

## Moldflow Analysis Report

Part name : Reflector

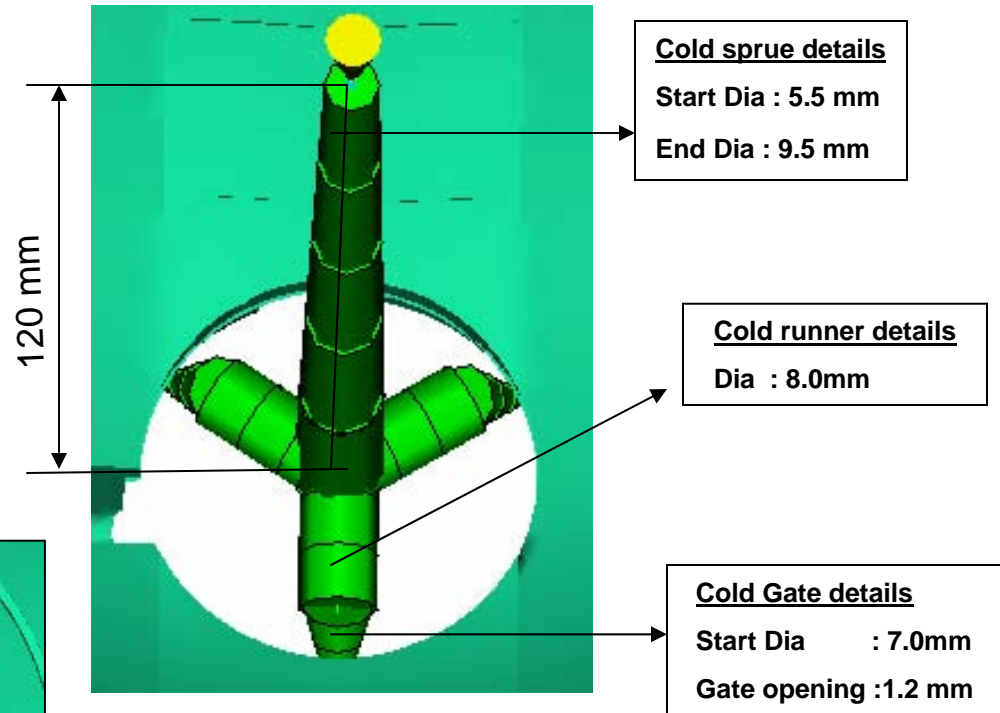


**Objective :** Analyze flow in the cavity as per the product design provided by ABC Corporation Ltd. & find the best gate location to minimize problems of flow marks, sink marks & pin marks in the component.

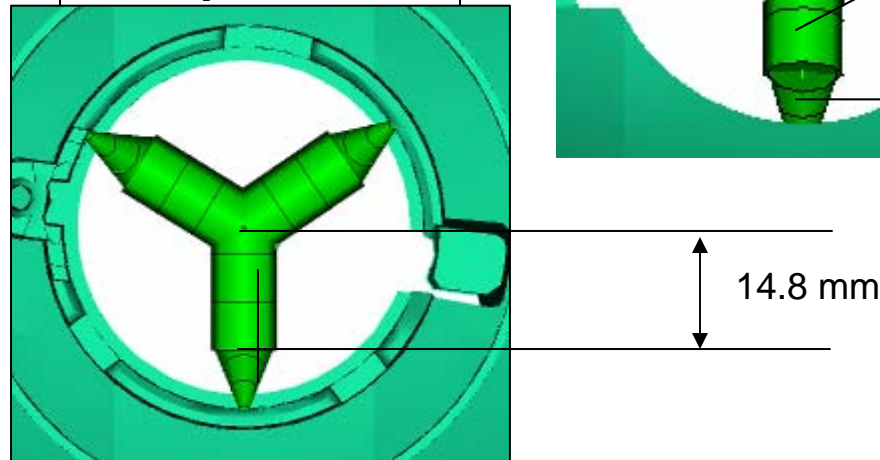
# 1.0 General Details

## Feed system details:-

Cold sprue with 3 sub cold runner & submarine type gate  
( dimensions are confirmed by ABC Corporation engineer )



### Gate positions



### 3.0 Material details

Family name	POLYCARBONATES (PC)
Trade name	Lexan 143R
Manufacturer	SABIC Innovative Plastics US, LLC
Family abbreviation	PC
Material structure	Amorphous

Material ID	6623
Grade code	CM6623
Supplier code	SBCUSA
Fibers/fillers	Unfilled

Maximum shear stress	0.5	MPa
Maximum shear rate	40000	1/s

Melt density	1.0477	g/cm <sup>3</sup>
Solid density	1.1915	g/cm <sup>3</sup>

<b>Mold temperature range (recommended)</b>	
Minimum	70 C
Maximum	120 C
<b>Melt temperature range (recommended)</b>	
Minimum	280 C
Maximum	320 C
Absolute maximum melt temperature	360 C
Ejection temperature	125 C

<b>Mechanical properties data</b>	
Elastic modulus, 1st principal direction (E1)	2280 MPa
Elastic modulus, 2nd principal direction (E2)	2280 MPa
Poissons ratio (v12)	0.417
Poissons ratio (v23)	0.417
Shear modulus (G12)	804.5 MPa

## 4.0 Process details

These parameters supplied by ABC Corporation

Mold surface temperature  C

Melt temperature  C

**Filling control**

Injection time  of  s

**Velocity/pressure switch-over**

By %volume filled  at  % [0:100]

**Pack/holding control**

%Filling pressure vs time

**Pack/Holding Control Profile**

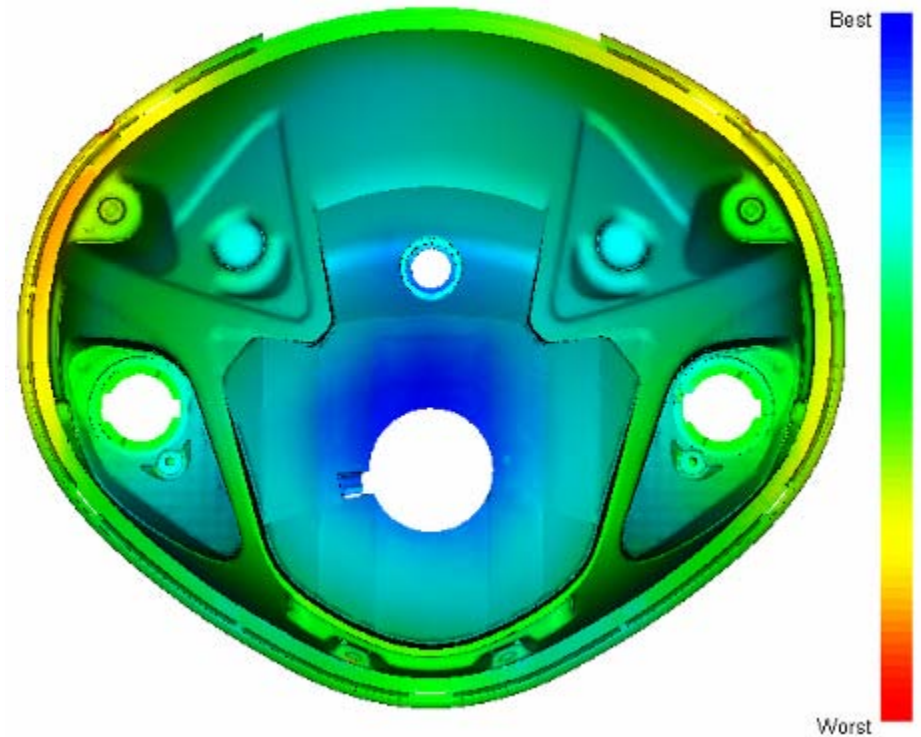
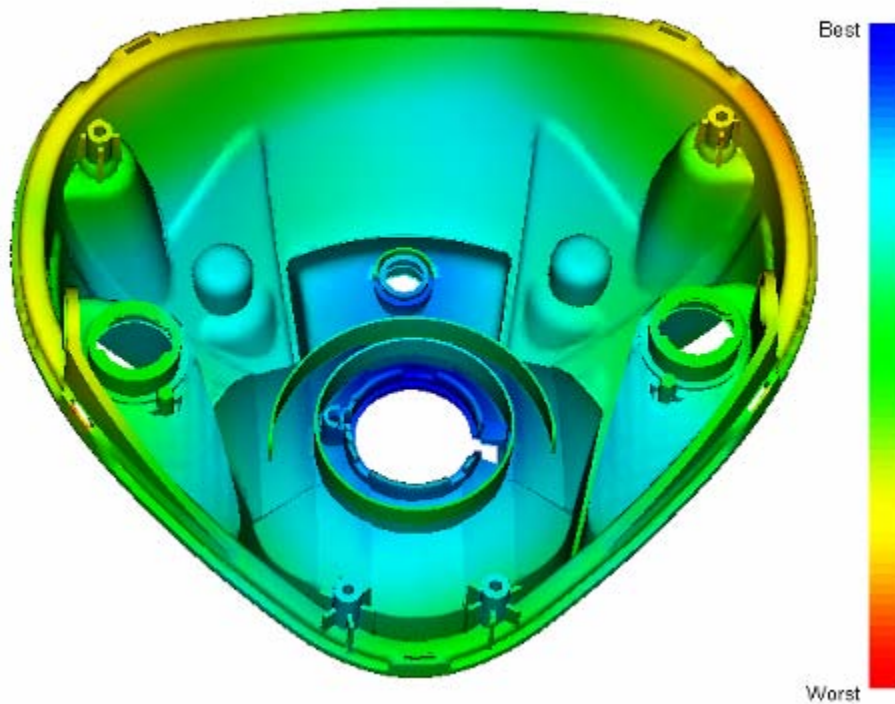
%Filling pressure vs time

	Duration s [0:300]	%Filling pressure % [0:200]
1	0	80
2	2.5	80

## 5.0 Gate location analysis

Best gate location  
= 1.000

Best gate location  
= 1.000



**Comments:** Best gate location as per moldflow considering parting line and thickness of part. Blue color area is the best area for gate location

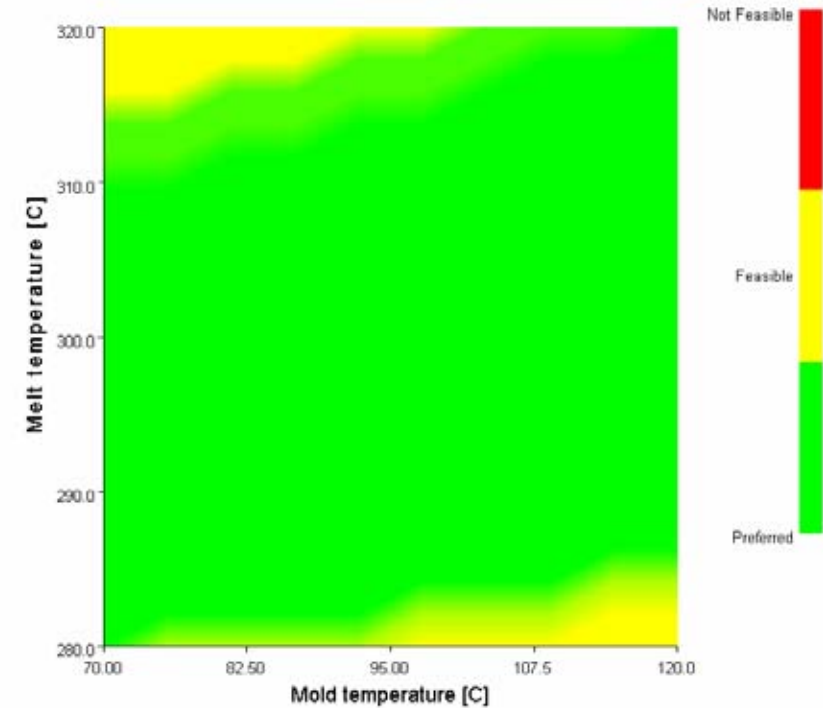
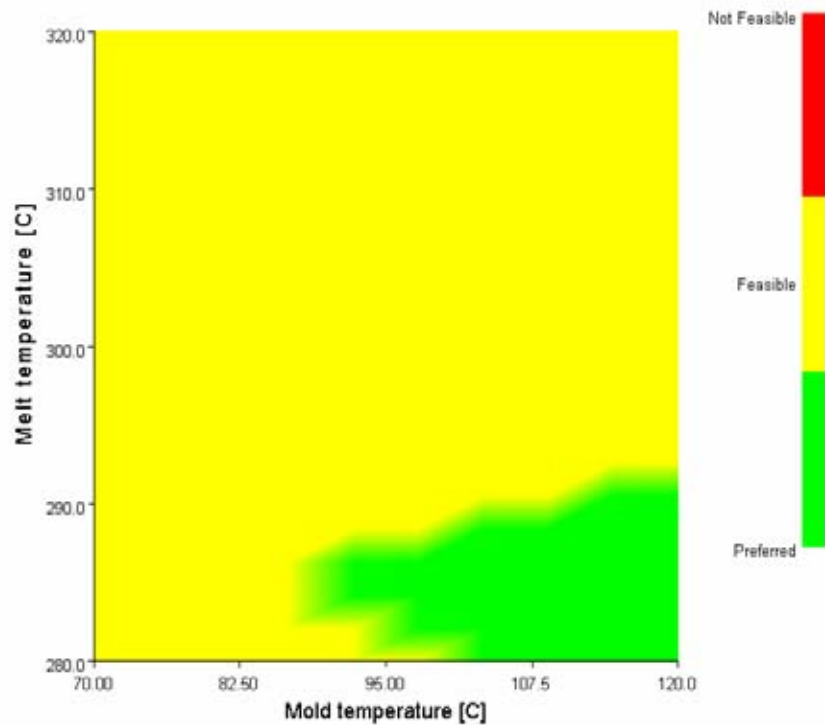
## 6.0 Molding window

Molding window:2D Slice Plot

Molding window:2D Slice Plot

Injection time = 2.560[s]

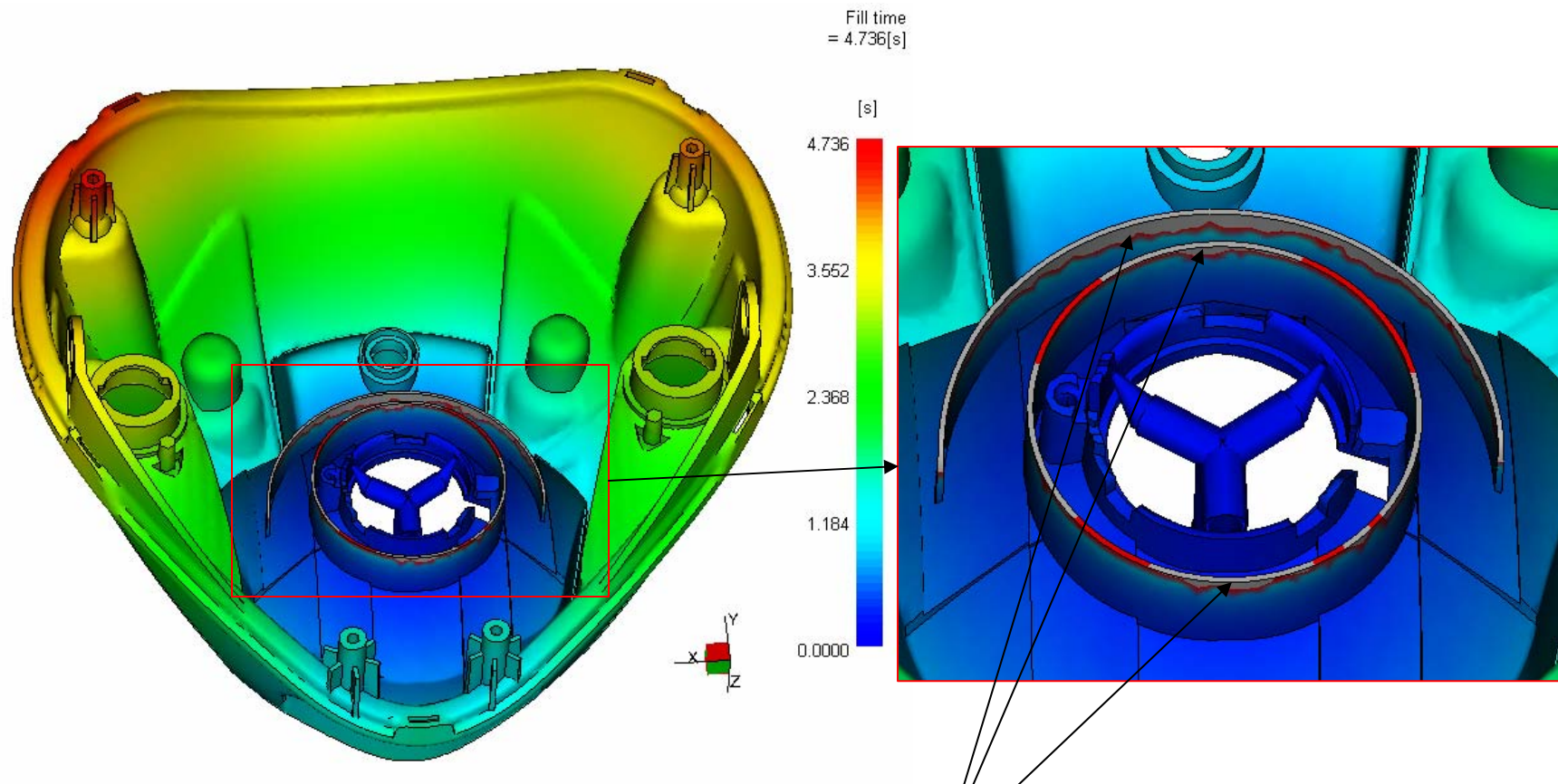
Injection time = 1.520[s]



**Comments:** Molding window shows at injection time above 2.5sec, lesser preferred window is observed & at injection time 1.5sec to 2.5sec, more preferred window is observed. Ideally injection time has to be lesser than what is maintained now.

Also mold temperature maintained now is very less & that also has to be increased

## 7.1 Fill time plot

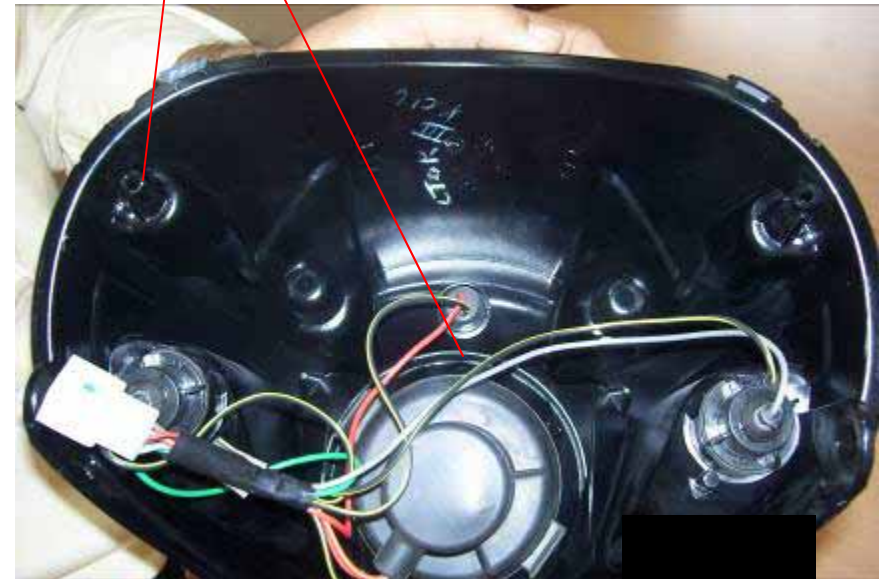
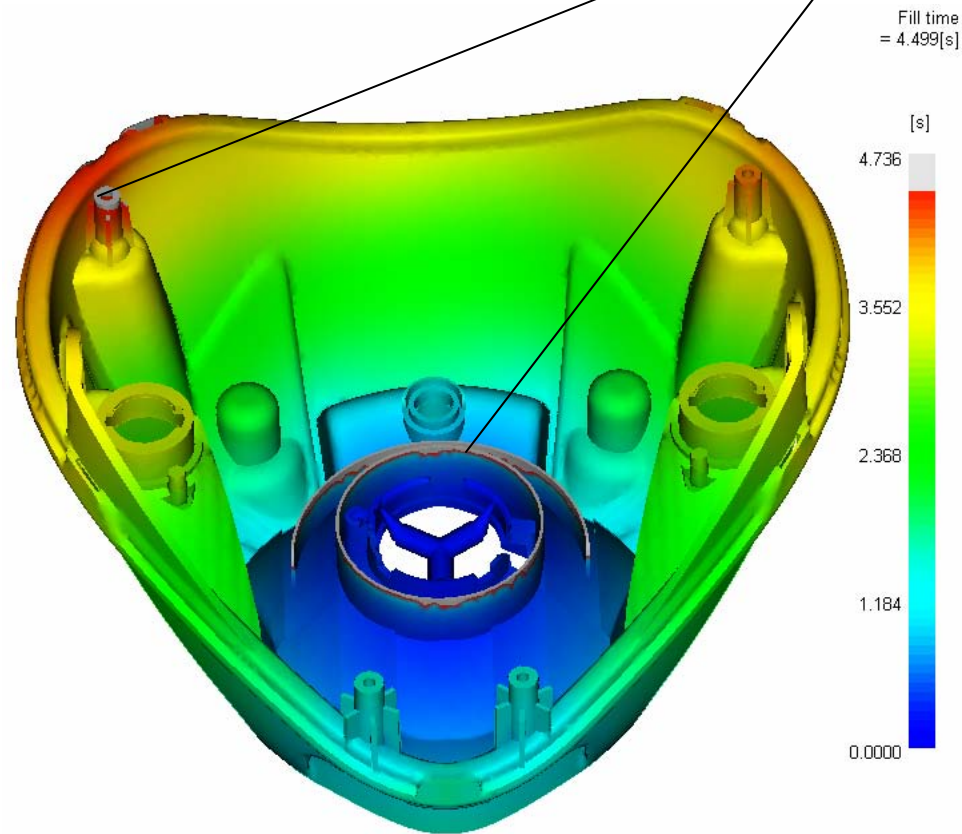


Short shot possible area area

**Comments:** This shows fill time plot & highlights short shot observed are at centre ribs (grey color area), due to hesitation ,this can be overcome by increasing the rib thickness or increasing packing pressure

## 7.5 Comparison of results

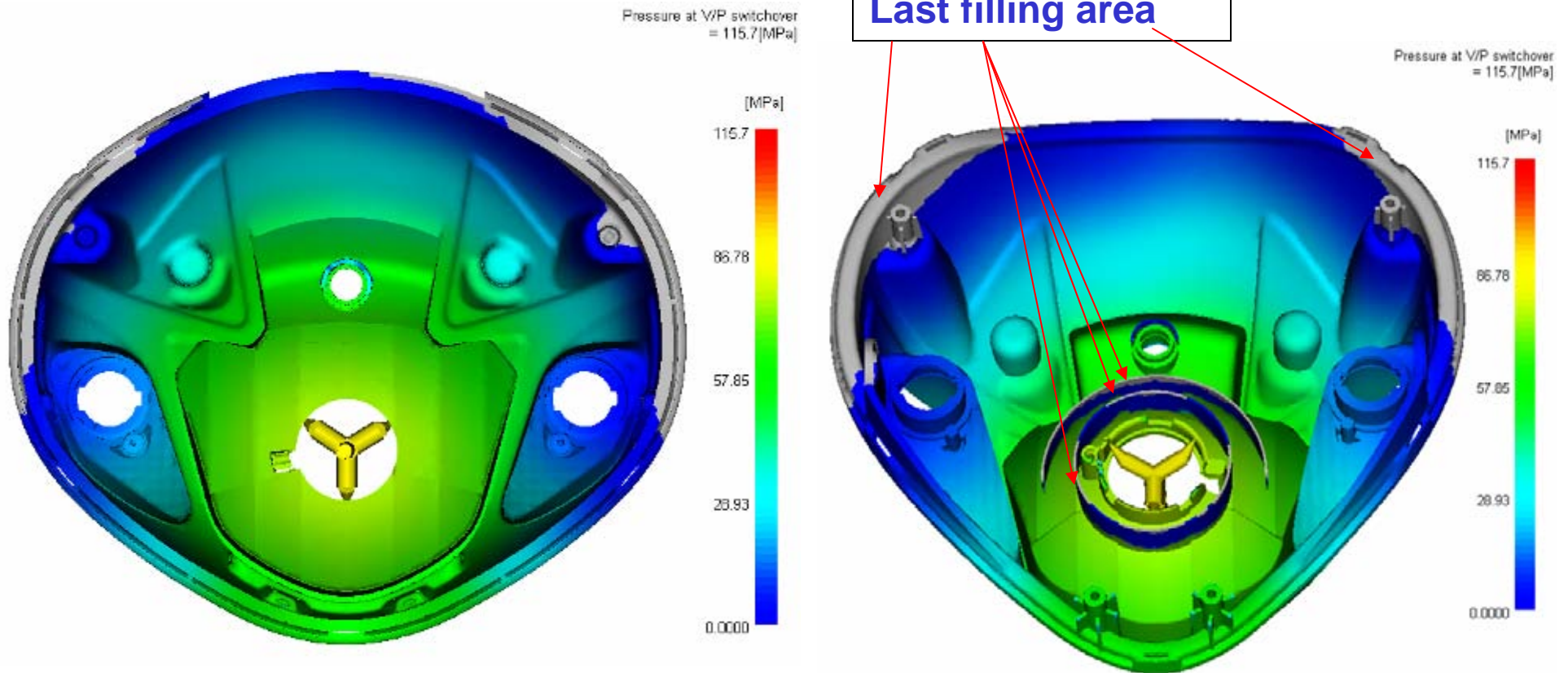
This is last filling area



Moulded sample

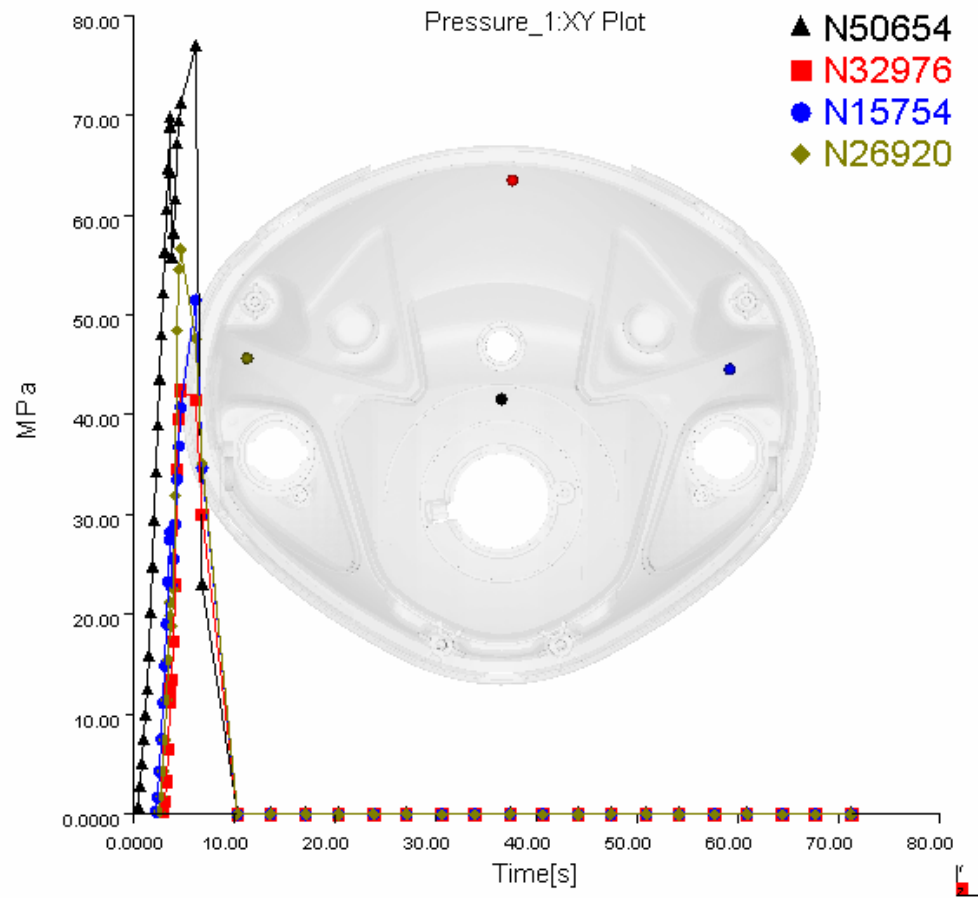
**Comments:** If temperature drop is very high ,short shot can occurs at last filling area .

## 8.0 Pressure at V/p switch over



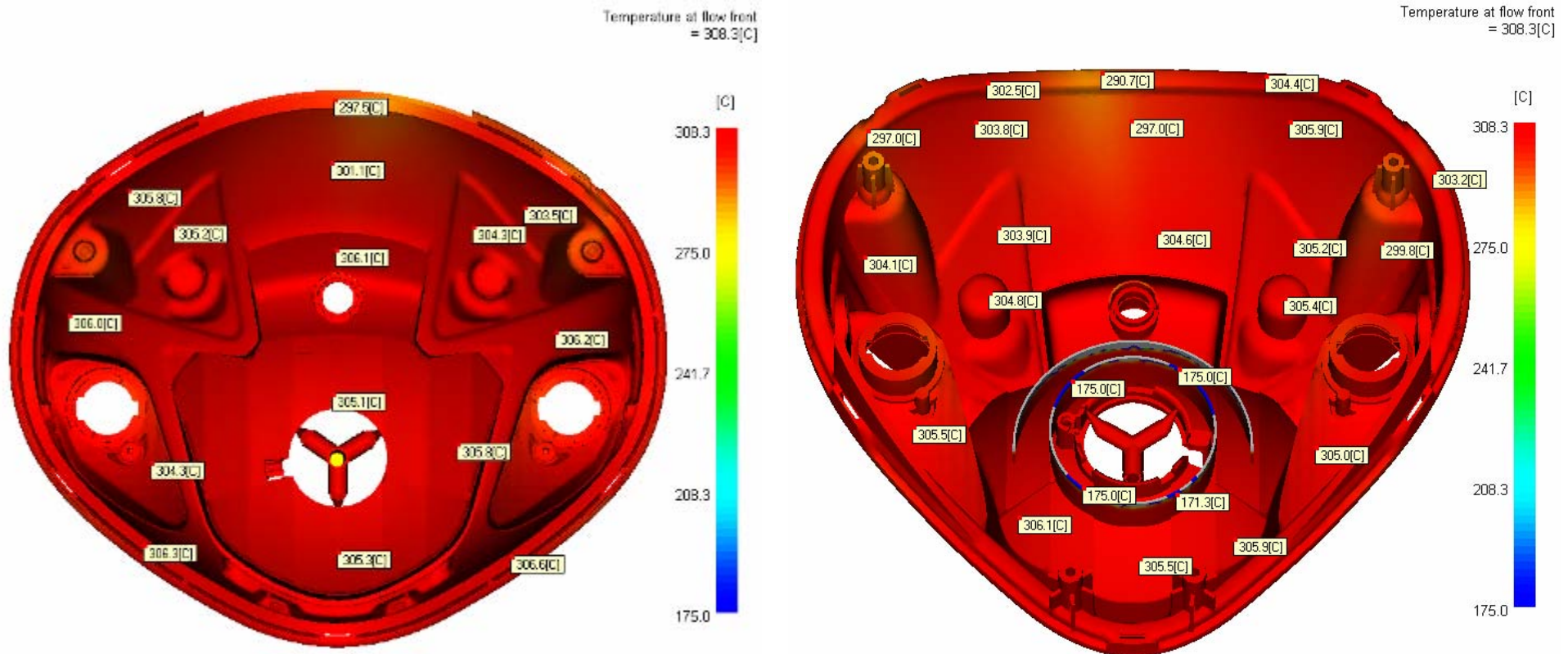
**Comments:** This plot shows pressure at v/p switchover & maximum pressure needed to fill the part is 115.7 MPa. V/p switch over is done after 93 %of part filled, Grey area shown in plot is filled during packing

## 9.1 Pressure at four different points



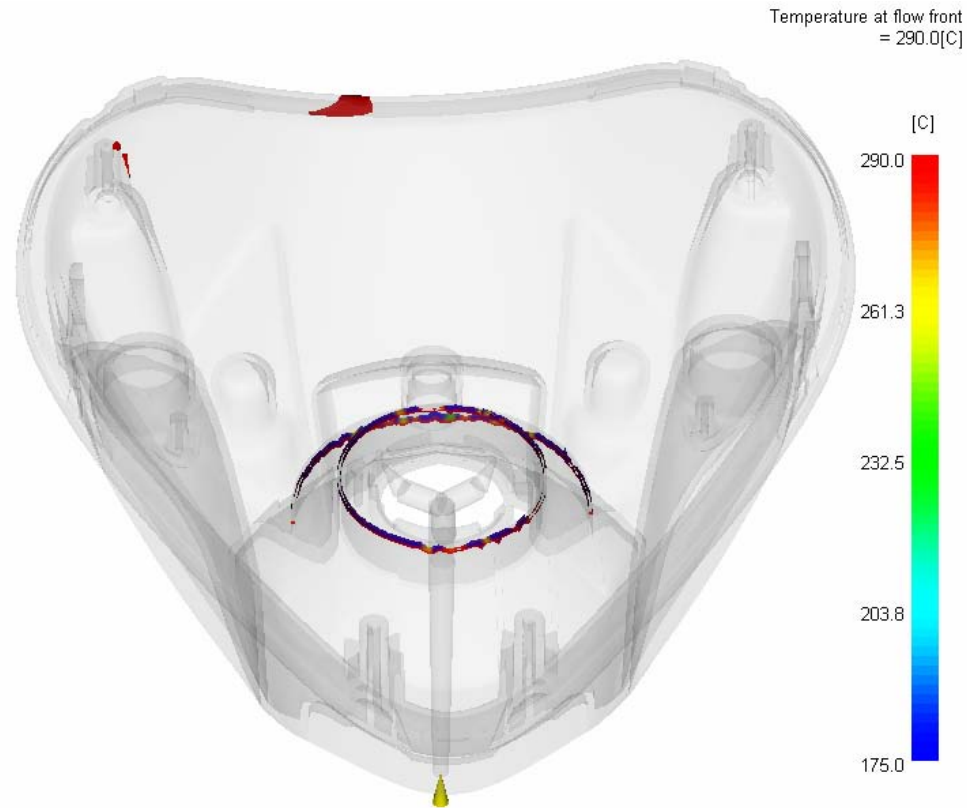
**Comments:** This plot shows pressure at four different points. It is observed that the packing pressure acting in different regions is different. This will have effects on shrinkage.

## 10.0 Temperature at flow front during cavity filling



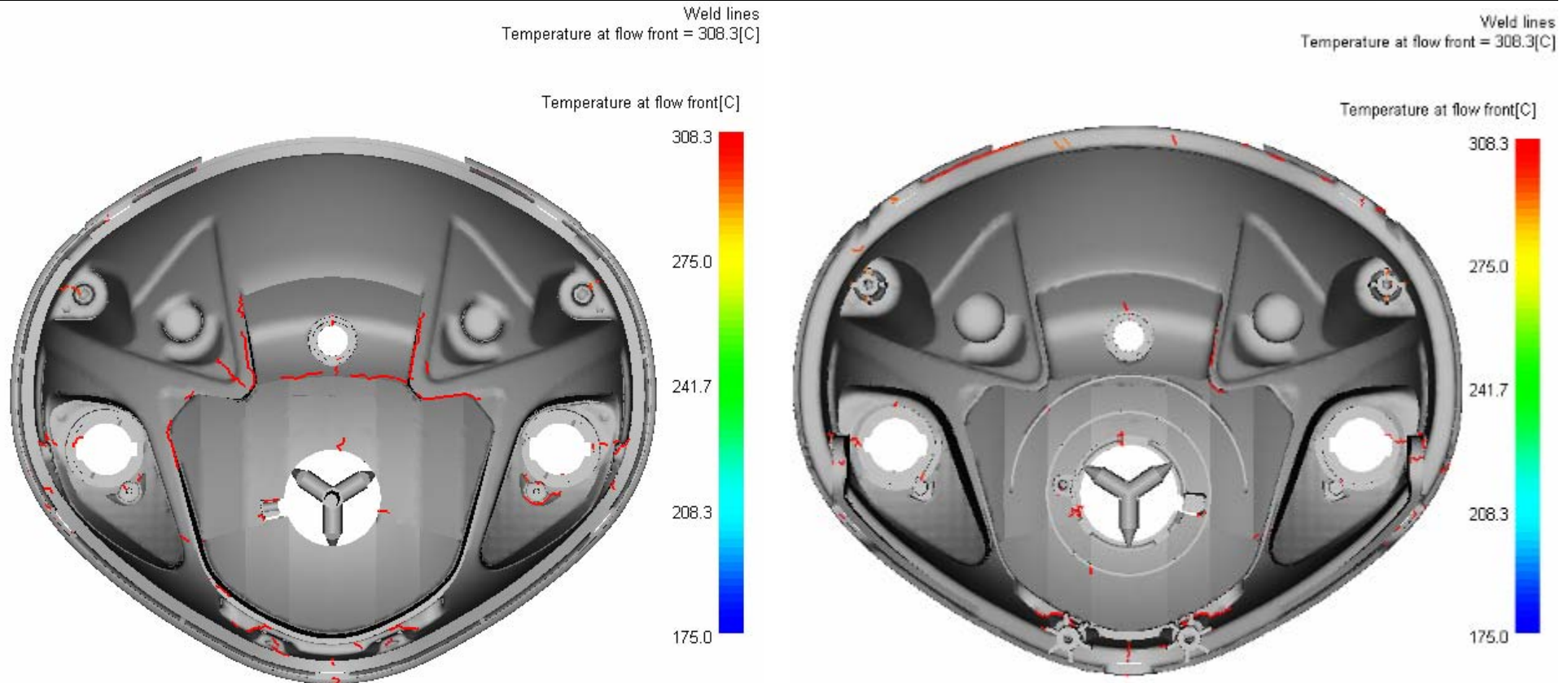
**Comments:** This plot shows rise in temperature observed is up to 3.3° C due to shear heating & drop in temperature is observed up to 130 °C . But average temperature drop observed is 15° C (refer next slide for more details )

## 10.1 Temperature at flow front during cavity filling



**Comments:** Average temperature drop observed is 15° C only . But in above highlighted area temperature drop is to the extent of 15 ° C to 130 ° C . So there is chances of **short shots** in these area

## 11.0 weld line plot overlaid with flow front temperature



### Comments:

since rise in temperature is up to **3.3 ° C** & average drop in temperature is up to **15 ° C** is observed at weld line locations (refer previous slide). As temperatures are high enough to fuse the flow fronts properly, these weld lines may not be structurally weak

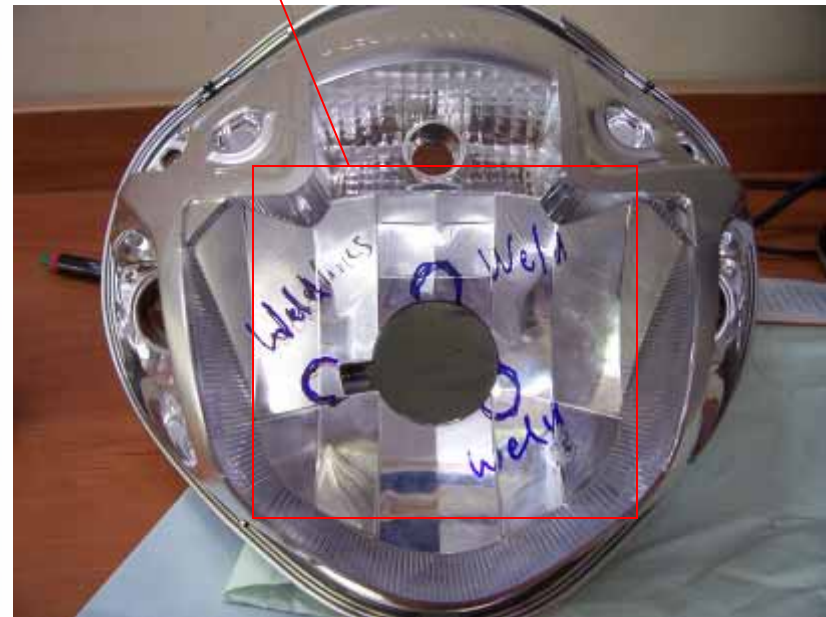
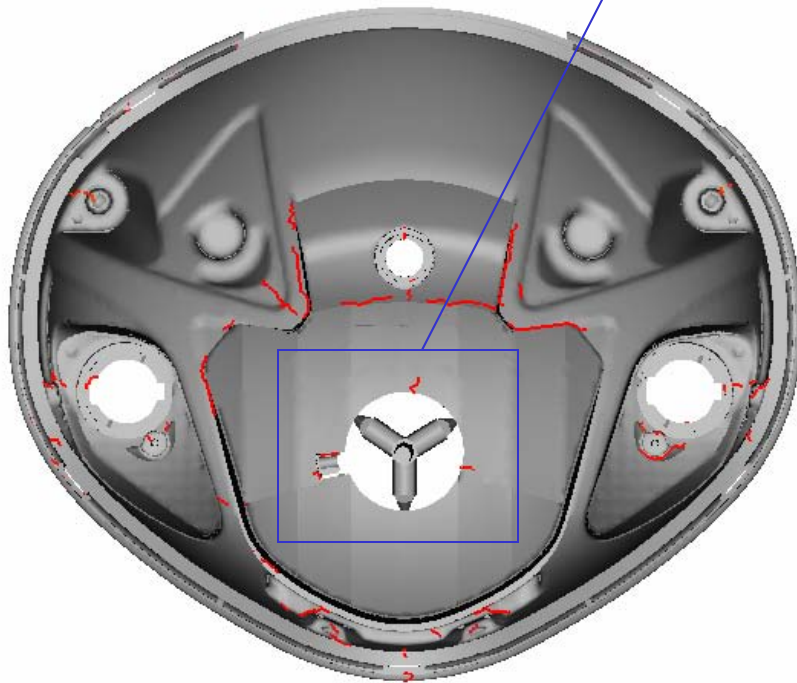
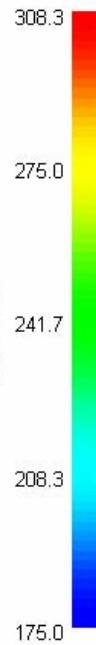
But there are chances of visible weld line at these areas ,since part is having multiple gates we cannot avoid this weld lines

# 11.1 Comparison of results with moulded sample

## Weld lines locations

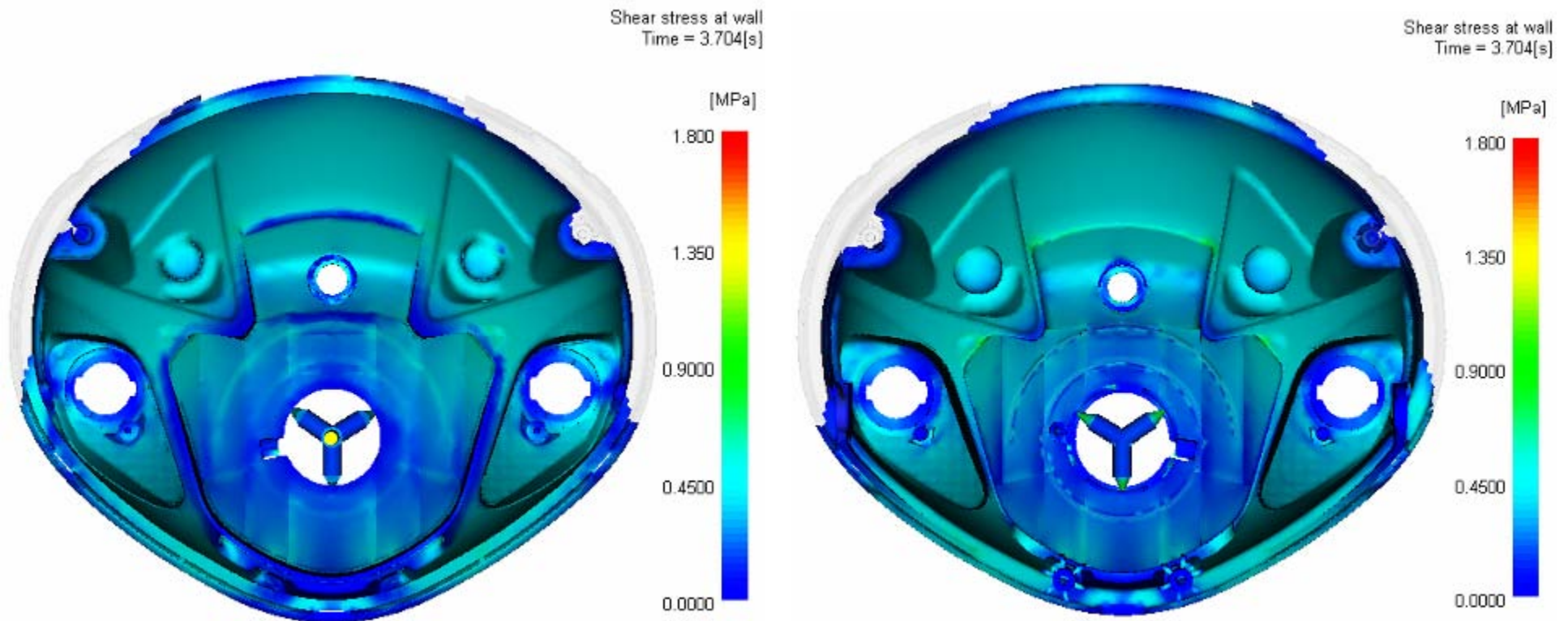
Weld lines  
Temperature at flow front = 308.3[C]

Temperature at flow front[C]



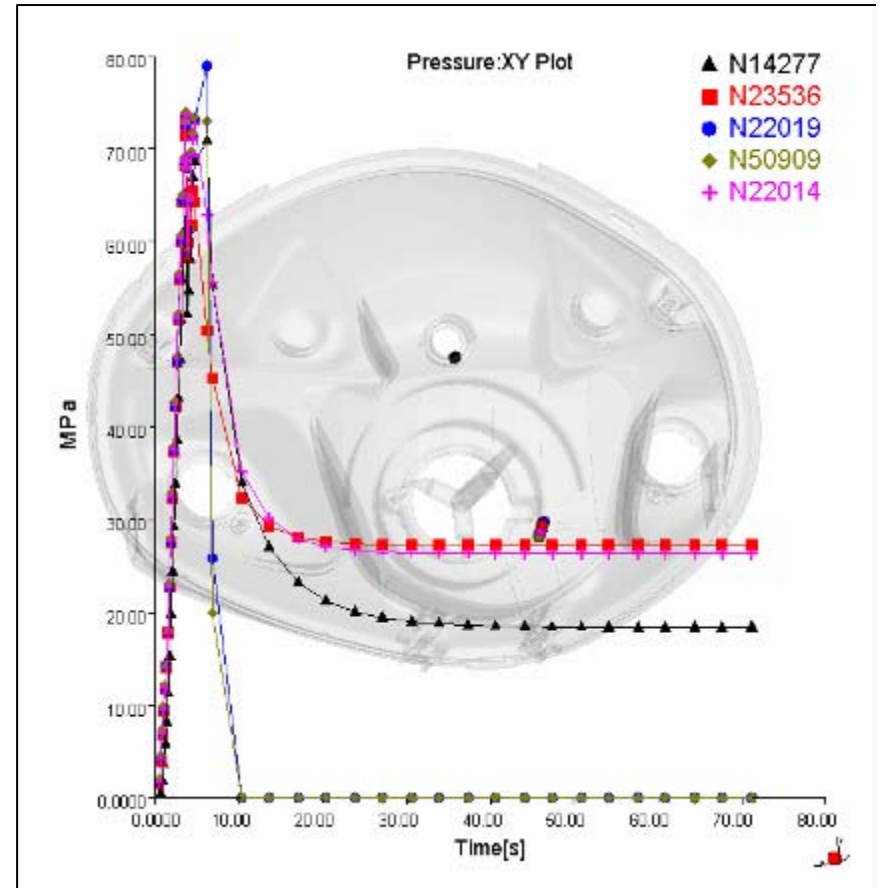
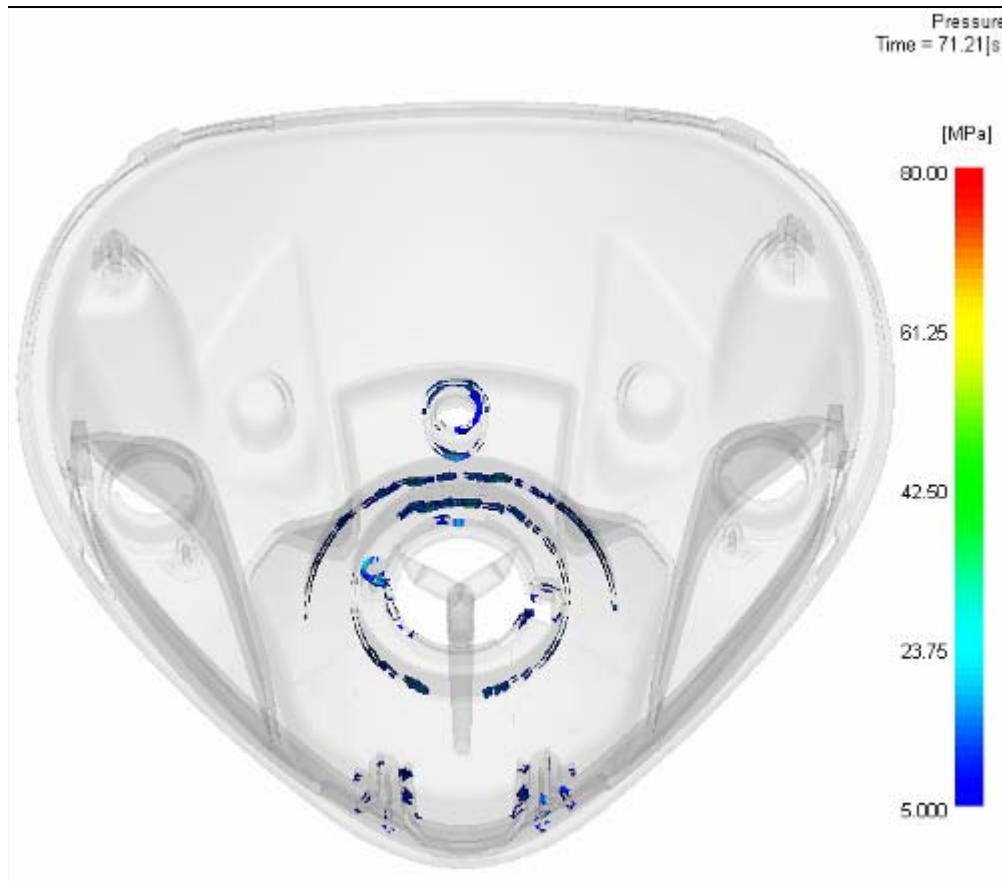
Moulded sample

## 14.0 shear stress plot



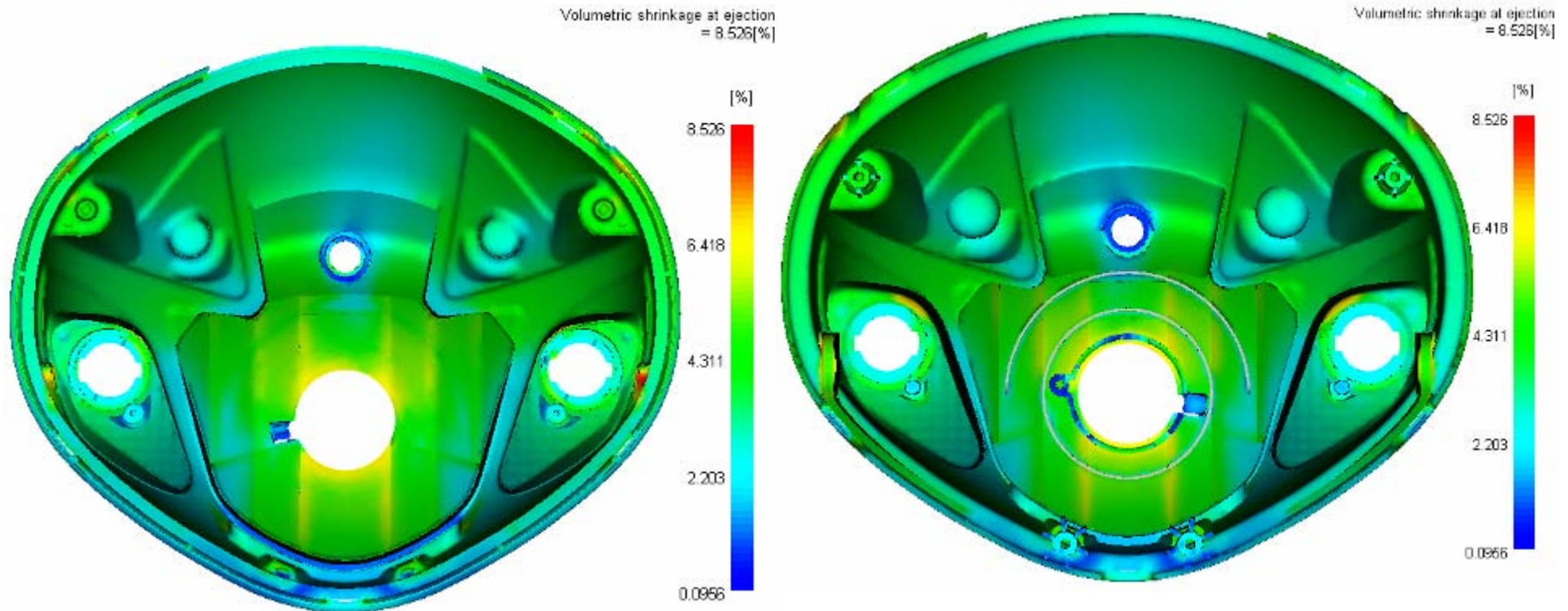
**Comments:** Above plot shows maximum shear stress during filling i.e. 1.8MPa, which is higher than recommended for material (0.5 MPa) ( refer next slide for more details)

# 15. Residual pressure at end of cycle



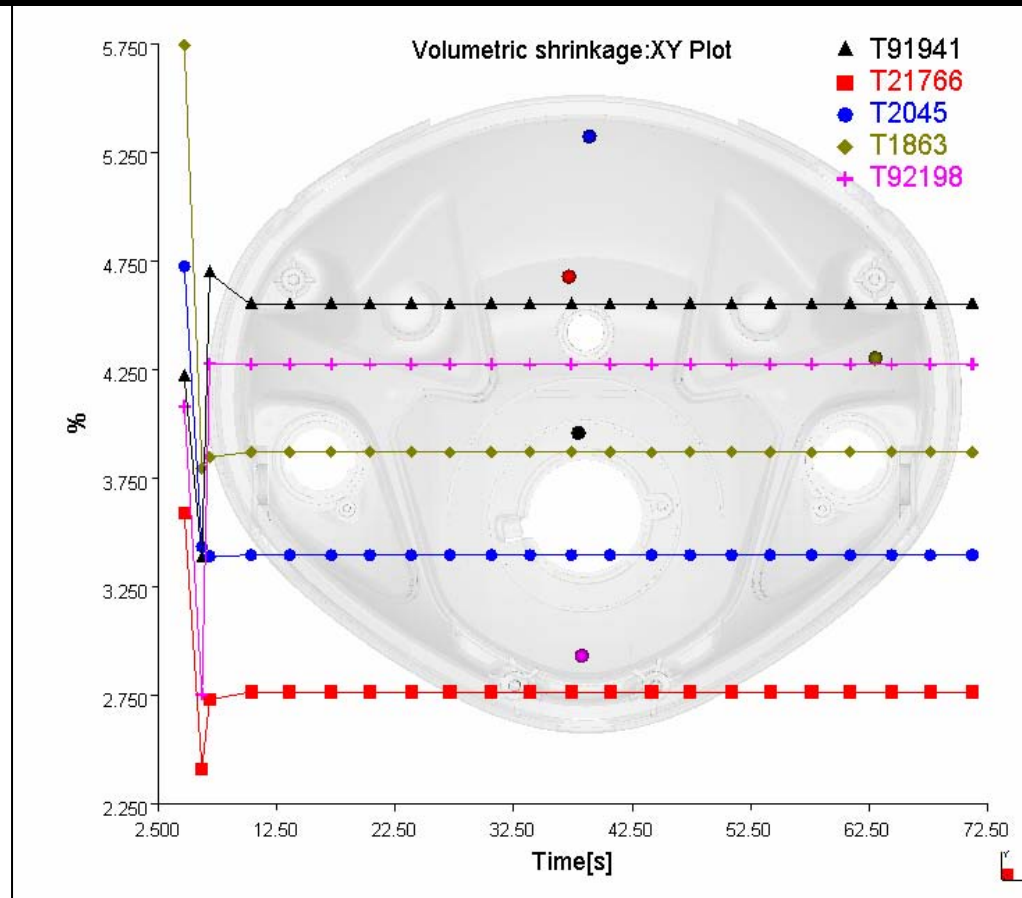
**Comments:** In above plot , only in above highlighted area, pressure is high even after packing is removed. This may result in part sticking in mold

## 16.0 volumetric shrinkage at ejection



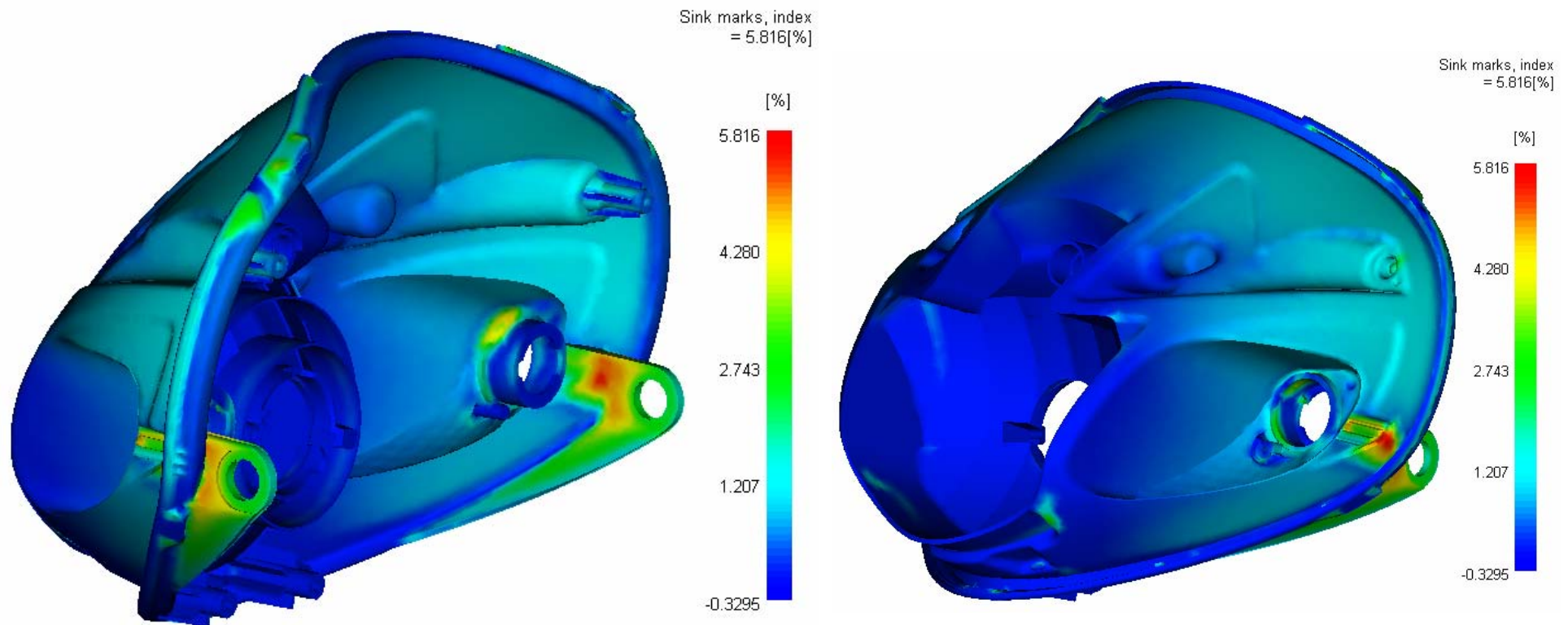
**Comments** :this plot shows volumetric shrinkage at ejection of part & maximum shrinkage observed is up to **8.526 MPa** ( for details refer next slide)

## 16.2 volumetric shrinkage at ejection at different locations



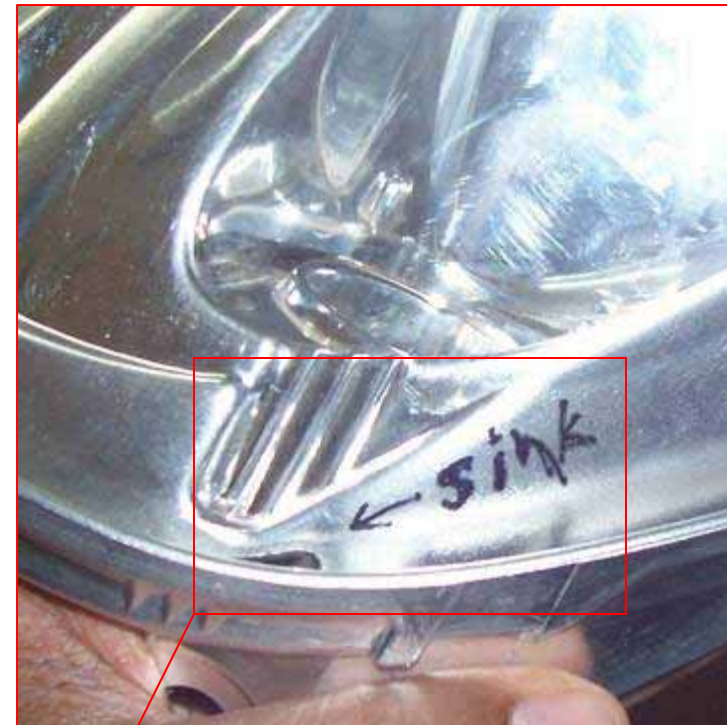
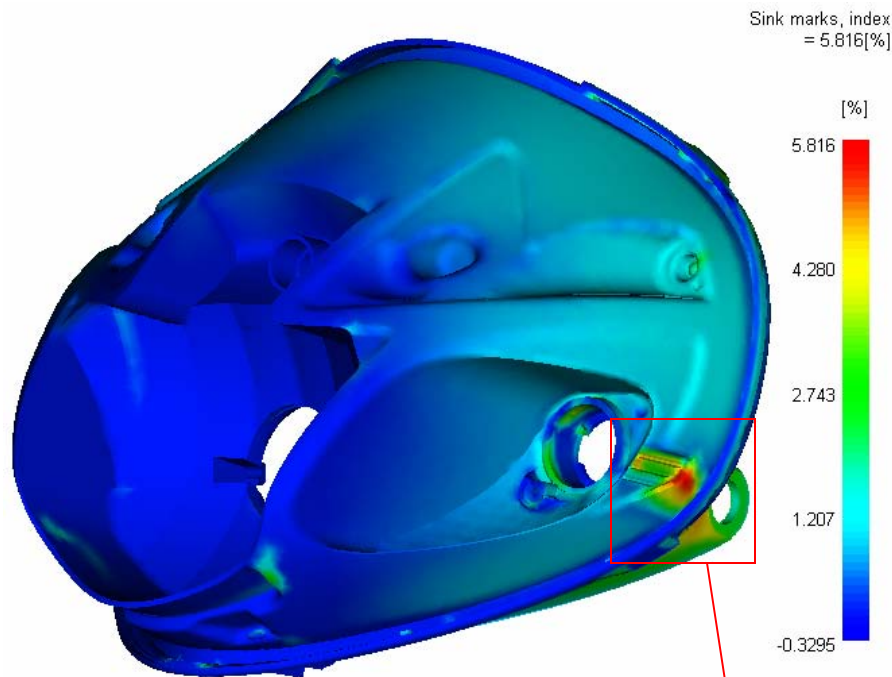
**Comments :** These curves show volumetric shrinkage vs. time at different locations. As the curve indicates, material is initially shrinking and then expanding. This means **packing is not enough**.

## 17.0 Sink marks index plot



**Comments :** This plot shows possibilities of sink marks . At red colour area , heavy sink is expected . Part thickness has to be reduced at heavy sink index area

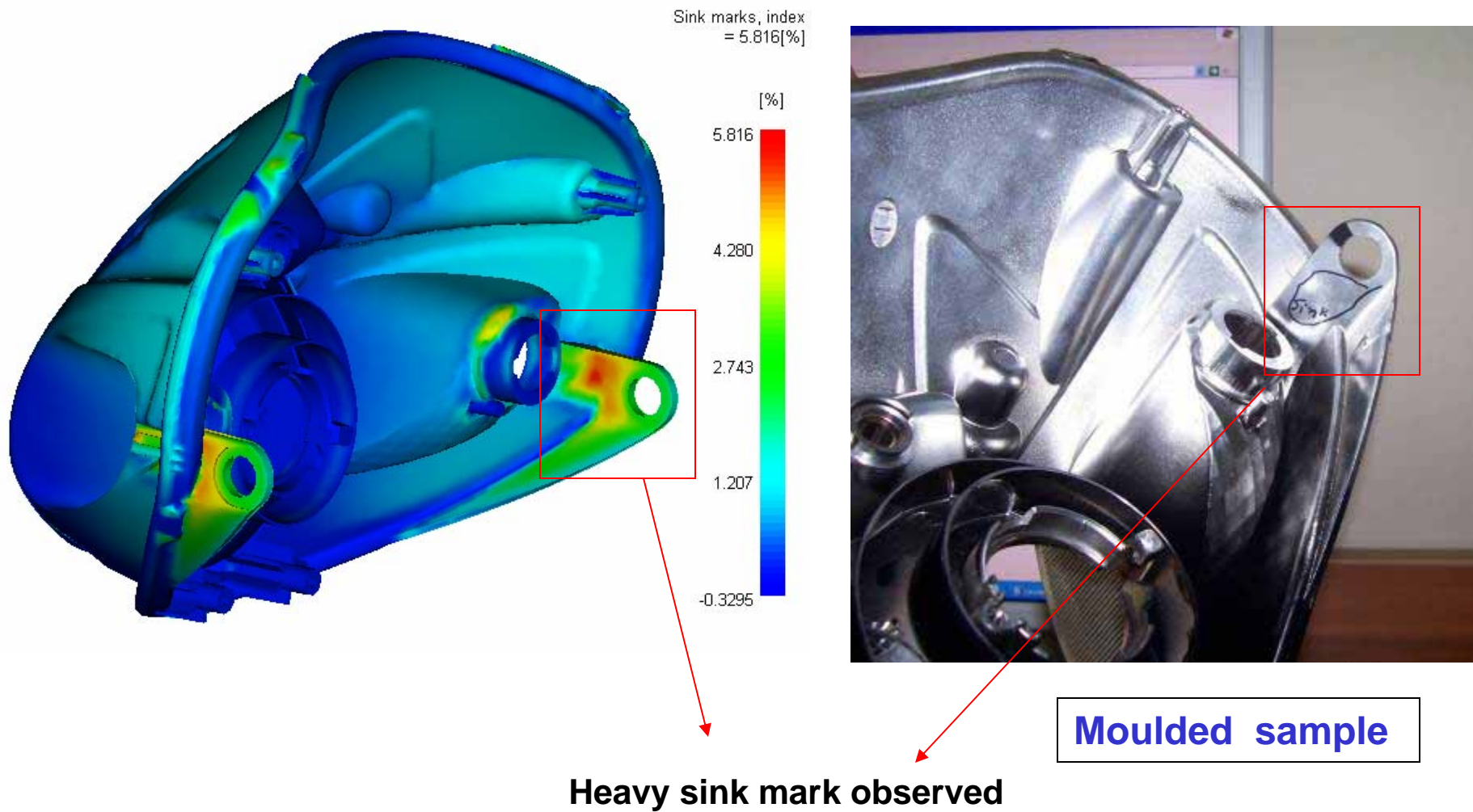
## 17. 1 Comparison of results with moulded sample



Moulded sample

Heavy sink mark observed

## 17. 2 Comparison of results with moulded sample



## 21.0 Summary & conclusions of existing designs



- 1 . This Reflector is analyzed with existing feed system with Cold sprue with 3 sub cold runner & submarine type gate & given process parameters for material – PC grade “Lexan 143 R”
- 2 . Part is filling in 4.73 sec with flow rate 96-99 CC/sec ,but short shot is observed at centre ribs .
- 3 . Pressure at V/P switch over is 115.7 Mpa .V/P switch over is done after 93% of part filled & Packing is done with 92.56 Mpa
4. The rise in temperature is observed up to 3.3 ° C due to shear heating & Drop in Temperature is observed up to 130° C but average drop in temperature is up to 15° C only . with high temperature drop ,there is inconsistency observed in full shot .
5. Since part is filled with 3 gates ,there are chances of many visible weld lines ,but temperature drop observed at weld lines is up to 15 ° C & rise in temperature observed is 3.3° C .As temperatures are high enough to fuse flow fronts properly ,these weld lines may not be structurally weak .but visible weld line marks are un avoidable
6. since this part is having multiple gates and multiple flow paths , air traps are un-avoidable but need to be vented properly
7. Maximum shear rate observed during filling is 42422 1/s > 40000 1/s ,but observed only in gate area only ( it is more than recommended for material ),so gate size has to be increased .

## 21.0 Summary & conclusions of existing design (continued)

8. Maximum shear stress observed during cavity filling is up to **1.8 Mpa** . Regions above the limit of 0.5 MPa could be subject to **stress cracking during ejection** or **in service**
9. Maximum volumetric shrinkage observed is up to **8.52%** ,at these areas ,there may be heavy visible sink marks . but sink marks may be controlled by **increasing packing pressure & packing time** or by **decreasing the part thickness**
10. Maximum clamp tonnage required is **249.4 tonne**.

## 22.0 Suggestions

1. Further iteration are carried with below processing parameter .i.e **increasing injection rate** , **increasing mold temperature** , **reducing melt temperature** & **increasing packing time** . Only iterations that showed considerable change are discussed in the report.

Mold surface temperature  C

Melt temperature  C

**Filling control**

Injection time  of  s

**Velocity/pressure switch-over**

By %volume filled  at  % [0:100]

**Pack/holding control**

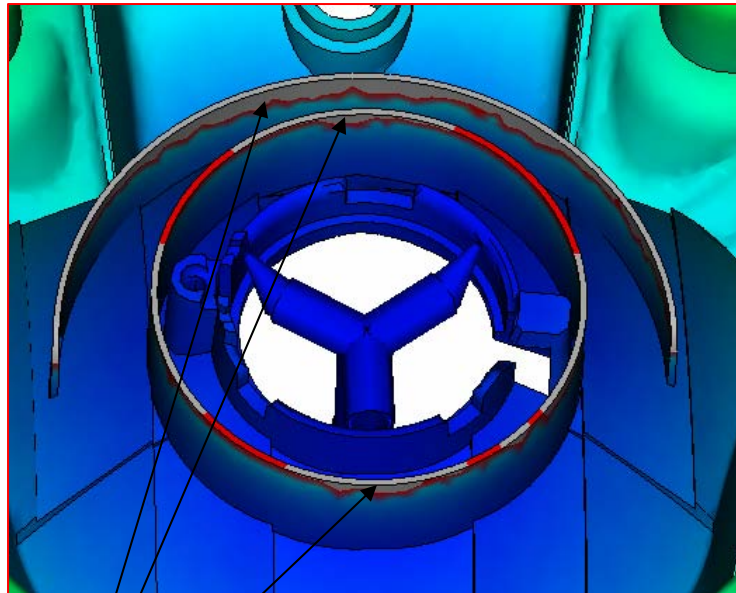
%Filling pressure vs time

**Pack/Holding Control Profile**

%Filling pressure vs time

	Duration s [0:300]	%Filling pressure % [0:200]
1	0	80
2	11	80

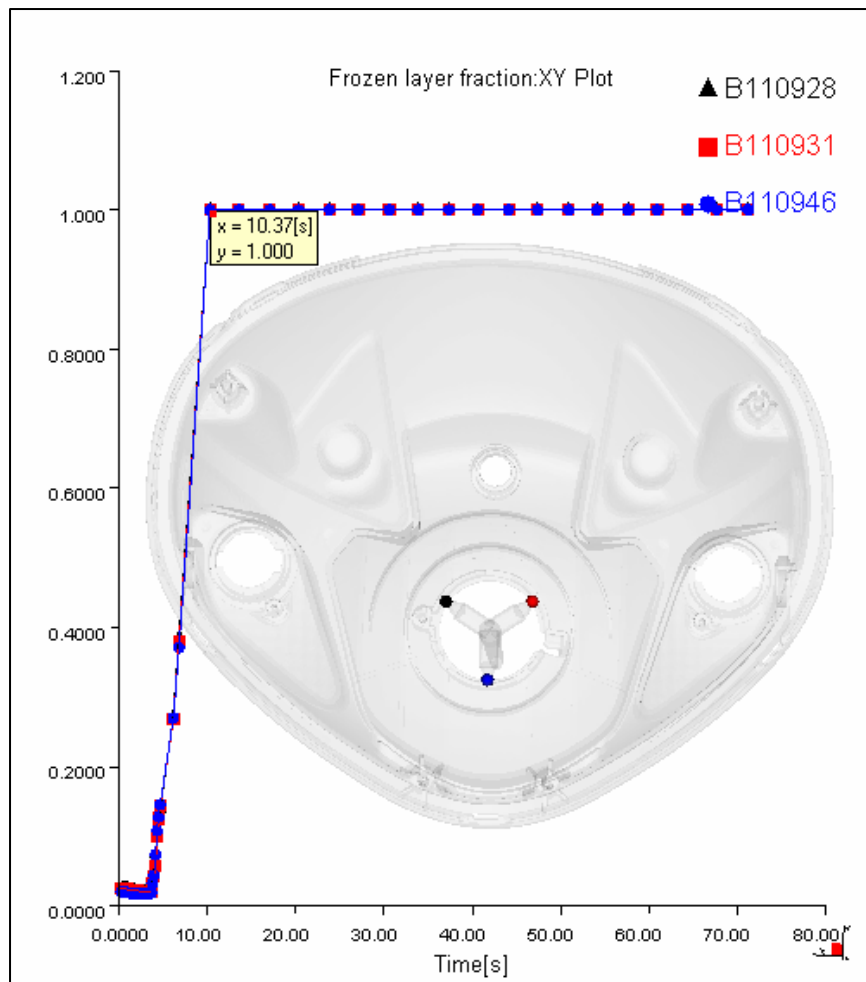
## 22.1 Suggestions (continued)



Short shot possible area area

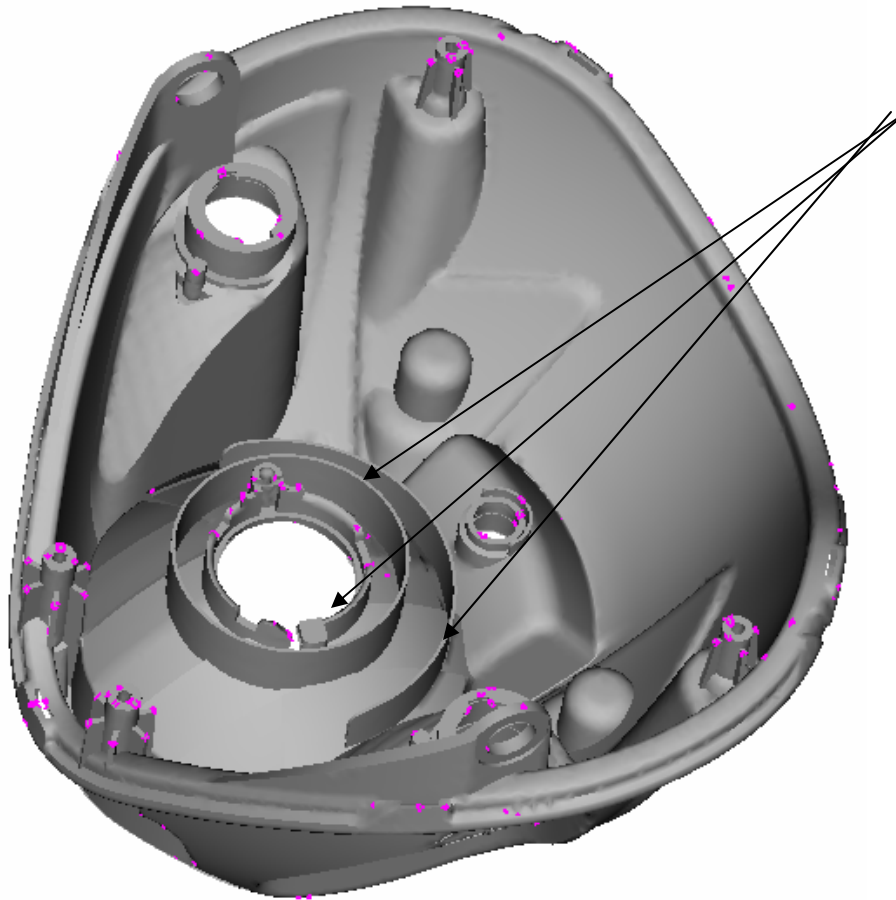
2 .As hesitation to fill & high temperature drop is observed at end of these ribs; so either **rib height has to reduced** or **rib thickness has to be increased**

## 22.2 Suggestions (continued)



3. since gate is freezing at 10.37 sec ,so packing can given up to  $(10.37\text{sec}-4.7\text{sec}) = 5.6 \text{ sec}$

## 22.3 Suggestions (continued)



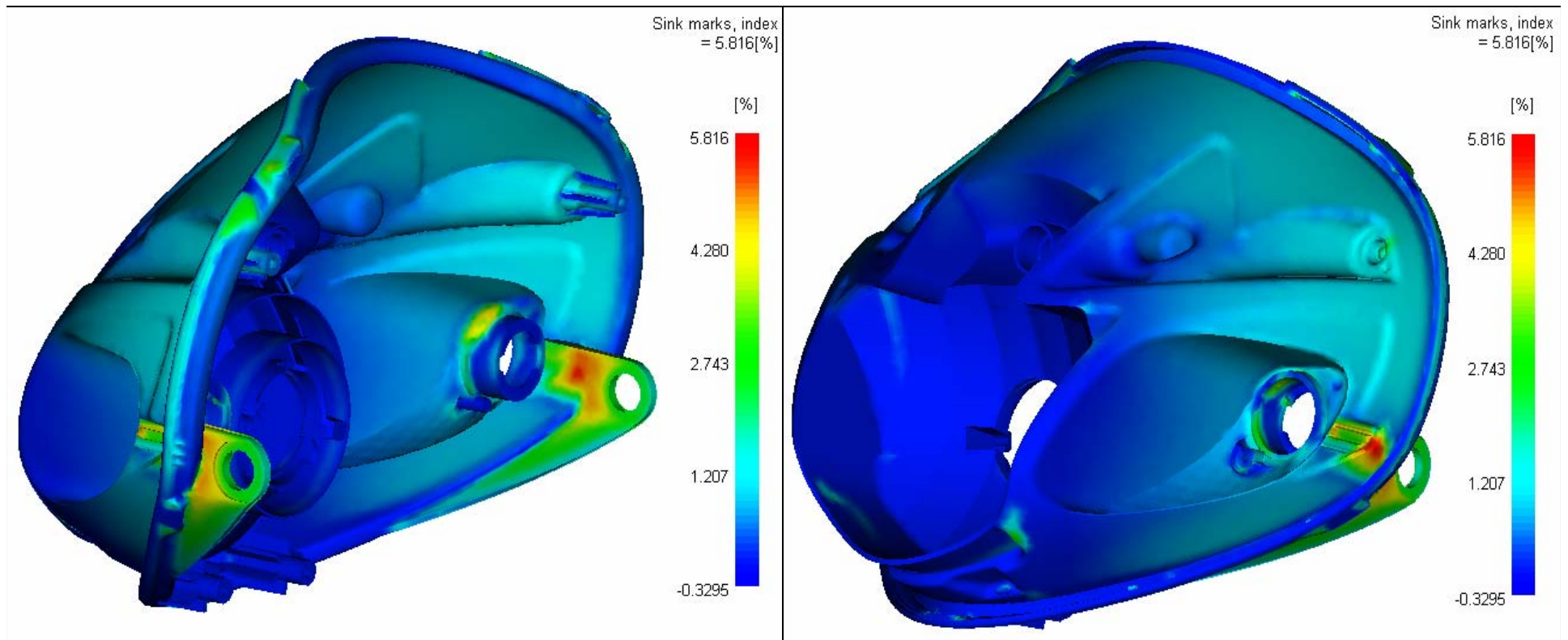
4. **Moldflow doesn't simulate the air entrapment in cavity in absence of air vents.**

**You should provide vents in these areas to remove entrapped air or else there would be short shots.**

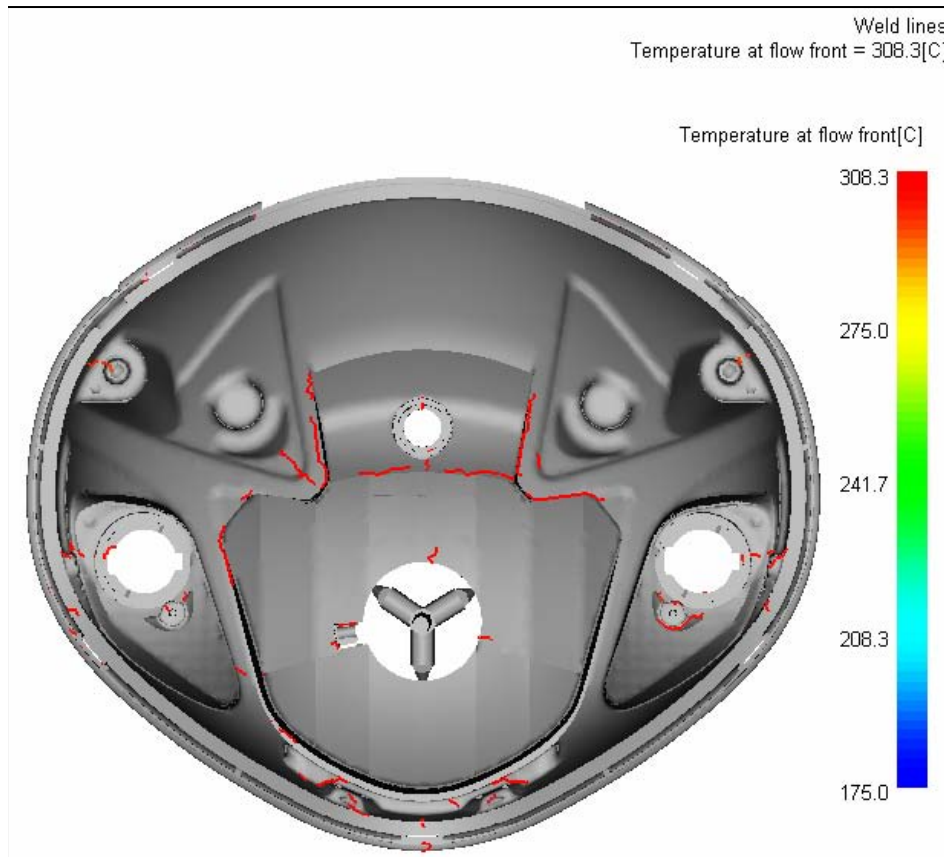
**It is also recommended to increase the thickness of these ribs so there is least resistance to flow and you can provide blade ejection which also serves the purpose of venting**

## 22.4 Suggestions (continued)

### 5 . Part thickness has to be reduced at heavy sink index area



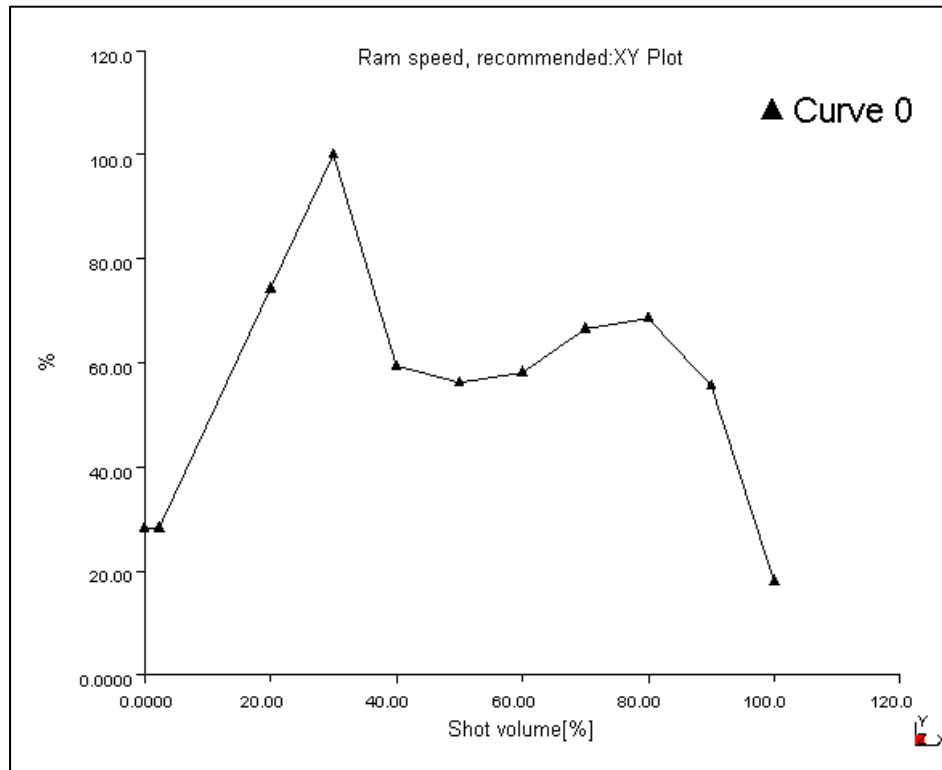
## 22.5 Suggestions (continued)



6 . Since multiple gates are provided , there will be multiple flow paths .so we cannot avoid weld lines .

To reduce the no of weld lines **reduce no of gates. One simulation with single gate is discussed at the end of the report**

## 23.12 Ram speed recommended (x-y plot)



Recommended ram speed profile (rel):	
%Shot volume	%Flow rate
0.0000	28.2038
2.3075	28.2038
20.0000	74.2558
30.0000	100.0000
40.0000	59.4123
50.0000	56.2012
60.0000	58.1045
70.0000	66.5076
80.0000	68.5063
90.0000	55.5506
100.0000	17.8656

**Comments :** This plot shows the recommended ram speed profile ,  
i.e % shot volume vs % flow rate , use this injection profile to maintain a  
constant flow front speed in the mold