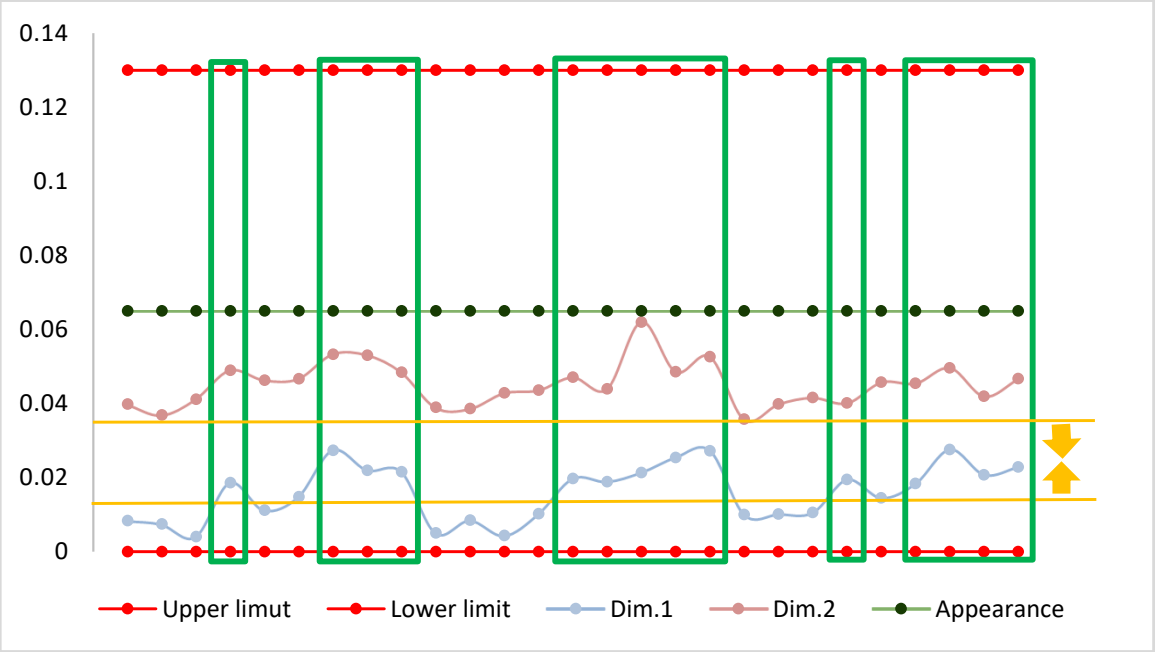
| Injection velocity | Melt Temp. | Packing pressure | Appearance | CPK | |
|---|---|---|---|---|---|
| | | | | 1.04 | 3.32 |
| | | | | Dim.1 | Dim.2 |
| 55 | 195 | 800 | 1 | 14.408 | 12.790 |
| 55 | 200 | 800 | 1 | 14.407 | 12.787 |
| 55 | 205 | 800 | 1 | 14.404 | 12.791 |
| 55 | 195 | 900 | 1 | 14.419 | 12.799 |
| 55 | 200 | 900 | 1 | 14.411 | 12.796 |
| 55 | 205 | 900 | 1 | 14.415 | 12.797 |
| 55 | 195 | 1000 | 1 | 14.427 | 12.803 |
| 55 | 200 | 1000 | 1 | 14.422 | 12.803 |
| 55 | 205 | 1000 | 1 | 14.422 | 12.798 |
| 60 | 195 | 800 | 1 | 14.405 | 12.789 |
| 60 | 200 | 800 | 1 | 14.409 | 12.789 |
| 60 | 205 | 800 | 1 | 14.404 | 12.793 |
| 60 | 195 | 900 | 1 | 14.410 | 12.794 |
| 60 | 200 | 900 | 1 | 14.420 | 12.797 |
| 60 | 205 | 900 | 1 | 14.419 | 12.794 |
| 60 | 195 | 1000 | 1 | 14.421 | 12.812 |
| 60 | 200 | 1000 | 1 | 14.425 | 12.799 |
| 60 | 205 | 1000 | 1 | 14.427 | 12.803 |
| 65 | 195 | 800 | 1 | 14.410 | 12.786 |
| 65 | 200 | 800 | 1 | 14.410 | 12.790 |
| 65 | 205 | 800 | 1 | 14.411 | 12.792 |
| 65 | 195 | 900 | 1 | 14.419 | 12.790 |
| 65 | 200 | 900 | 1 | 14.415 | 12.796 |
| 65 | 205 | 900 | 1 | 14.418 | 12.795 |
| 65 | 195 | 1000 | 1 | 14.428 | 12.800 |
| 65 | 200 | 1000 | 1 | 14.421 | 12.792 |
| 65 | 205 | 1000 | 1 | 14.423 | 12.797 |

*The CPK of Dim.1 is the lowest, will pay attention to it in every production.

# Dimension And Appearance Results From The Molding Windows-Cav 2

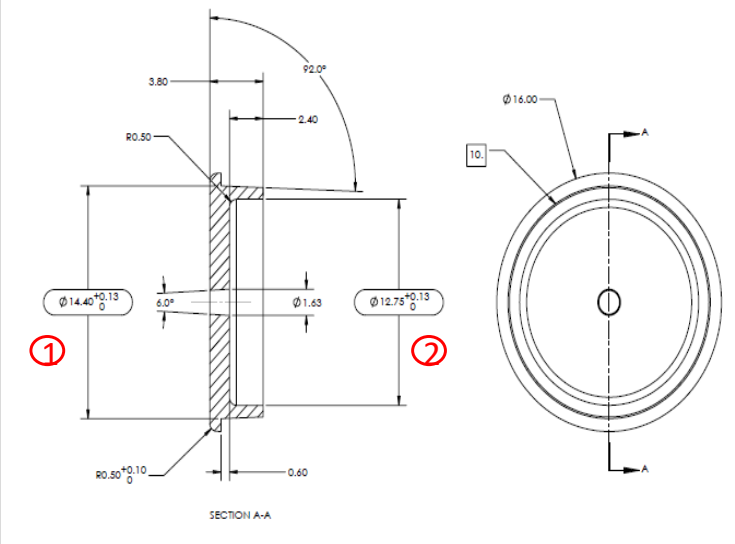
| | Injection velocity (mm/s) | Melt Temp. (°C) | Packing Pressure(Bar) |
|---|---|---|---|
| 1 | 55 | 195 | 800 |
| 2 | 55 | 200 | 800 |
| 3 | 55 | 205 | 800 |
| 4 | 55 | 195 | 900 |
| 5 | 55 | 200 | 900 |
| 6 | 55 | 205 | 900 |
| 7 | 55 | 195 | 1000 |
| 8 | 55 | 200 | 1000 |
| 9 | 55 | 205 | 1000 |
| 10 | 60 | 195 | 800 |
| 11 | 60 | 200 | 800 |
| 12 | 60 | 205 | 800 |
| 13 | 60 | 195 | 900 |
| 14 | 60 | 200 | 900 |
| 15 | 60 | 205 | 900 |
| 16 | 60 | 195 | 1000 |
| 17 | 60 | 200 | 1000 |
| 18 | 60 | 205 | 1000 |
| 19 | 65 | 195 | 800 |
| 20 | 65 | 200 | 800 |
| 21 | 65 | 205 | 800 |
| 22 | 65 | 195 | 900 |
| 23 | 65 | 200 | 900 |
| 24 | 65 | 205 | 900 |
| 25 | 65 | 195 | 1000 |
| 26 | 65 | 200 | 1000 |
| 27 | 65 | 205 | 1000 |




*The suitable molding parameters are group 4, 7~9, 14~18, 22, 24~27 (green area).

# Dimension And Appearance Results From The Molding Windows-Cav 3

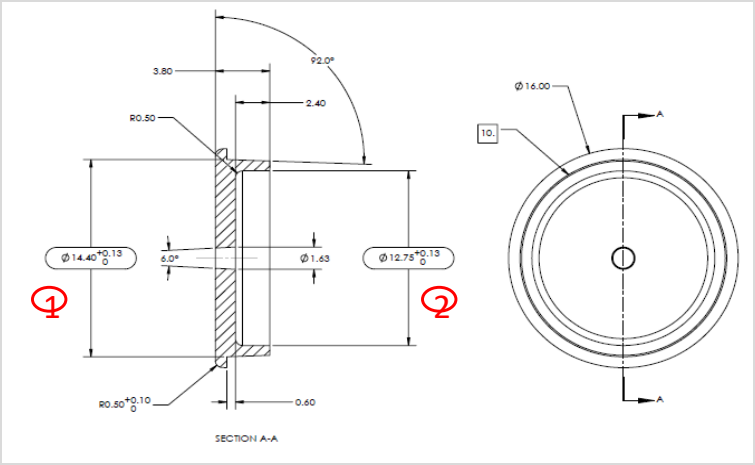


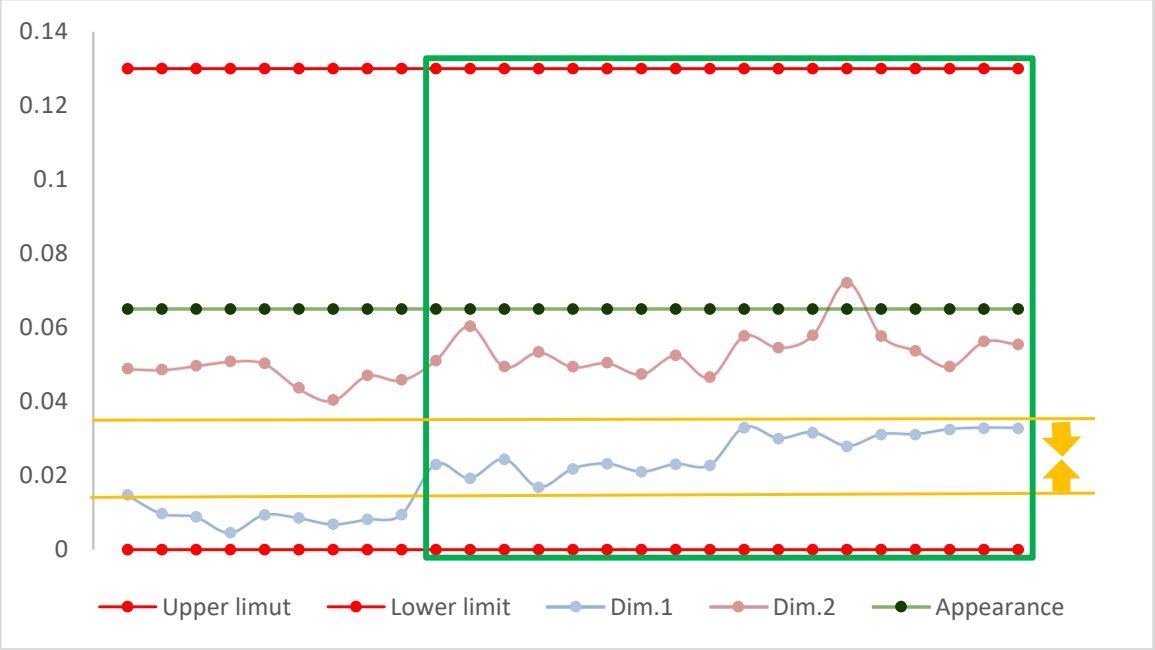

| Appearance grade | |
|---|---|
| Perfect | 0 |
| Minor | 1 |
| Limit sample | 2 |

| Injection velocity | Melt Temp. | Packing pressure | Appearance | CPK | |
|---|---|---|---|---|---|
| | | | | 2.39 | 3.87 |
| | | | | Dim.1 | Dim.2 |
| 55 | 195 | 800 | 1 | 14.415 | 12.799 |
| 55 | 200 | 800 | 1 | 14.410 | 12.799 |
| 55 | 205 | 800 | 1 | 14.409 | 12.800 |
| 55 | 195 | 900 | 1 | 14.405 | 12.801 |
| 55 | 200 | 900 | 1 | 14.409 | 12.800 |
| 55 | 205 | 900 | 1 | 14.409 | 12.794 |
| 55 | 195 | 1000 | 1 | 14.407 | 12.790 |
| 55 | 200 | 1000 | 1 | 14.408 | 12.797 |
| 55 | 205 | 1000 | 1 | 14.409 | 12.796 |
| 60 | 195 | 800 | 1 | 14.423 | 12.801 |
| 60 | 200 | 800 | 1 | 14.419 | 12.810 |
| 60 | 205 | 800 | 1 | 14.424 | 12.800 |
| 60 | 195 | 900 | 1 | 14.417 | 12.803 |
| 60 | 200 | 900 | 1 | 14.422 | 12.799 |
| 60 | 205 | 900 | 1 | 14.423 | 12.801 |
| 60 | 195 | 1000 | 1 | 14.421 | 12.797 |
| 60 | 200 | 1000 | 1 | 14.423 | 12.803 |
| 60 | 205 | 1000 | 1 | 14.423 | 12.797 |
| 65 | 195 | 800 | 1 | 14.433 | 12.808 |
| 65 | 200 | 800 | 1 | 14.430 | 12.805 |
| 65 | 205 | 800 | 1 | 14.432 | 12.808 |
| 65 | 195 | 900 | 1 | 14.428 | 12.822 |
| 65 | 200 | 900 | 1 | 14.431 | 12.808 |
| 65 | 205 | 900 | 1 | 14.431 | 12.804 |
| 65 | 195 | 1000 | 1 | 14.432 | 12.799 |
| 65 | 200 | 1000 | 1 | 14.433 | 12.806 |
| 65 | 205 | 1000 | 1 | 14.433 | 12.805 |

# Dimension And Appearance Results From The Molding Windows-Cav 3

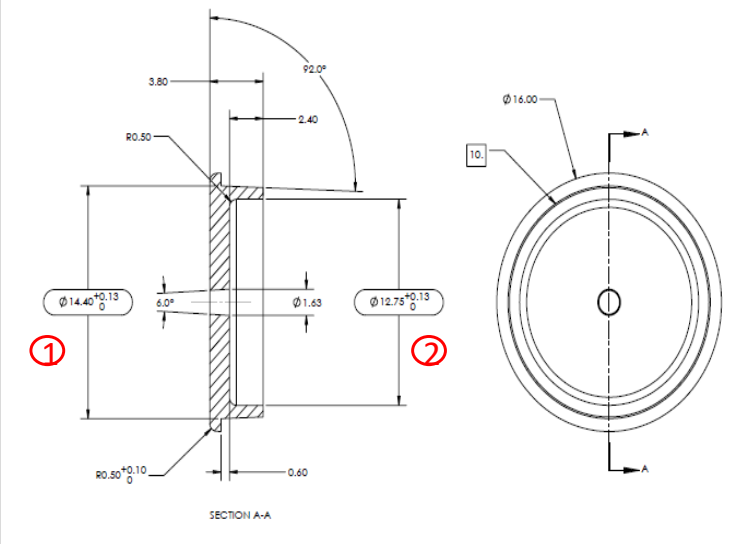
| | Injection velocity (mm/s) | Melt Temp. (°C) | Packing Pressure(Bar) |
|---|---|---|---|
| 1 | 55 | 195 | 800 |
| 2 | 55 | 200 | 800 |
| 3 | 55 | 205 | 800 |
| 4 | 55 | 195 | 900 |
| 5 | 55 | 200 | 900 |
| 6 | 55 | 205 | 900 |
| 7 | 55 | 195 | 1000 |
| 8 | 55 | 200 | 1000 |
| 9 | 55 | 205 | 1000 |
| 10 | 60 | 195 | 800 |
| 11 | 60 | 200 | 800 |
| 12 | 60 | 205 | 800 |
| 13 | 60 | 195 | 900 |
| 14 | 60 | 200 | 900 |
| 15 | 60 | 205 | 900 |
| 16 | 60 | 195 | 1000 |
| 17 | 60 | 200 | 1000 |
| 18 | 60 | 205 | 1000 |
| 19 | 65 | 195 | 800 |
| 20 | 65 | 200 | 800 |
| 21 | 65 | 205 | 800 |
| 22 | 65 | 195 | 900 |
| 23 | 65 | 200 | 900 |
| 24 | 65 | 205 | 900 |
| 25 | 65 | 195 | 1000 |
| 26 | 65 | 200 | 1000 |
| 27 | 65 | 205 | 1000 |




*The suitable molding parameters are group 10~27 (green area).

# Dimension And Appearance Results From The Molding Windows-Cav 4

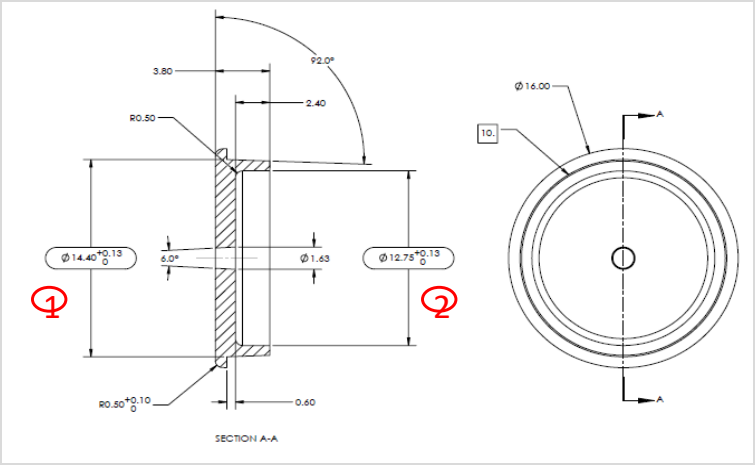


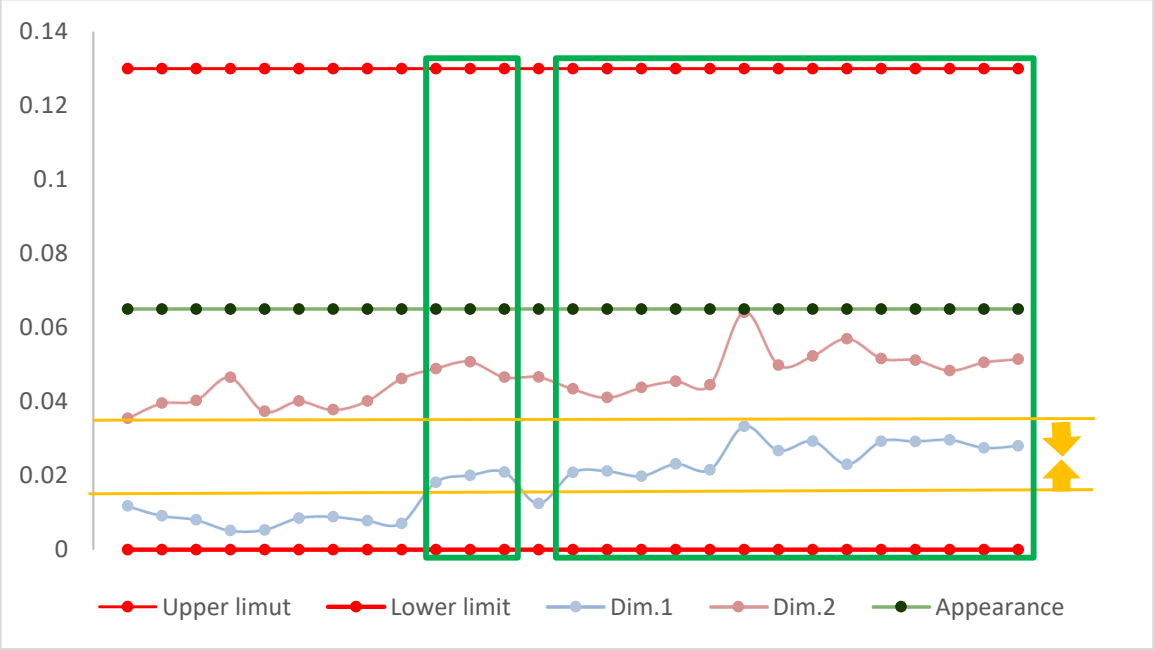

| Appearance grade | |
|---|---|
| Perfect | 0 |
| Minor | 1 |
| Limit sample | 2 |

| Injection velocity | Melt Temp. | Packing pressure | Appearance | CPK | |
|---|---|---|---|---|---|
| | | | | 2.13 | 4.28 |
| | | | | Dim.1 | Dim.2 |
| 55 | 195 | 800 | 1 | 14.412 | 12.786 |
| 55 | 200 | 800 | 1 | 14.409 | 12.790 |
| 55 | 205 | 800 | 1 | 14.408 | 12.790 |
| 55 | 195 | 900 | 1 | 14.405 | 12.797 |
| 55 | 200 | 900 | 1 | 14.405 | 12.787 |
| 55 | 205 | 900 | 1 | 14.409 | 12.790 |
| 55 | 195 | 1000 | 1 | 14.409 | 12.788 |
| 55 | 200 | 1000 | 1 | 14.408 | 12.790 |
| 55 | 205 | 1000 | 1 | 14.407 | 12.796 |
| 60 | 195 | 800 | 1 | 14.418 | 12.799 |
| 60 | 200 | 800 | 1 | 14.420 | 12.801 |
| 60 | 205 | 800 | 1 | 14.421 | 12.797 |
| 60 | 195 | 900 | 1 | 14.413 | 12.797 |
| 60 | 200 | 900 | 1 | 14.421 | 12.793 |
| 60 | 205 | 900 | 1 | 14.421 | 12.791 |
| 60 | 195 | 1000 | 1 | 14.420 | 12.794 |
| 60 | 200 | 1000 | 1 | 14.423 | 12.796 |
| 60 | 205 | 1000 | 1 | 14.422 | 12.795 |
| 65 | 195 | 800 | 1 | 14.433 | 12.814 |
| 65 | 200 | 800 | 1 | 14.427 | 12.800 |
| 65 | 205 | 800 | 1 | 14.429 | 12.802 |
| 65 | 195 | 900 | 1 | 14.423 | 12.807 |
| 65 | 200 | 900 | 1 | 14.429 | 12.802 |
| 65 | 205 | 900 | 1 | 14.429 | 12.801 |
| 65 | 195 | 1000 | 1 | 14.430 | 12.798 |
| 65 | 200 | 1000 | 1 | 14.428 | 12.801 |
| 65 | 205 | 1000 | 1 | 14.428 | 12.801 |

# Dimension And Appearance Results From The Molding Windows-Cav 4

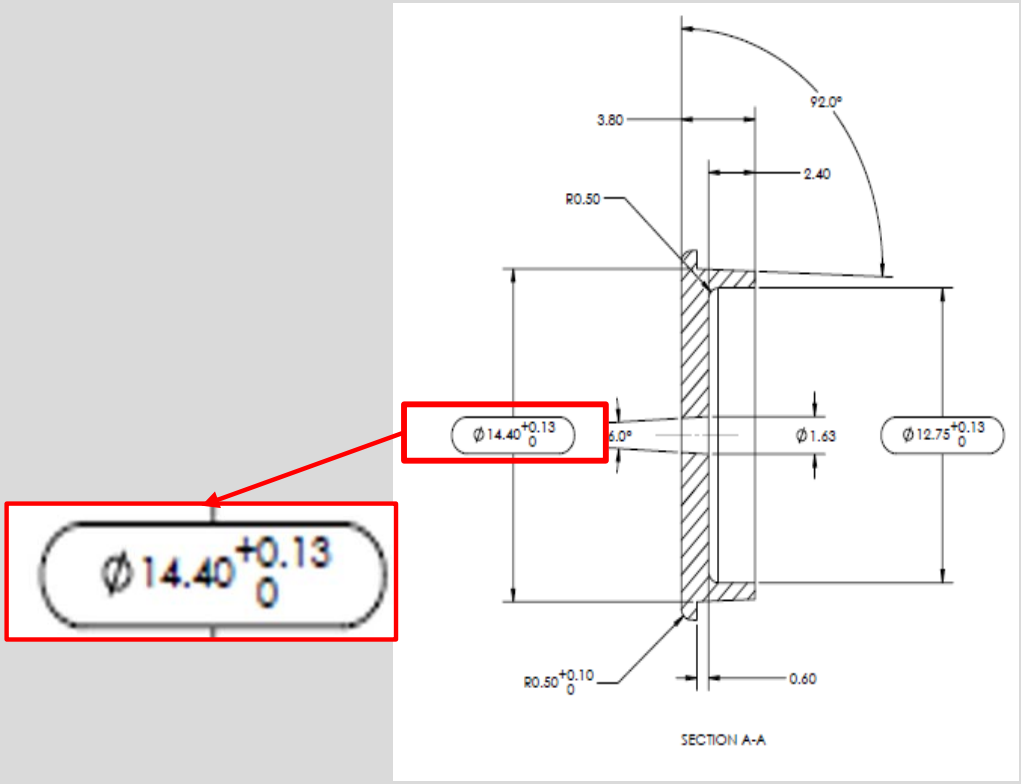
| | Injection velocity (mm/s) | Melt Temp. (°C) | Packing Pressure(Bar) |
|---|---|---|---|
| 1 | 55 | 195 | 800 |
| 2 | 55 | 200 | 800 |
| 3 | 55 | 205 | 800 |
| 4 | 55 | 195 | 900 |
| 5 | 55 | 200 | 900 |
| 6 | 55 | 205 | 900 |
| 7 | 55 | 195 | 1000 |
| 8 | 55 | 200 | 1000 |
| 9 | 55 | 205 | 1000 |
| 10 | 60 | 195 | 800 |
| 11 | 60 | 200 | 800 |
| 12 | 60 | 205 | 800 |
| 13 | 60 | 195 | 900 |
| 14 | 60 | 200 | 900 |
| 15 | 60 | 205 | 900 |
| 16 | 60 | 195 | 1000 |
| 17 | 60 | 200 | 1000 |
| 18 | 60 | 205 | 1000 |
| 19 | 65 | 195 | 800 |
| 20 | 65 | 200 | 800 |
| 21 | 65 | 205 | 800 |
| 22 | 65 | 195 | 900 |
| 23 | 65 | 200 | 900 |
| 24 | 65 | 205 | 900 |
| 25 | 65 | 195 | 1000 |
| 26 | 65 | 200 | 1000 |
| 27 | 65 | 205 | 1000 |



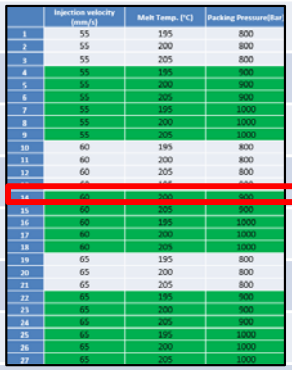
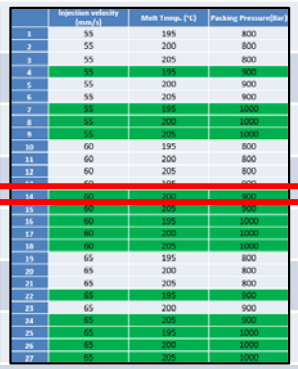
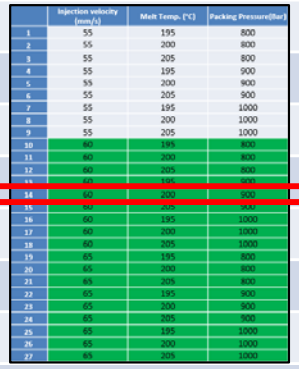
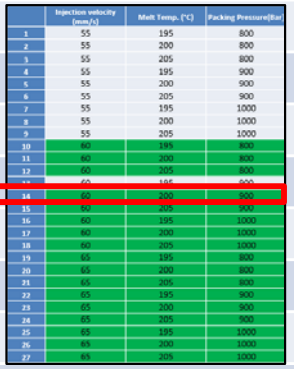

*The suitable molding parameters are group 10~12, 14~27 (green area).

# The Cause Analyzed And Solution Of Dim.1




| Item | Content |
|---|---|
| Cause analyzed | 1. The mold dimension is 14.46 mm and mold shrinkage is 4.5/1000. Theoretically, the part dimension after molding is 14.40 and is reach to lower limit (14.40 mm). |
| Solution | 1. Modifying mold dimension from 14.46 mm to 14.53 mm (Steel safe for this dimension).<br>2. Changing the Dim.1 tolerance from ““+0.13/**-0**" to ““+0.13/**-0.05**", If so, the CPK value can reach to 1.33. |

# $T_{production}$ Parameter (Based On Group 14)

| Parameters | $T_{production}$ Parameter (Based On Group 14) | | | | | | |
|---|---|---|---|---|---|---|---|
| Mold Temperature (˚C) | Core: 60 , Cavity: 60 | | | | | | |
| Melt Temperature (˚C) | 200 | 205 | 200 | 190 | 180 | 170 | 40 |
| **Filling** | | | | | | | |
| Filling Time (s) – Actual value |  |  | 0.16 |  |  | | |
| Initial Ram position (mm) | | | 20 | | | | |
| Section-1 Screw position, injection velocity (mm/s) | | | 18.7 , 80 | | | | |
| Section-2 Screw position, injection velocity (mm/s) | | | 14.5 , 60 | | | | |
| Section-3 Screw position, injection velocity (mm/s) | | | 13 , 30 | | | | |
| Actual injection pressure (bar) | | | 630 | | | | |
| Screw speed (mm/s) | | | 100 | | | | |
| Back pressure (bar) | Cav1 | Cav2 | 150 | Cav3 | Cav4 | | |
| Metering delay time(s) | | | 6 | | | | |
| Suck back (mm / mm/s) | | | 2 , 30 | | | | |
| **Packing** | | | | | | | |
| Packing speed (mm/s) | | | 10 | | | | |
| Time(s) / Packing Pressure (bar) | | | 0.5/900~2/900 | | | | |
| **Cooling** | | | | | | | |
| Cooling Time (s) | | | 10 | | | | |
| Cycle Time (s) | | | 16 | | | | |

Max Injection Pressure of machine (spec.) : 2500 bar

*Based on dimension results from the molding windows for all cavities, will choose group 14 as $T_{production}$ parameter to have best control of molding process and lowest process risk.

# Thank You !