CHAPTER 12

SOLIDWORK Plartic Flow Analysis

When a plastic part is made by injection molding, the plastic pellets are loaded into a hopper. They get heated and melted into liquid resin and then forced into a cavity to fill it (Fill Stage). This is when the shrinkage starts to take place. To minimize the shrinking, additional liquid resin is forced into the cavity under constant pressure (Pack Stage). The plastic starts to solidify in the mold, and within a few seconds when it reaches the ejection temperature (Cool Stage), it is then ejected from the mold.

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Options

Customize.

Button Size

Save/Restore Settings..

Add-Ins..

This lesson will walk us through the 5 basic steps of performing the flow analysis: Injection Location, Mesh, Material, Run and View the analysis results.

1. Opening a part document:

Click File, Open.

Open the part document named: Plastics_Flow Analysis.sldprt

(This model has 2 configurations: With Runner & Gate and Without Runner & Gate. The Without Runner & Gate is the active configuration).



Click the drop down arrow next to the gear symbol (Options) and select **Add-Ins** (arrow).

Under SOLDWORKS Add-Ins, enable the checkbox for **SOLIDWORKS**-**Plastics** (arrow).





Two new tabs: **SOLIDWORKS Plastics**

and Analysis Preparation are added to the CommandManager.

3. Setting up the Mesh:

Switch to the **SOLIDWORKS Plastics** tab and select: **New Study** (arrow).

For Study Name, enter: Flow Analysis.

For Analysis Procedure, select: Shell (arrow).

Click OK.

A PlasticManager tree appears on the left side of the screen.

4. Viewing the PlasticsManager tree:

The PlasticsManager tree contains the information regarding the simulation study such as:

* Domains

Represents a volume in space through which you simulate a heat or fluid flow.

* **Boundary Conditions** Settings for specifying the injection location.

* Shell Mesh

The shell analysis procedure requires a shell mesh, which is appropriate for thin-walled parts with uniform thickness.

Several other tools such as Material, Process Parameters, Run, and Results will be added to the PlasticsManager tree <u>after</u> the Shell Mesh is created.









5. Adding an Injection Location:

Injection locations introduce polymer material at the specified melt temperature into the cavity.

Expand the **Boundary Condition** feature and double click on **Injection Location** (arrow).



For injection location, select the <u>sketch point</u> as noted (3D Sketch1).





(A red conical pointer appears at the injection location. Its diameter can only be changed using the solid analysis procedure).

Click OK.

The Injection Location is captured and saved under the Boundary Conditions section.



6. Creating a mesh:

A mesh subdivides each domain of the simulation model, the cavity, runner system, cooling channel, inserts, and mold, into discrete cells.



Within each cell, SOLIDWORKS applies the appropriate conservation equations. The conservation equations compute the flow of melted polymer and heat, simulate phase change as the melt cools, and predict residual stresses and their effect on the unconstrained part shape.

For Surface Mesh, use the **default** mesh density.





For Refinement Method, select Curvature-Based.

Click Create.

Click OK.

A green check mark on the Shell Mesh node indicates that a shell mesh is created.

After a shell mesh is created, several commands appear under the Shell Mesh node. Right-click on the Shell Mesh icon to access these commands.



7. Selecting a Polymer:

The default material data base offers thousands of materials and the polymers are organized by the family and company. They can be applied to the mold cavities and mold inserts.

From the **PlasticsManager** tree, expand the **Material** option and double click on **Polymer** to Open Database.



Select the following:

Default Database, Sort by Family, ABS, 22 (P) BASF / ABS6003 (arrows).



Click OK.

Depending on the material selected for the cavity, insert, mold, or cooling channel domain, the complete list of material properties appears in the selected material's dialog box.

At this point, the information needed to run an analysis is completed. The next step is to run the flow analysis and interpret the results.

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8. Running the Flow Analysis:

Analysis Program

Display Partial Results

Close after finished

Always on top

The cells have filled 50 % The processing at time = 0.49 sec The max. injection pressure = 12.84 Mpa (1.86e+003 psi)

The cells have filled 60 % The processing at time = 0.62 sec The max. injection pressure = 15.80 Mpa (2.29e+003 psi)

Warning: Closing the active SOLIDWORKS part file will terminate the analysis.

Show Log

SHELL - FLOW/PACK

🚯 Analysis Manager

Without Runner & Gate

Suspend

Resume

Help

Model

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From the **PlasticsManager** tree, expand the **Run** feature. Right-click **Flow** and select: **Run** (arrow).

The Analysis Manager dialog-box appears and the analysis is started. This analysis may take several minutes.

Execution State

Running

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When the analysis is completed, the Flow Results are displayed on the left side of the Plastics-Manager tree. We will take a look at some of them in the next steps.

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Features Sketch Surfaces Evaluate A	nalysis Preparation SOLIDV	WORKS Plastics	P 15 4 11 8 18 .	🗊 - 🕸 - 🛞 🔬 - 🕎 -		S Results Adviser X
	 Plastics_Flow Analysi 	is (W				Address BREND
	Max : 1.1873 sec		FLOW/ Fill Time		Tune - Shell	This part can be successfully filled o
Results (2)					Element : 2335/ Node : 11672	with an injection pressure of 38.3 II MPa (5553.76 psi).
~	1.0034				Material : ABS	The injection pressure required to fill is less than 66% of the
Flow					Configuration : 1	specified for this analysis, which
Available Results						specified limit. v
Fill Time Pressure at End of Fill						Fill Time:
Central Temperature at End of Fill Average Temperature at End of Fill						The fill time plot displays the profil
Bulk Temperature at End of Fill Flow Front Central Temperature	0.8029					of the plastic melt as it flows through the mold part cavity during
Shear Stress at End of Fill						the filling stage of the injection molding process. The blue region
Volumetric Shrinkage at End of Fill Frozen Layer Fraction at End of Fill						indicate the start or beginning of the flow front. The red regions indicate
Cooling Time Temperature at End of Cooling						either of the following: • The flow front position at any
Gate Filling Contribution						given time interval during an animation of the filling
Velocity Vector at End of Fill						stage • The end of fill when the flow
Weld Lines	0.6024					has stopped, even if the software detects a short
Air Traps						shot
1.1873	0					-
0.00080779						
Clipping Options	0.4019					-
8						
Animation ^						
a						
	0.2013					
Report Options						Two views of the same part with a centrally located injection location.
						The filling pattern radiates out fron the center (blue) to the end of fill
						(red) located at each corner of the part. Since till time is a function of
						flow length (among other things), the corners that are the furthest
	8.078e-04					away from the injection location ar the last to fill. The color scale
	TX					located to the left of the part indicates the time it takes for the
	Y					flow front to reach a given region o ♥ the cavity
	12					× >
Model 3D Views Motio	on Study 1					
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9. Viewing the Fill Time plot:

Use the **Fill Time** plot to view the profile of the liquid plastic as it flows through the cavity of the mold. The **blue** color regions are the first areas to fill and the **red** are the last one to fill.



The Isoline Mode available for Shell Mesh, indicates where particular value is constant.

Under **Clipping Options**, click the **Isoline** button (arrow).

The Isoline Mode only available for Shell Mesh. Isoline plots the regions of plastic material where results fall within the range of min and max values.

The maximum and minimum values of the results shown on the active plot and the **Results Adviser** appears on the right side indicating the part can be successfully filled with an injection pressure of 38.3 MPa (5553.76 psi).



10. Animating the results:

In the same **Results** window, under **Animation**, click **Play** (arrow).



The melt flow front position is animated showing the filling stage. Use the tools in the Animation section to control the animation speed, to pause, stop, or loop the animation.

Starting from the Injection Location, the **blue** color areas get filled first and the **red** color areas are filled last.

Click the **Stop** (square) button to stop the animation but keep the Results dialog box open for the next step.

11. Displaying the Weld Lines:

Weld Lines are formed when two or more flow fronts come together. They appear when there are multiple injection locations or multiple wall thicknesses in the part. To avoid the weld lines, either move the injection locations or make changes in the plastic part, but they cannot be eliminated if there are through holes in the part.

Click **Control** + 6 to change to the bottom orientation.

8 🕙 😳 · · \oplus 8 Max: 147.0200 deg Min : 2.8000 deg Results ? ~ deg 147.0200 Flow Available Results Pressure at End of Fill Central Temperature at End of Fill Average Temperature at End of Fill Buik Temperature at End of Fill Flow Front Central Temperature Temperature Growth at End of Fill Shear Stress at End of Fill Shear Stress at End of Fill Volumetric Shrinkage at End of Fill Frozen Layer Fraction at End of Fill Cooling Time Pressure at End of Fill 118.1760 Cooling Time Temperature at End of Cooling Sink Marks Gate Filling Contribution The plot displays the weld line locations and the angle 89.3320 Ease of Fill of the flow field as the weld line form. Velocity Vector t End of Fill Weld Lines Air Traps 🖹 🕁 🕙 🐼 4 1 ⁺┣ 147.02 \$ 👰 Configuration : Default [Flow Analys 60.4880 The Boundary Conditions (Geometry .,_____ 2.8 🕨 🕜 Mesh ▶ Q₃⁶ Material Clipping Options ♦ 60 Process Parameters Image: Image:

Click the Weld Lines checkbox (arrow).

Click **OK** to close the Flow Results.

Under Results, double-click the **X-Y Plot** (arrow). The X-Y plots are used to visualize key results such as the evolution of the Clamp force as a function of the cycle time, or to view pressure buildup at the injection point.



Advisor

Flow Results

💐 X-Y Plot

Display Setup

Summary and Report

Remove All Results

Run
 Results

Click **OK** to close the X-Y Plot option.

12. Viewing the results:

Double-click on Flow Results to see all other result plots.

► 💭 Run	
✓ Results	
Flow Results	
X-Y Plot	
Summary and Report	
🙀 Export	
🕎 Remove All Results	
> 🔄 Display Setup	

The Fill Time results



The Pressure at End of Fill results





The Central Temperature at End of Fill results

The Average Temperature at End of Fill results





The Bulk Temperature at End of Fill results

The Flow Front Central Temperature results





The Temperature Growth at End of Fill results

The Shear Stress at End of Fill results





The Shear Rate at End of Fill results

The Volumetric Shrinkage at End of Fill results





The Frozen Layer Fraction at End of Fill results

The Cooling Time results





The Temperature at End of Cooling results

The Sink Marks results





The Gate Filling Distribution results

The End of Fill results



At this point, the Green color in the part indicates that it should be filled easily based on the references such as: Material, Injection Location and other parameters provided.

13. Saving your work:

Select Files, Save As.

Enter: Plastics_Flow Analysis_Completed.sldprt for the file name.

Click Save.

