Importance of Venting in Injection Molding

Pandiarajaguru

Newell Brands

Learning Objectives

- Causes of short fill in injection molding
- Importance of venting in molds
- Using simulation to predict failure
- How to avoid flow marks / Weldmarks

Description

Venting is crucial in injection molding and let's see how it is important in driving the product quality and process

Speaker(s)

About me - Pandiarajaguru

- B.Tech- Polymer Technologist with 14 yrs of experience, lives in Chennai, India
- Autodesk Certified Moldflow simulation engineer (Associate certification completed)
- Currently working as Senior Engineer in **Newell brands, R&D Chennai**
- Previously worked in Hero Moto corp ltd , Delphi connection systems , Thomson
- Supports **various divisions / Businesses like writing, baby, Appliances, Food etc. of Newell Brands.**
- Carries out preliminary DFM with the help of Moldflow software. Works closely with the Design team & PD team in validating the design.

Causes of Short fill in Injection Molding

Short shot is a filling issue / quality issue as the mold cavity is not filled completely. Short shot or short fill issue are generally due to the few of the below listed causes

- Material selection
- Process – Molding parameters
- Mold / Part design
- Flow restriction
- Hesitation
- Lack of Venting

Material Selection – Reasons behind filling concerns

Selecting a right material is a key to achieve 100% cavity filling. During molding, the molten resin / plastic flows through the cavity. The resin is generally selected based on flow properties mainly MFI. Improper material selection might lead to short fills - High viscous material on thin walls of the mold cavity. Material with higher MFI values(greater than 15) are considered as high flow grades, whearas material with lower MFI values are considered as low grades. For filling a thin walled component, if a low MFI material is used then We may end up in short filling issues. Also, if material is not rightly selected then the injection pressure requirement would be higher and may lead to need of higher capacity machines for molding

.

Selecting proper material is the key.for producing better parts

List of commercially available plastic materials used in consumer goods industry

- PP
- PS – GPPS
- HIPS
- ABS
- SAN
- PC
- HDPE

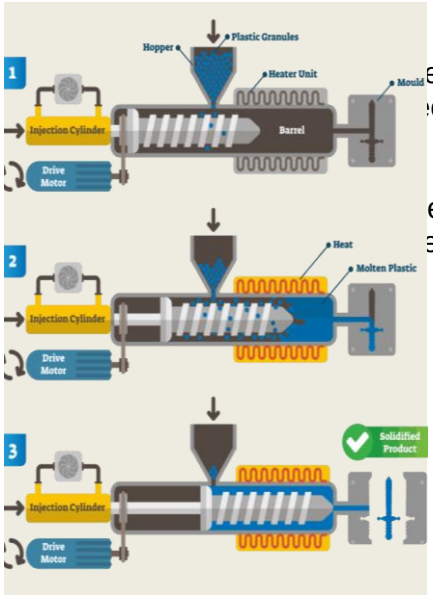
- Copolyester

* Improper material selection leads to short fill

Materials like PP, HDPE, PS are easy flow materials whereas PC, aBS, Copolyester requires higher injection pressures for filling the cavities

Process – Molding parameters – Reasons behind filling concerns :

Processing is another important factor which may cause filling concerns



essure
ed

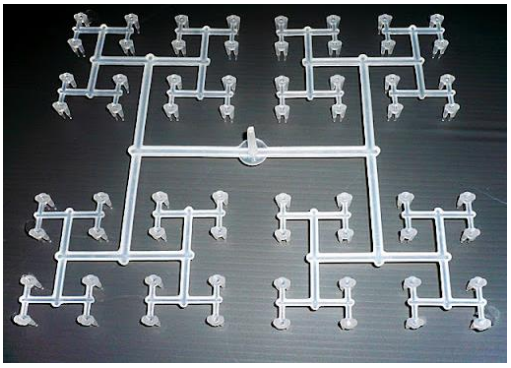
erature
e

Mold & Part Design :

Mold and Part design also plays a major role in cavity filling. Flow getting restricted due to improper mold and part design affects the filling pattern

Flow Restriction :

- Restriction in the flow due to gate location position - If the gate location chosen is not optimum then it might lead to flow restriction. It is recommended to have gate located in a symmetric location. It will be always good to have smaller flow lengths.
- Gate placed at wrong location might lead to filling imbalance / longer flow lengths
- Inappropriate gate / runner dimensions -If the runner dimensions are restrictive then it might cause flow restriction and may result in short shot as well



Hesitation :

- Melt hesitates to flow easily through the cavity due to variable wall thickness in the part design
- Melt stops or slows down in the cavity due to the thickness variations
- Thicker areas filled at first
- Thinner areas filled at last

Lack of Venting :

Adequate venting is required for producing good quality molded components

- During mold filling, the melt flowing through the runners / cavity pushes the air trapped inside the cavity
- The air will try to escape out of the cavity through the venting in the mold cavities
- Airtrap / gas trap will occur due to lack of venting

What is Airtrap :

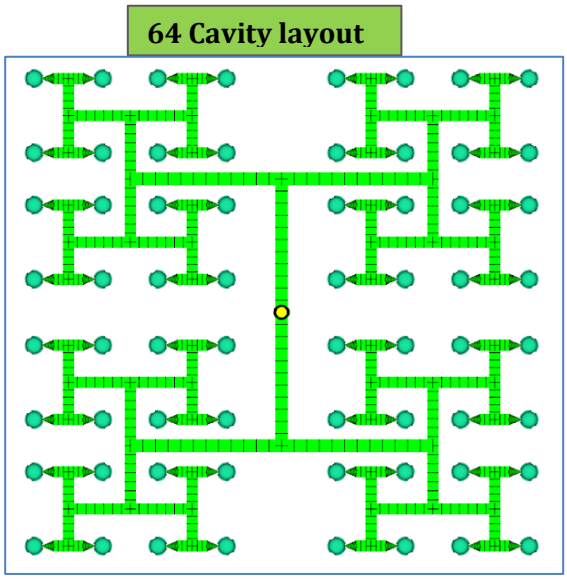
- Airtrap is a molding defect which commonly occurs in the last filling area of the cavity
- Airtrap is nothing but air trapped in the cavity walls during molding due to the converging flow fronts.
- As these airtraps can't escape from the cavity they will cause short shot or burn marks

Example of Venting issue :

Let us understand why venting is more important in molds through an example

Project information :

- Multicavity mold for making component of Pen
- 64 cavity tool
- Balanced layout



Problem statement :

- Difficulties in molding the parts due to airtrap
- Short filling is noticed in all 64 cavities
- A hole is formed at the top of the plunger due to airtrap which aesthetically affects the quality and makes this component unusable
- On looking the samples closer, there were flow marks too
- Short fill noticed in all the 64 cavities are at the same place

Observations :

- Tool drawing, Product drawing & the injection parameter sheet from the tool maker were checked
- Sub gate is used for filling the cavities.
- Gate location is noticed near the bottom of the component
- Modified trapezoidal runner
- High flow grade material used

Causes of filling issue in this project :

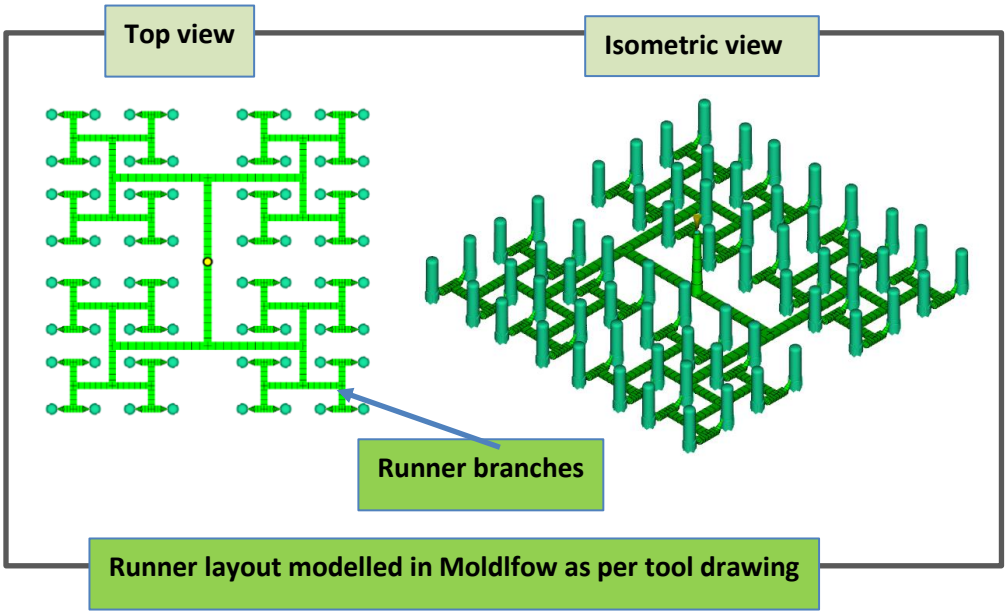
- Airtrap or Gas trap formed during filling phase has resulted in Short fill
- Gate location is near the core side & hence the cavity side is expected to fill at last. Airtrap is expected at the last filling area.
- Lack of venting in the cavities. **Venting is not provided in the mold initially in the last filling areas**

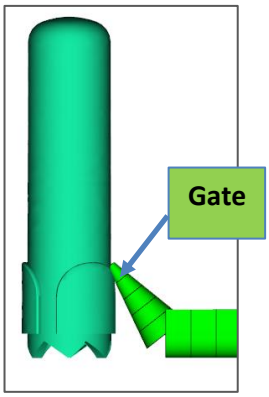
- Traces of flow marks in the samples indicate the pressure / temperature drop in the cavities
- The runner & Gate dimensions controls the temperature drop in the cavity as well as the flow marks.

Analyzing the Mold with the help of Moldflow :

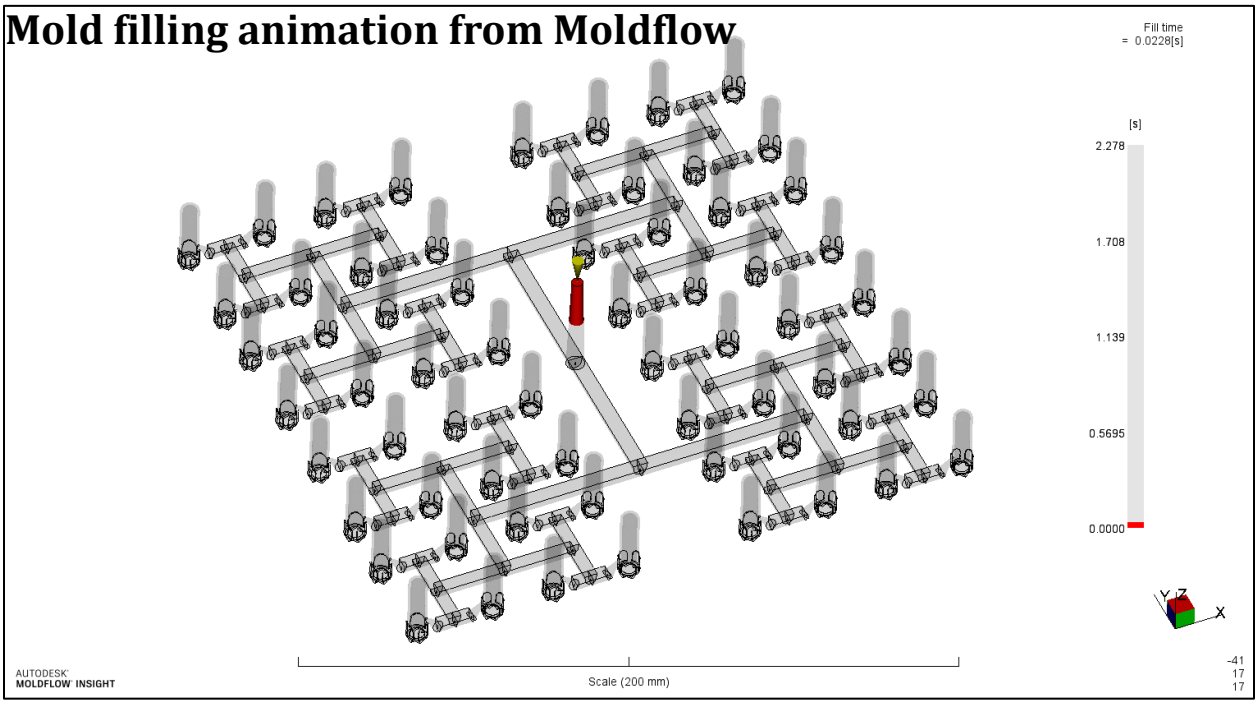
Autodesk Moldflow simulation is used predict / correlate the failure. The molding defect observed in the Molding is replicated with the help of Moldflow Simulation

- Full mold drawing was obtained from the tool maker
- Moldflow software was used for replicating the molding scenario.
- Full mold set up is modelled in Moldflow simulation. 64 cavities were modelled along with the gate/ runner set up
- Multicavity flow simulation was carried out.

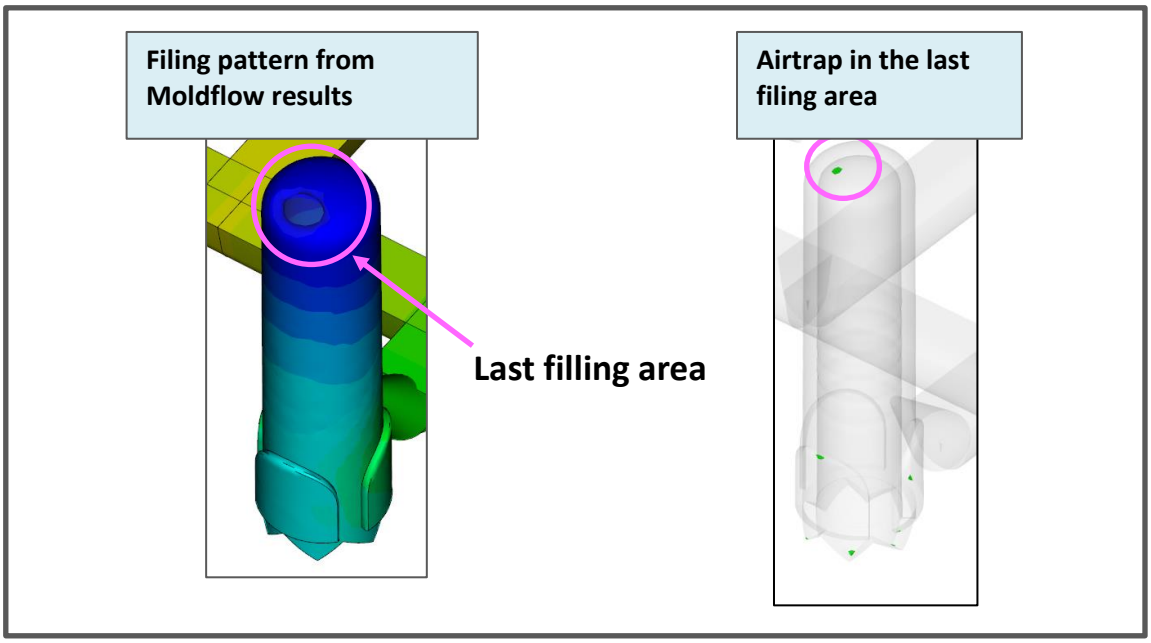




Mold filling animation from Moldflow



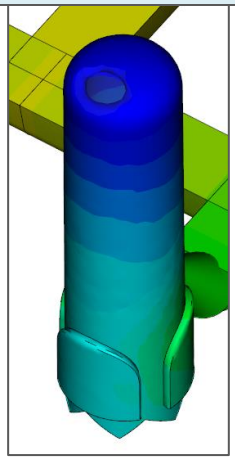
Filling pattern and Airtrap



Filling pattern and Airtrap

- As the gate location is near the core side, the last filling area is expected to be in the cavity side.
- The melt started to flow from the gate orifice near the petal area of the plunger, slowly filled the shroud area and the last filling area was expected to be the top of the plunger (opposite to the gating side). The air present in the cavity was pushed by the converging polymer flow front; Hence there was no venting provided to relieve the gas from the cavity, the air or gas could not escape and got trapped to form a hole or short shot in the part

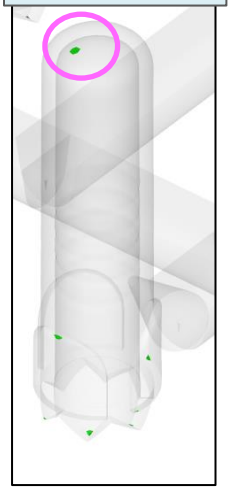
Filing pattern from Moldflow results



From the Moldflow results

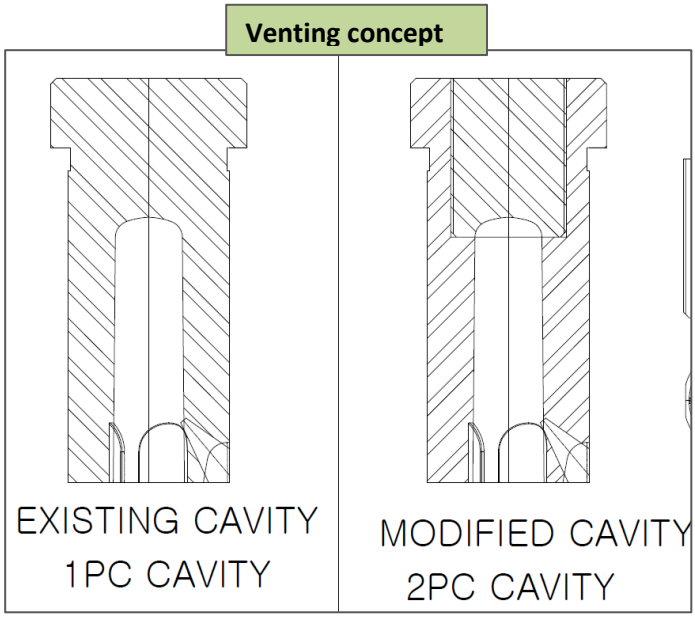
- Critical airtrap noticed in the last filling area in the cavity side at the top of the plunger
- Flow hesitation noticed and temperature drop(temperature of the molten material) & pressure drop also observed
- Airtraps formed in the core side can be always easily relieved with core pins, but airtrap in the cavity side is tough to eliminate without venting

Airtrap in the last filing area

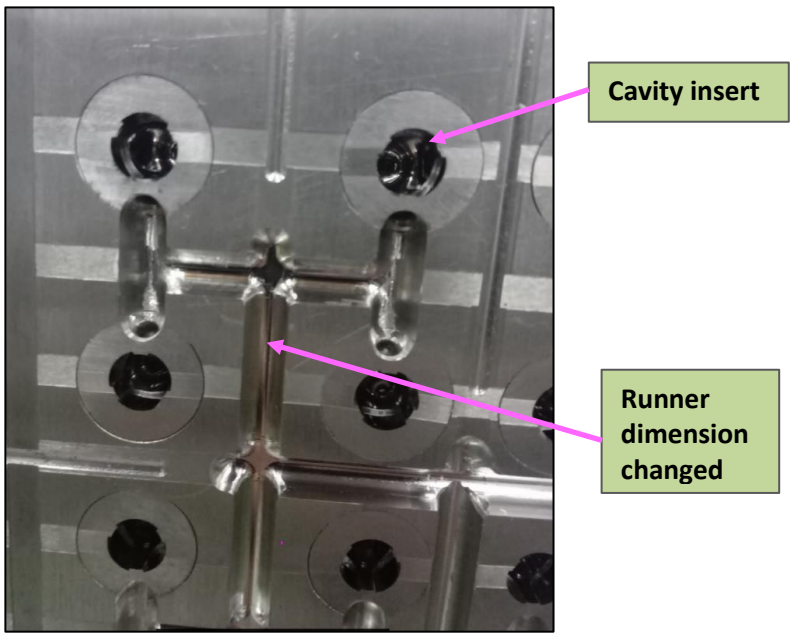


Tooling recommendations

- To relieve the air trap or gas trap, it was recommended to provide venting at the top of the plunger where the hole is formed
- Cavity was split into two pieces. Two piece cavity insert concept used.
- Gas vent clearance to be provided in the tool



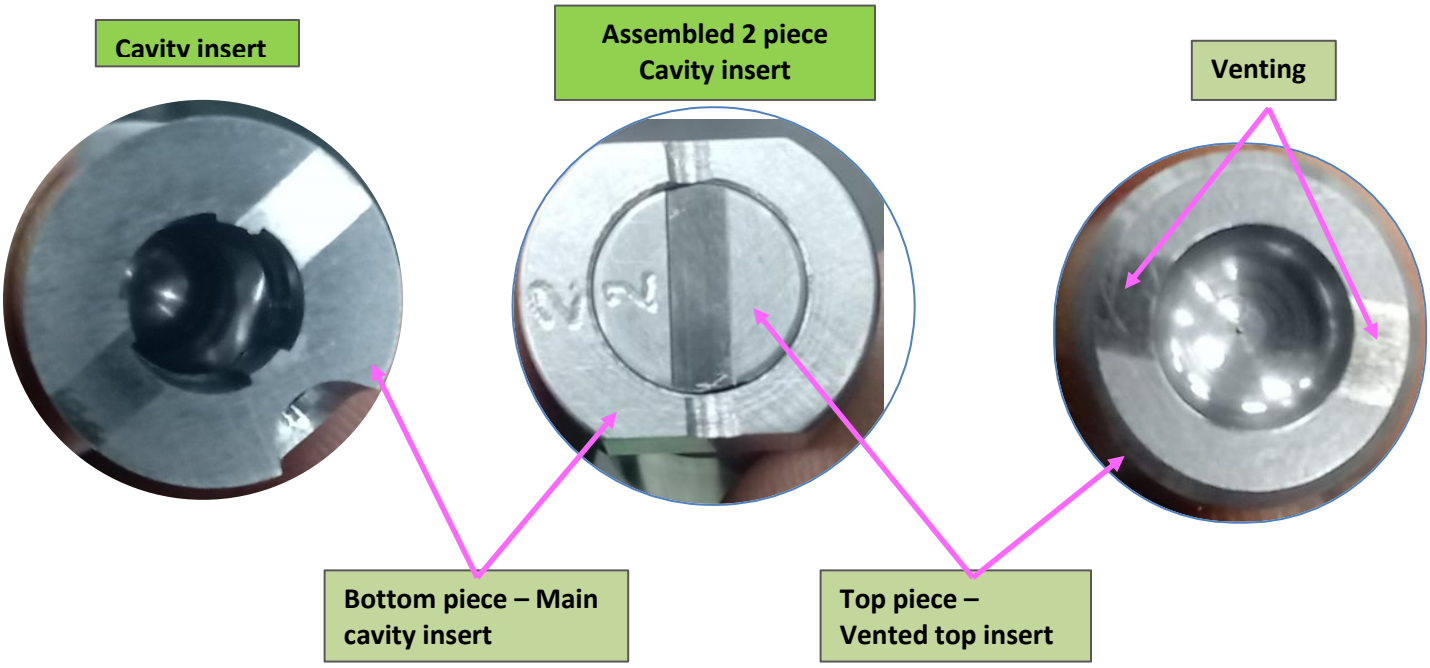
- It was suggested to increase the gate dimension allow more material into the cavity
- It was also suggested to increase runner dimensions to aid the flow



Tool trials after effecting tooling modifications

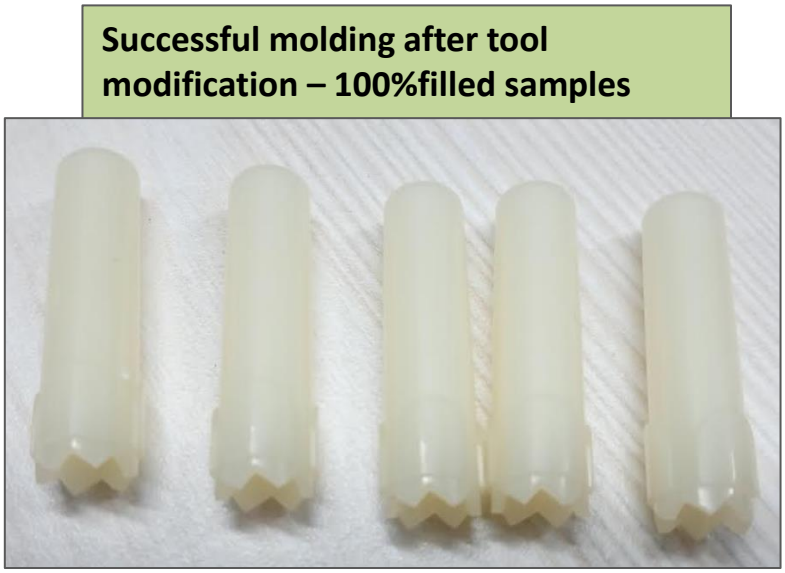
- The tool maker had made the corrections in the tool and tool trial was carried out
- Few key Process parameters were suggested to the tool maker based on the Moldflow simulation results
- Initially higher injection time was used by the tool maker, later it was reduced to 1.0s for better filing behavior
- After tool modification, the filling results were great and we have achieved 100% filling. The hole formed earlier doesn't exist anymore

Modified cavity inserts after adding venting slots

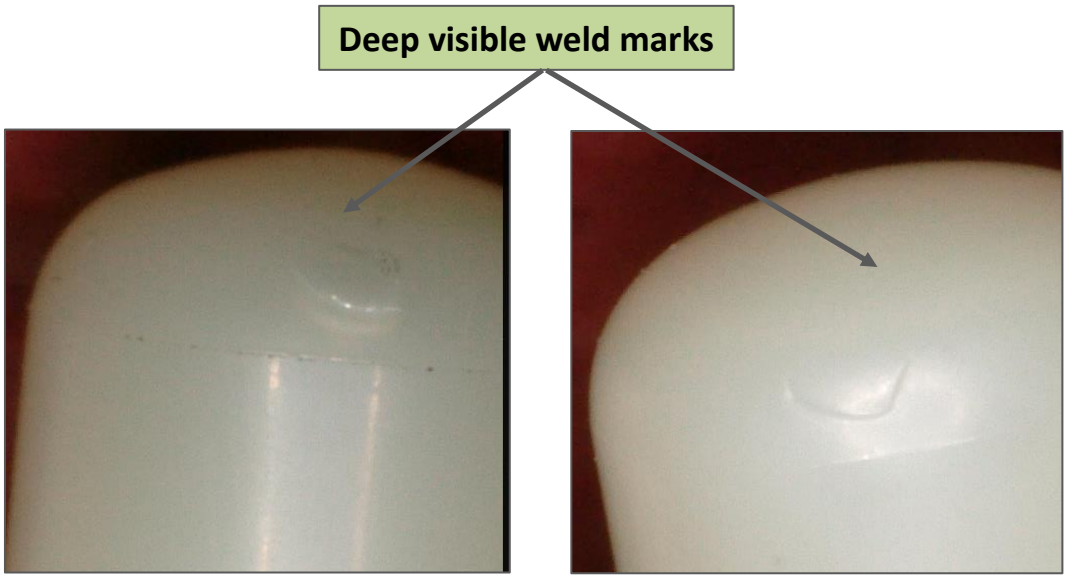


After effecting modifications in all 64 cavities

- The tool maker had made the corrections in the tool in all the 64 cavities
- Successfully all 64 cavities filled completely.
- Few of the cavities showed some **visible weld marks and flow marks** which is a surface defect
- The weld marks were visible and deep
- These weld marks affects the product quality aesthetically
- And also there were few flow marks in few of the cavities



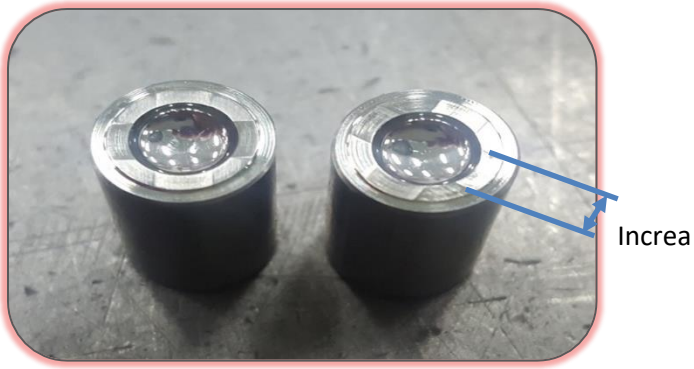
Weldmarks in the samples :



Avoiding weldmarks :

Optimizing the Venting

- To avoid the weld marks, it was recommended to increase the venting land to avoid visible weld marks
- As per the suggestion, the tool maker had widened the venting land area.
- Venting land area was increased
- Additionally venting was provided on four sides
- Trial has been conducted with this modified venting.
- Current samples looks free from visible weldmarks



Conclusion - Before and After providing vent

- The molded components are defect free now