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Redesign and Flow Analysis of An Automotive Injection Mouldedcomponent Using Computer Aided Engineering

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Abstract

Computeraided engineering can be applied to polymer industry in many areas of processing in which the process can be simulated and results can be viewed on the display screen. Mold flow is one of the CAE package particularly used for analyzing the flow behavior of plastic melt, product mouldability and quality, cooling requirements, areas of structural weakness, position of weldlines and air entrapment, volume and shot weight predictions. The aim of this analysis to verify filling, reduce stress levels to desired levels and to check for presence of voids, weld lines and air entrapment in an automotive component - front dial cover plate made up of polypropylene and elastic property development material (PP+EPDM). Solid model of the component was created in a Pro/Engineer package and then, that model was imported in to mold flow and the analysis was carried out. After analysis it was found that quality is low in a particular area, and improvements were suggested.

Key words: Computer aided engineering, Flow Analysis, Weld line, Mold Flow.

Introduction

Injection moulding is plastic forming process used in the production of most (about 70%) plastic parts. Injection molding is generally used in the high speed, manufacture of low –cost, high –volume part. Injection molding is the most versatile of the plastic processing techniques used for the molding of the automobile component. This processing technique is becoming all the more relevant due to the fact that the current trend in the automobile industry is more concentrated on substitution of metal components by plastic for fuel efficiency due to weight reduction. Components made out of plastic polymer blends and composites are presently used as engine parts of the automobile where heat resistance is the major property demanded.

The component to be analyzed is MM front dial cover plate used in automobile dashboards and meter boards. The material used for this purpose is Polypropylene and elastic property development material [PP+EPDM]. Commercial name vistaflex 150B.The material shows low friction, good abrasion resistance, good impact strength, creep rupture strength.

Mould for used for this component is single cavity mold. The aim of this analysis is to view the gate locations, Weld line, and pressure. Mould flow plastics insight facilities flow analysis of products to predict thermoplastic polymer flow inside the metal. The program simulates flow by calculating a flow front that grows form node to connecting node, starting at the injection node. The cycle is continuous until the flow front has expanded to fill the last node. MPI Flow-fusion works by simulating the flow of the metal on both the top and bottom surface of the mould cavity (surface mesh). The mesh comprised of triangular elements. Each element has three nodes.

Experimental

Product Modeling

The model of the component is designed in Pro/engineer package. (Figure-1)

Figure 1:

Importing The Model

The STL file is ensured to be complete and incorrupt. Only one solid was present. The mesh triangles were properly oriented. There were not any intersections between any triangular surfaces, no triangle overlaps.

Table 1: Material Details

Name	PP+EPDM Visatflex 150B
Material structure	Crystalline
Mold Temp.	40 C
Melt Temp.	240 C
Melt Temp. Range	220 – 260 C
Mold Temp. Range	20 – 60 C
Max. Shear Stress	0.25 MPa
Max. Shear Rate	100000 1/S
Ejection Temp.	119 C
Density	0.90211 g/Cm3
Filler	No

The above table shows the material details set default in the mold flow software**.** The above material details can be obtained from the mould flow analysis software by choosing the appropriate material name. For e.g.: by choosing PP+EPDM, we can able to identify the important parameters like shear stress, max. Temperature

Model Preparation For MPI/Flow- Fusion Analysis

The mouldflow 'FUSION" capability allow to perform detailed analyses directly on a thin-wall surface mesh model imported from CAD package. FUSION significantly reduces model preparation time. The recommended maximum aspect ratio for a surface mesh is 6.

Model Details

Total no. of nodes	3721
No. of elements	7484.7
Maximum aspect ratio	18.4
Part Volume	195 cm^3
Part Weight	196 gms
Total Projected Area	531 cm^2

Process Parameters

The Figure -2 shown below entails the process parameter details that will affect the mold during the analysis.

```
Process parameters :
------------------
Fill time                                          =      1.5000 s
Cooling time                                       =     20.0000 s
Velocity/pressure switch-over by                   = Automatic
Packing/holding time                               =     10.0000 s
Ram speed profile (rel):
  % shot volume         % ram speed
  --------------------------------
       100.0000            100.0000
         0.0000            100.0000
Pack/hold pressure profile (rel):
       duration  % filling pressure
  --------------------------------
         0.0000 s           80.0000
        10.0000 s           80.0000
        20.0000 s            0.0000
Ambient temperature                                =     25.0000 C
Inlet melt temperature                             =    240.0000 C
Ideal cavity-side mold temperature                 =     40.0000 C
Ideal core-side mold temperature                   =     40.0000 C
```

Figure 2: Process Parameters

The above process parameters like mold temperature, melt temperature, injection pressure, fill time, cooling time, velocity/pressure switch-over by, shot volume are affect the component part during injection molding.

Results and Discussions

Gate Location Analysis

The injection location represents the position where polymer is injected, allowing the software to simulate the flow pattern inside the mould cavity. In order to mould the best part possible: the optimum injection location for the part had to be identified. The optimum injection location created balance flow, allowing the extremities of the mould to fill at the same time and pressure. The number and position of injection location are identified such that the volumetric shrinkage at the need of flow is close to the design value using the optimum holding pressure. The gate location analysis is used to identify the best place to inject on the part. Figure-3a indicates the gate location suggested by mold flow.Figure-3b indicates the best gate location plot obtained by the analysis.

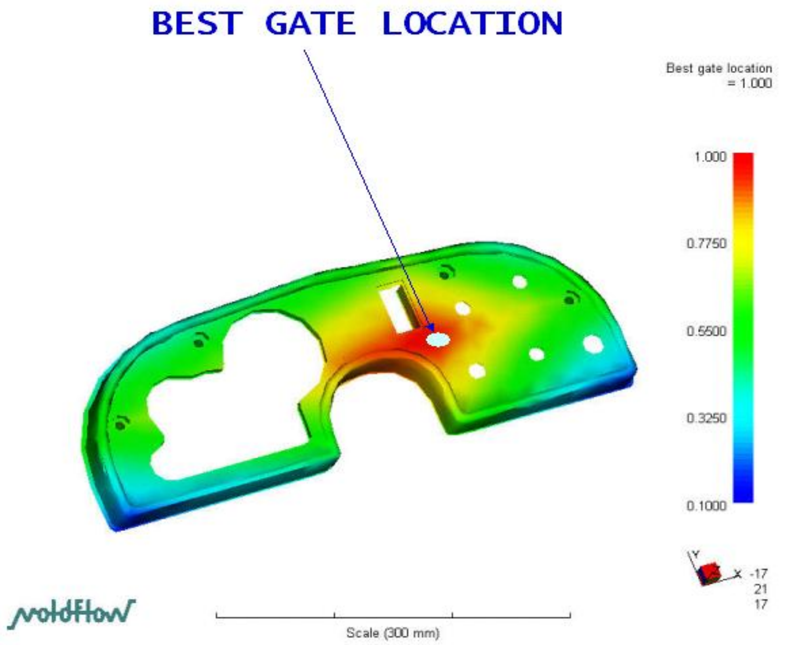

Figure 3:

The Gate Location result rates each place on the model for its suitability for an injection location. The most suitable areas are rated as best, and the least suitable areas of the model are rated as worst. For this model nearer to center areas, which is in red color, is the best location suggested by mold flow.
By keeping this as the reference point we can do the analysis by keeping this as maximum limits.

Fill Time Analysis
Due to imbalance of Clamp force, gate location not selected as per the Mold flow suggestion. For this study gate is located at the center of the product [1]. The Fill time result shows the position of the flow front at regular intervals as the cavity fills. Each color contour represents the parts of the mold, which were being filled at the same time. At the start of injection, the result shows dark blue, and the last places to fill are red. (Figure-4)

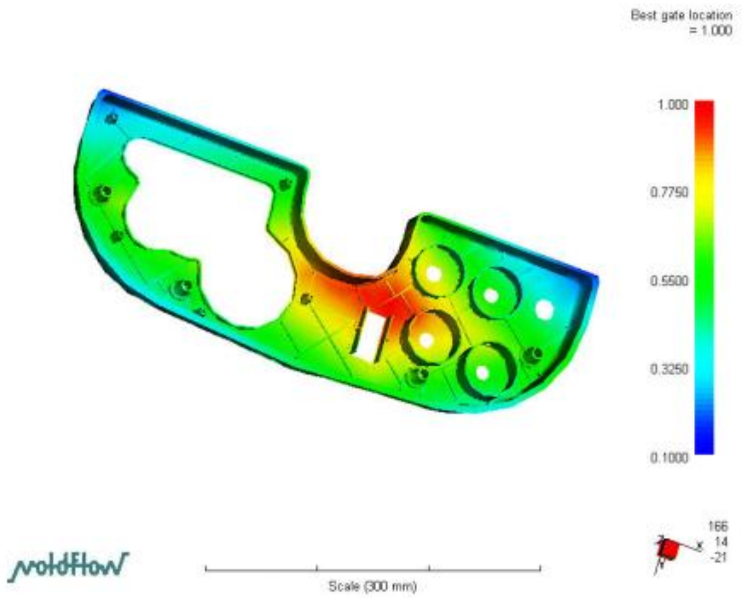

Figure-4

Pressure Analysis:
The maximum pressure inside the mold is 37.62 MPa, the recommended pressure is 100 MPa for single cavity. So for this model pressure is within the Limit. The pressure at the end of fill should be nearer to Zero, for this model that also within the limit (Figure-5)

PRESSURE

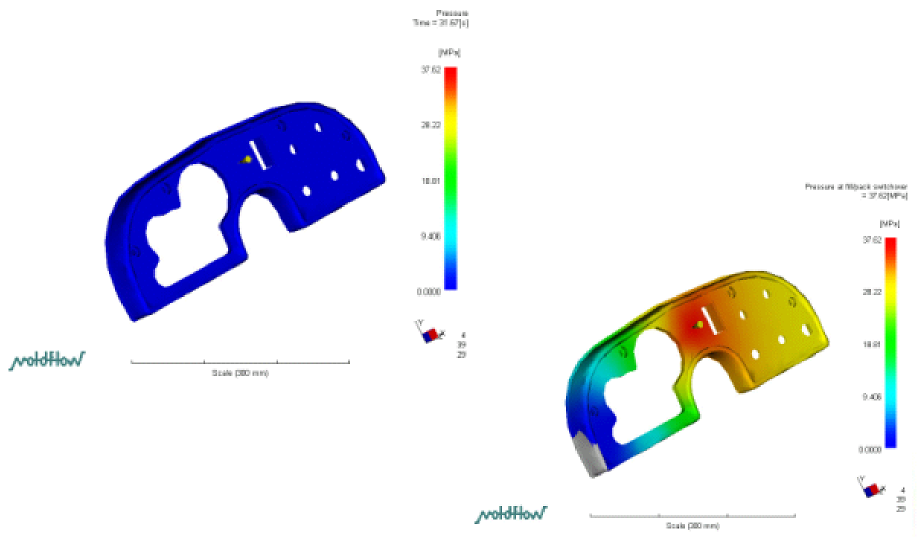

Figure 5:

Graph for pressure at injection location (Figure-6):

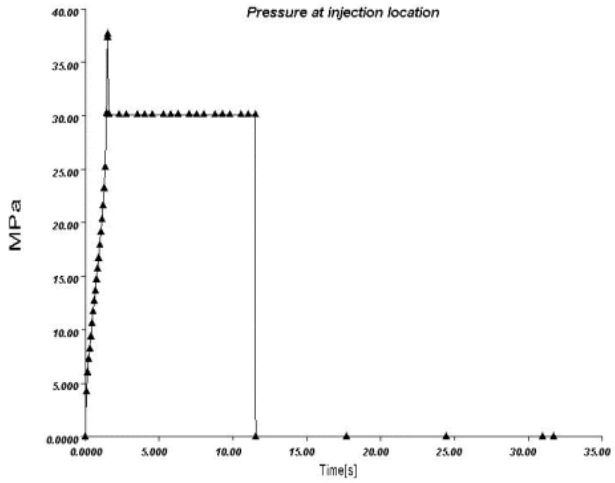

Figure 6:

Temperature Analysis:

Temperature at flow front difference should be less than 20 ° C. The Temperature at the rib areas difference is more due to lesser wall thickness, so it will easily freeze the material. Suggested to keep the cooling channels away from these areas and possibly to increase the wall thickness (Figure-7).

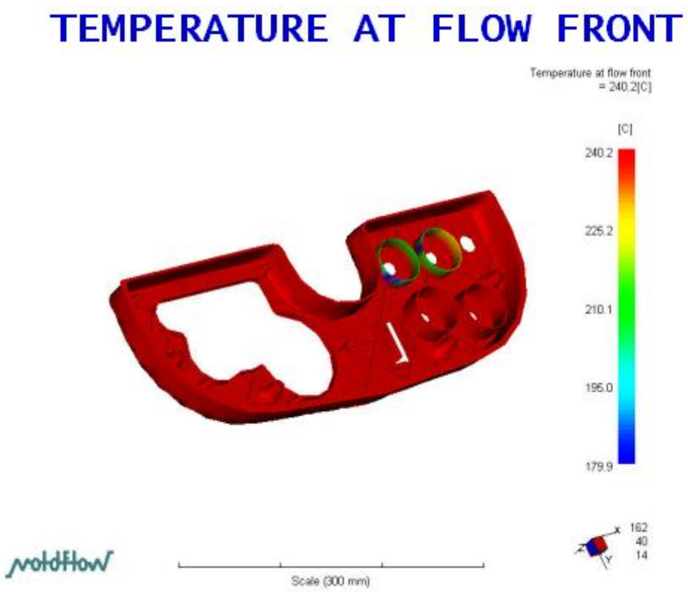

Figure 7:

Clamp Force:

The clamp force is a function of injection pressure and the projected area of the part. The projected area is the area of the model projected onto the XY plane. Shows the force of the mold-clamp over time. The clamp force is the resultant value of the pressure distribution Over the entire part. It is a history of the force resultant from filling and packing pressure that acts to open the mold. (Figure-8)

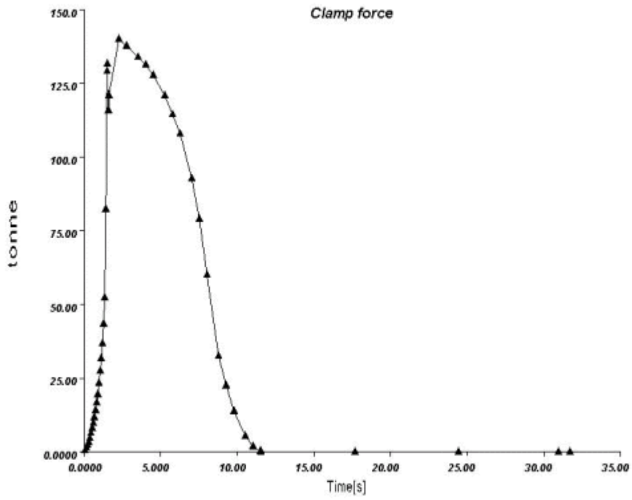

Figure 8:

Airtraps Analysis:

Air traps as shown in black dots in the plot may be where the melt stops at a convergence of at least 2 flow fronts, or at the ends of flow paths [1]. (Figure-9)

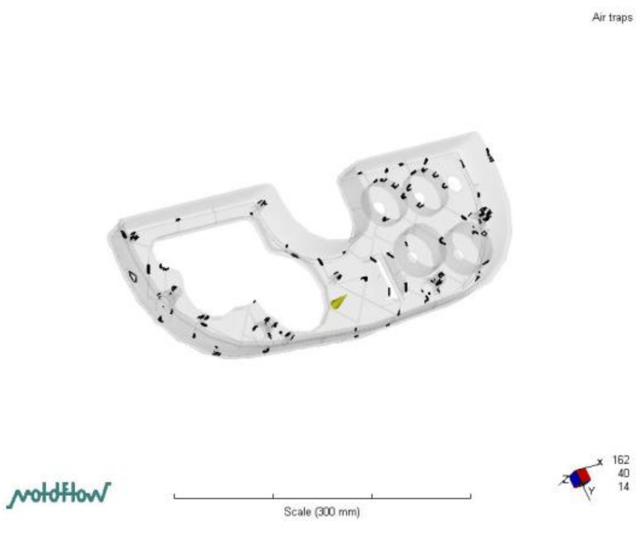

Figure 9:

Weld line Analysis:

Black lines shows where weld lines are likely to occuron model. The Weld lines result is generated at the end of a filling analysis, and shows where weld lines are likely to occur on your model [2]. Weld lines occur in places where two flow fronts have converged. The presence of weld lines may indicate a structural weakness and/or a surface blemish. (Figure-10)

Figure-10

Time to freeze:

The Time to freeze, part result shows the amount of time taken for all of the elements in the part to freeze to ejection temperature, measured from the start of the cycle. (Figure-11)

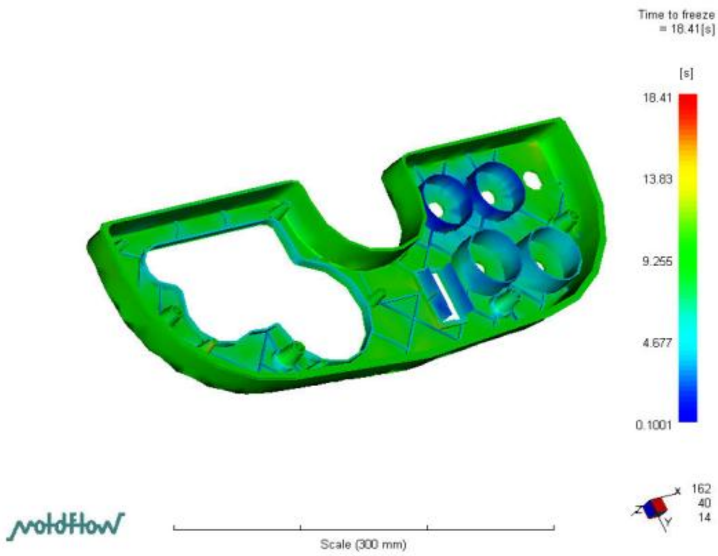

Figure 11:

Bulk Shear Rate:
Bulk Shear rate all areas less than recommended for the material (100000 1/s). But for this model the maximum is 13477 1/s. Within Limit. (Figure-12)

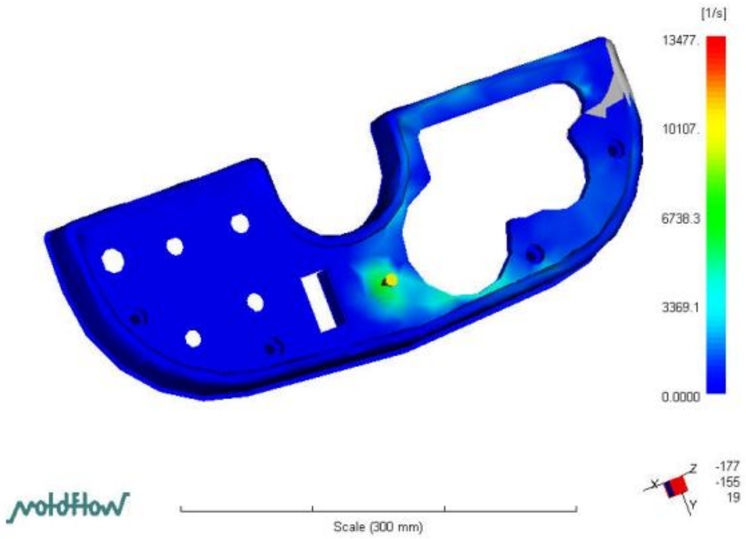

Figure 12:

Shear Stress Analysis:
Shear stresses at all areas are less than recommended for the material (0.25bMPa).Shear stress values has been attained for 7.025 secs. (Figure-13)

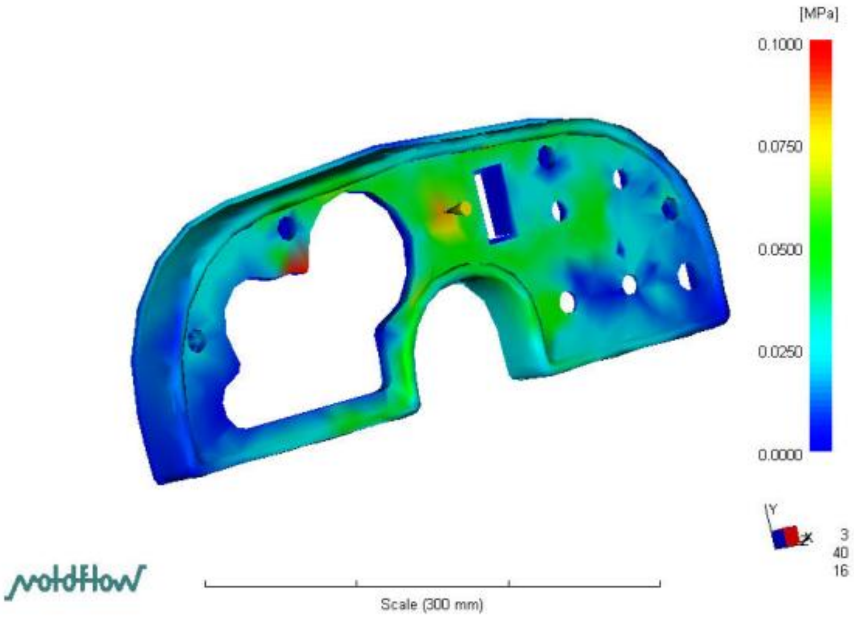

Figure 13:

Deflection at All Effects:
The deflection values include the effects of both warpage and shrinkage. Here the deflection is slightly more. The warpage effect is more due to lesser wall thickness and improvements in the wall thickness are here forth suggested. (Figure-14)

Figure 14:

Result & Conclusion

The mold flow software is very much efficient tool for mold flow process analysis for injection molding components. This tool is henceforth aiding in saving effective time during the redesign and analysis of the components to be manufactured.

The Filling analysis for the MM Front dial cover plate was carried out as per the given design of part. The process settings run with Mold flow default. The component -FRONT DIAL was analyzed first for the best gate location. From the analysis it is inferred that the best gate location is at the center of the mould. The filling process was analyzed after setting the best gate location and the results proves that the filling is proper. The component was further analyzed for bulk shear and shear stress and both were in the safe limits. But defection due to warpage and shrinkage were inferred to be slightly more so it is suggested to increase the wall thickness in some rib areas. Further improvements can be done in the design by avoiding weld lines and air traps formations by redesigning the component replacing an alternate material.

References

[1] Du Hwan Chun, (1999) ‘cavity filling analysis of injection molding simulation: bubble and weld line formation’, Journal of material processing technology pp.177-181.

[2] Hrishikesh Kharbas, Lih_ShengTurnj, Rick Spindler (2002),'Study of Weld-Line and Micro Structure of Injection molded Micro cellular parts'.
[3] John T. Tester, TyHargroder (2001), 'Reducing Distortion in Simulated Injection Molded Wind turbine Blades'
[4] C.F.Merhar, K.A Belter and K.Ishii, (1994) 'Weld line strength in injection molded PVC parts' SPe ANTEC Proceeding.
[5] N. Merah, M. Ifran-ul-haq, Z. Han,(2004) 'Effects of Injection Molding Weld on Fatigue Crack Resistance Of CPVC at Different Temperature', Journal of Material Processing Technology-155-156(2004)1261-1265
[6] Osman G Erosy, NihanNugay, (2004) 'A New Approach to Increase Weld Line Strengths of Incompatible Polymer Blend Composites: Selective filler Addition' Vol.45 pp. 1243 -1252.
[7] S.Roth, I.Kuhnert, G.Menning (2003) 'Fiber orientation in weld line areas of an Air – intake manifold of a car', International Journal of Plastic technology' Vol.7 pp.1-8.
[8] Shogun Guo, A.Ait-Kadi, M.Bousmina, (2004) 'A modified model predictions and experimental results of weld-line strength in injection molded PS/PMMA blends' Journal of Polymer Vol.45 pp.2911 -2920