

Autodesk® Moldflow® Insight 2012

AMI Profiles

Autodesk®

Revision 1, 18 March 2012.

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Profiles

1

Profiles are used to ensure that the simulation matches the actual molding process as accurately as possible.

Ram speed, velocity or filling profiles are used in the filling phase to control the movement of the screw. Pressure or packing/holding profiles are used in the packing/holding phase to control the packing and holding pressure applied to the mold. The change from velocity to pressure profile control occurs when the velocity/pressure switch-over point is reached. Both types of profiles help reduce mold defects such as flashing, short shots, jetting, burning, sink marks, warpage, flaking, and more.

Temperature profiles are used to simulate the surface temperature of zones of the mold through the injection cycle.

Gas profiles are used to control the injection of gas when simulating gas injection molding.

Changes in the filling profile are typically set to correspond with changes in the mold geometry taking into account the flow restrictions inside the mold. The aim of profiling is to maintain a constant flow front. When the flow front reaches a cross sectional constriction within the mold, the rate of injection (screw velocity) should be reduced. It should be increased when the cross sectional area at the flow front increases. This is important when the flow front reaches the gate. If the melt is injected too fast, it can result in jetting, burning, flaking, melt degradation and surface defects. A common approach is to use a high screw velocity while the melt is moving through the runner system to avoid cooling of the flow front, reduce the velocity when the flow front approaches the gate, and finally increase the velocity once the melt is filling the part.

The velocity should be reduced when the flow front reaches the end of filling to prevent overpacking of the cavity, which may cause stress problems, warpage, and flashing. This facilitates a smooth transition to the packing phase where a pressure profile is used to ensure uniform shrinkage, reduce warpage, and to pack the part well without overpacking.

Linear and constant profiles can be used in the filling phase and the packing phase.

You can also choose to use a relative or absolute velocity profile.

Profiles

Use a profile dialog to edit profile settings.

Editing profiles

The **Filling Control Profile Settings** dialog is used to enter filling profiles to vary the ram movement during filling.

The **Pack or Holding Control Profile Settings** dialog is used to enter packing and holding profiles to vary the pressure applied to the cavity during the packing and holding phases of the injection molding process.

The **Mold surface temperature profile** dialog is used enter the mold surface temperature profile of a zone throughout the injection molding cycle.

You can use the following shortcuts to enter or change values in the displayed profile:

Function	Method
To delete a row	Select the row number, and then use your keyboard Delete key
To insert an empty row	Highlight a row, and then use your keyboard Insert key. An empty row will be inserted above the selected row.
To edit a cell	Select the cell, or press F2
Navigation	Use these Keyboard keys for navigation: Page Up , Page Down , Home , End , and the cursor keys.

NOTE: A cell must contain a number at all times, and **0** can be used.

Types of profiles

2

Profiling operating parameters can give greater control over the final product. Different profiles can be modeled to ensure an accurate analysis.

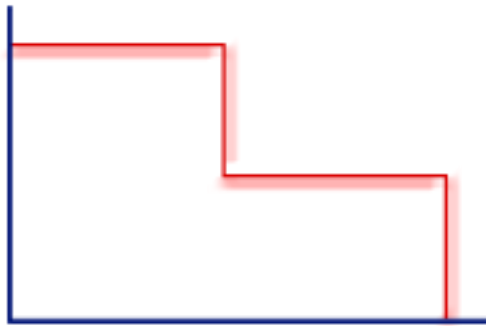
The following profiles can be incorporated:

- Ram speed or filling profiles, which are used to vary the screw movement during the filling phase.
- Pressure or packing profiles, which are used during the packing phase.
- Temperature profiles, which are used where you have the ability to control the temperature of specific zones of the mold surface through the cycle time.
- Gas profiles, which are used to control the rate of gas injection in Gas-injection analyses.

Profiles are specified as a series of steps. You can create a mixed profile, which has sections of both constant and linear adjustment of the parameter profile.

Constant profile

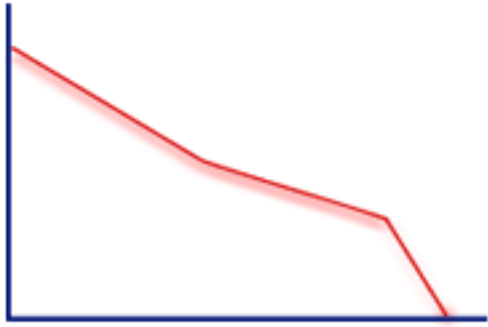
A constant profile specifies steps with a constant value, for example, a constant pressure or screw movement as shown in the following diagram.



NOTE: To create a stepped constant profile, you must enter steps with a duration of **0** seconds.

Linear profile

A linear profile specifies a change in parameter value, which increases or decreases linearly during the step, as shown in the following diagram.



Linear profiles

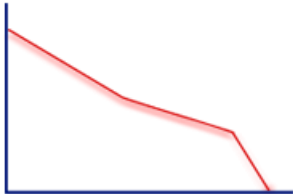
3

Linear profiles specify operating parameters, such as pressure or flow rate, which increase or decrease in a linear manner through a step.

Profiling operating parameters can give greater control over the final product. Factors such as warpage can be reduced by profiling the packing pressure over time. Autodesk Moldflow profiles are used to simulate these adjustments.

Profiles are defined in the Process Settings Wizard (**Home tab > Molding Process Setup panel > Process Settings**) by a table outlining how the parameter is to change through the cycle. If a **Packing pressure vs time** profile is specified with the values in the following table, a profile that looks similar to the following diagram will result.

Time	Packing pressure
0	150
5	130
10	120
12	100




Constant profiles

4

Constant profiles specify operating parameters, such as pressure or flow rate, which have a constant value through a step.

Profiling operating parameters can give greater control over the final product. Factors such as warpage can be reduced by profiling the packing pressure over time. Profiles within the Autodesk Moldflow product are used to simulate these adjustments.

Constant profiles can have a stepped value incorporated. Profiles are defined in the

Process Setting Wizard ( **Home tab > Molding Process Setup panel > Process Settings**) by a table outlining how the parameter is to change through the cycle. If a **Packing pressure vs time** profile is specified with the values in the following table, a profile that looks like the following diagram will result.

Time	Packing pressure
0	150
5	150
5	125
10	125
10	100



In this example, the time value is duplicated to achieve the vertical step, and the packing pressure value is duplicated to achieve the horizontal step.

NOTE: A profile can have both constant and linear sections.

Absolute and relative filling profiles

5

There are two fundamentally different ram speed or filling profiles.

If you have not selected an injection molding machine, you can use a relative ram speed profile. If you know key machine parameters, such as screw diameter and maximum injection rate, you can use an absolute ram speed profile.

A cushion warning limit can be entered, but it does not affect the profile. The cushion is the distance between the forward screw position and the zero screw position, which contains polymer left in the barrel after the cavity is filled. Most of the melt in the cushion is then used for compensation flow during the packing stage. If the screw moves past the cushion warning limit during an analysis, a warning is produced.

Unless you have configured specific molding machine limits, the default settings in the following table are used.

5000 cm ³ /s	Maximum machine injection rate
180MPa	Maximum machine injection pressure
7000 ton	Maximum machine clamp force

NOTE:

- The pressure profile is begun when the velocity/pressure switchover point has been reached.
 - If you enter a profile that injects less material than the cavity contains, the end of the filling profile is reached before the specified velocity/pressure switchover point occurs. When this happens, the velocity/pressure switchover occurs early, and the pressure profile is begun. The velocity/pressure switchover may also occur early due to material compression when a high pressure is required to fill a part.
-

Relative profiles

Relative profiles apply ram speed as a function of the total shot size or stroke, which are determined from the geometry of the part, the runner system and the gate. Relative profiles are usually used when the actual injection molding machine has not yet been selected.

The following relative ram speed profiles are available.

- Flow rate vs % Shot volume

■ % Ram speed vs % Stroke

In a relative ram speed profile, 100 percent stroke indicates the position of the screw after plastication when it is ready to start the shot, and zero percent stroke indicates the position of the screw at the end of injection. A shot volume of 100 percent corresponds to when the part is completely filled, and zero percent shot volume indicates the injection has not yet started.

NOTE: If you have input a maximum percentage stroke value that is less than 100, or a minimum percentage stroke value that is more than zero, the profile will be extended by using the percentage ram speed values of the closest data entries. For example, the profile in the following Table 1 will be extended to the profile in Table 2.

Table 1: Original profile

% stroke	% ram speed
80	75
60	100
40	50
20	10


Table 2: Profile extension

% stroke	% ram speed
100	75
80	75
60	100
40	50
20	10
0	10

Absolute profiles

Absolute profiles are used when key machine parameters are known, such as screw diameter and maximum injection rate. By running an analysis with an absolute ram speed profile, you can compare simulation results with actual results obtained using the molding machine.

Absolute ram speed profiles use the following machine settings in the injection

molding machine properties. You can get to this dialog by selecting  **Home tab > Molding Process Setup panel > Process Settings** , select **Advanced options**, edit the **Injection Molding Machine**, select the **Injection Unit** tab, then enter the **Screw diameter**.

The stroke or ram position is measured as a positive value, offset from the point where the ram cannot move any further forward because it has hit the barrel end. The starting ram position defines the shot size. If this ram position in the profile does not match the shot size, the profile will be extended to or cut off at the starting ram position value.

Zero or negative velocities in absolute profile steps are ignored.

The following absolute ram speed profiles are available:

- Ram speed vs ram position
- Flow rate vs ram position
- % Maximum ram speed vs ram position
- Ram speed vs time
- Flow rate vs time
- % Maximum ram speed vs time


Absolute and relative filling profiles

A filling profile can improve the quality of the finished part.

Specifying a filling profile

A filling profile is used to specify the movement of the ram during the filling phase of the molding cycle.

Filling profiles should cover the time until the velocity/pressure switch over point, at which time the packing/holding profile will begin.

- 1 Ensure that you have selected an analysis sequence that includes **Fill + Pack**.
- 2 Click  **Home tab > Molding Process Setup panel > Process Settings**, or double-click the **Process Settings** task in the **Study Tasks** pane.
- 3 You may need to select **Next** to step to the **Fill + Pack Settings** page of the **Process Settings Wizard**.
- 4 Set the **Filling control** option to **Relative ram speed profile** or **Absolute ram speed profile**, and choose a **by** method from the drop-down list of options.
- 5 On the **Fill + Pack Settings** page, select **Edit Profile** in the **Filling control** group.
- 6 Enter data into the table to describe the required filling control profile. You can use the table by clicking on each box and entering the profile data.

NOTE: In order to specify a constant profile, you must specify instant profile steps, that is, steps with a duration of 0 seconds.

- 7 Click **Plot Profile** to preview the profile you have entered.


- 8 Click **Close** to close the plot profile, then click **OK** to close the **Filling Control Profile Settings** dialog.
- 9 Click **OK** to close the **Process Settings Wizard**.

Absolute and relative filling profiles

Use these dialogs to specify filling parameters during the filling phase of the injection molding process.

Filling Control Profile Settings dialog


This dialog is used to input a ram speed profile to describe the movement of the ram during the filling phase of the injection molding process. The parameters used to define a ram speed profile differ between different models and makes of injection molding machines. Therefore, a varied selection of input methods are available. Examples of how to enter data for the input methods are provided.

To access this dialog, ensure that you have selected an analysis sequence that includes Fill or Fill+Pack, click  (**Home tab > Molding Process Setup panel > Process Settings**), if necessary click **Next** one or more times to navigate to the **Fill Settings** or **Fill+Pack Settings** page of the Wizard, set the **Filling control** option to **Absolute ram speed profile** or **Relative ram speed profile**, then click **Edit profile**.

%Flow rate vs %shot volume	Controls the speed of the ram (flow rate) as a function of the ram position (shot volume).
Reference	Allows you to set a reference point for the specified ram speed profile.
Stroke volume	Specifies the stroke volume of the injection molding machine.

Stroke Volume Settings dialog

This dialog is used to specify the stroke volume for a ram speed profile based on %Shot volume vs %flow rate, or %Stroke vs %ram speed.

To access this dialog, ensure that you have selected an analysis sequence that includes Fill or Fill+Pack, and click  (**Home tab > Molding Process Setup panel > Process Settings**). If necessary click **Next** one or more times to navigate to the **Fill Settings** or **Fill+Pack Settings** page of the Wizard. Set the **Filling control** option to **Relative ram speed profile**, and select a profile. Click **Edit profile**, and set the **Stroke volume** option to **Specified**. Click **Edit settings** and the **Stroke Volume Settings** dialog will open.

Machine screw diameter	Specifies the size of the injection molding screw on the molding machine.
Stroke length	Enter the stroke length, or, the distance (mm) that the injection molding machine screw will move during the filling phase of the cycle.

Packing profiles

6

The efficacy of thermoplastic packing has important effects on warpage, shrinkage, and the incidence of defects, such as sink marks. The main output of a Pack analysis is volumetric shrinkage, and the distribution and magnitude of volumetric shrinkage play a key role in part quality.

A Pack analysis should be performed after the part has been optimized for filling, the runners have been sized and balanced and, preferably, a Cool analysis has been run. In addition to the inputs for a Fill analysis, the following three inputs are required to run a Pack analysis:

- Packing time
- Packing pressure
- Cooling time

Determining a suitable packing pressure

The packing pressure is used to pack out a part and is often related to the fill pressure. As a rough guide, the packing pressure should be about 80 percent of the fill pressure; however, the packing pressure can vary significantly. Packing pressures are commonly between 20-100 percent of the fill pressure, and can be higher or lower. An important aspect of the packing pressure is that it cannot be so high that it exceeds the clamp limit of the machine.

The following formula is used to estimate the maximum pressure that should be used. This formula will determine a pressure, assuming a constant gradient across the part so that 80 percent of the machine capacity will be used. This is a conservative approach, but this can be used as a starting point.

$$P_{max} = \frac{\text{Clamp force} \times \text{tonnes}}{\text{Total projected area of model} \times 100} \times 0.8$$

Determining a suitable packing time

You can repeatedly check the part weight and increase the packing time to identify the time at which the gate freezes. Gate freeze occurs when the part weight no longer increases. For example, set a two-second packing time followed by a second analysis with a four-second packing time. If the part weight increases, gate freeze occurred after two seconds. Repeat the analysis, increasing the packing time until the part weight remains stable.

Optimizing a packing profile

Warpage is caused by a variation in shrinkage, so when shrinkage is reduced, warpage also is reduced.

The filling and cooling of the part should be optimized to create a packing profile. Because the way in which part is cooled influences the packing, the packing profile should be based on a Cool+Fill+Pack analysis sequence, which accounts for the effects of mold cooling in the Fill+Pack results.

The size of the part and the type of material used will determine the range of shrinkage. Larger parts will normally have a larger acceptable range of shrinkage. Because warpage is caused by a variation in shrinkage, the volumetric shrinkage of a part influences both the potential warpage and dimensional stability of a part. If a part shrinks uniformly, it changes in size, but injection molded plastics do not shrink uniformly. The amount of warpage is reduced when the volumetric shrinkage is minimized. The range of volumetric shrinkage across the part has an effect on warpage that is beyond the effect of the magnitude of shrinkage.

With a typical part, dimensions are smaller and incidences of sink marks and voids near the end of fill are higher. Alternatively, the opposite is true near the gate where you can expect larger dimensions, and fewer and smaller sink marks and voids, which is due to the amount of packing. Typically, the area around the gate is packed much better than the end of fill. This variation in shrinkage between the end of fill and the gate area can cause warpage. A small distribution in shrinkage across the part causes the properties across the part to become more uniform.

Uniform volumetric shrinkage requires the pressure in the cavity to be controlled. Volumetric shrinkage is a function of the pressure on the plastic when it freezes off; the higher the pressure, the lower the shrinkage. Normally there is a wide variation in shrinkage across the part because of the high pressure gradient. The viscosity of plastic is high, so the resulting pressure gradient prevents the area near the end of fill from having a pressure equal to the pressure around the gate; therefore, the shrinkage at the end of fill is normally higher than around the gate. The amount of shrinkage can be controlled if the pressure is lowered over time during the packing phase of the cycle. This can be done after areas at the end of fill have frozen off, and while areas closer to the gate are still cooling. The freeze front is moving from the end of fill towards the gate, so the lower pressure near the gate results in shrinkage similar to the shrinkage near the end of fill.

The extent to which this technique is useful depends on the size of the part and gate, the type of material, the molding conditions used to fill the parts, and the wall thickness variation in the parts. The two basic methods of packing are using a constant pressure and using a linear pressure profile to vary packing pressure. With constant packing pressure, the machine is applying a uniform amount of pressure for a specified time. Some machines change the magnitude of pressure once but the new pressure is held constant at the new level.

Profiled packing is a linear decay in the packing pressure over time after a period of constant pressure, as shown in the following graph. When properly applied, packing profiles produce a more uniform volumetric shrinkage in the part. Profiles improve the shrinkage distribution by evening out the pressure distribution in the part. This is because the less pressure applied to the part the higher the shrinkage. In effect, a packing profile is designed to achieve an acceptable amount of volumetric shrinkage at the end of fill, and achieve that same level of shrinkage throughout the part.

(a) Pressure [MPa], **(b)** Time [Sec],  Constant Pressure,  Pressure Profile.

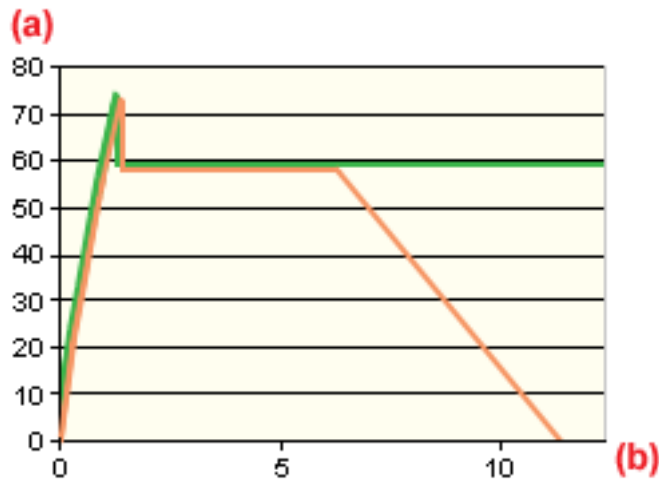


Figure 1: Packing Methods

Packing profiles are used when the injection molding machine is capable of producing profiles. If the part wall thickness changes significantly, a packing profile may not be beneficial. The thicker the wall, the higher the pressure required to have the same volumetric shrinkage as a thinner wall. The main reason for using packing profiles is that they reduce part warpage when the warpage is caused by area shrinkage variation.

NOTE: To summarize the process of optimizing a packing profile, obtain an acceptable amount of volumetric shrinkage at the end of fill, then achieve that same level of shrinkage throughout the part by reducing the pressure over time.

Packing profiles


A packing profile can improve the quality of the finished part.

Specifying a packing profile

A packing/holding profile is used to control the packing and holding phases of the molding cycle. You can use either hydraulic pressure, packing pressure, a filling pressure factor, or % Maximum machine pressure to specify the pressure in the packing/holding profile. The profile only needs to describe the time when a packing pressure is applied.

It is used after the velocity/pressure switchover point has been reached at the end of filling. Packing profiles are used to control the volumetric shrinkage distribution, and to avoid overpacking and related problems. The profile only needs to describe the time when a packing pressure is applied.

NOTE: You do not need to enter the cooling time in a packing profile.

- 1 Ensure that you have selected an analysis sequence that includes **Fill + Pack**.
- 2 Click  **Home tab > Molding Process Setup panel > Process Settings**, or double-click the **Process Settings** task in the **Study Tasks** pane.
- 3 You may need to select **Next** to step to the **Fill+Pack Settings** page of the **Process Settings Wizard**, and then click **Edit profile...**
- 4 Enter the packing profile data into the table provided. The left-hand column represents the time in seconds, and the right-hand column pressure values.

NOTE: In order to specify a constant pressure profile, you must specify instant profile steps, that is, steps with a duration of 0 seconds.

- 5 Click **Plot Profile** to preview the profile you have entered.
- 6 Click **Close** to close the plot profile, then click **OK**.
- 7 Select **Automatic** from the **Cooling time** drop down menu to have the cooling time calculated during the Fill+Pack analysis, or deselect it to specify the cooling time manually.

NOTE: The cooling time is the additional time after the end of the packing phase. This time allows the part to freeze at at least 80% through the thickness and become solid enough to be ejected.

- 8 Click **OK** to close the dialog.


Packing profiles

Use this dialog to specify parameters during the packing phase of the injection molding process.

Pack/Holding Control Profile Settings dialog

This dialog is used to enter a packing profile to describe the pressure applied to the cavity during the packing phase of the injection molding process.

The parameters used to define a packing profile differ between different models and makes of injection molding machines. Therefore, a varied selection of input methods are available.

To access this dialog, ensure that you have selected an analysis sequence that includes Fill or Fill+Pack, click  (**Home tab > Molding Process Setup panel > Process Settings**), if necessary click **Next** one or more times to navigate to the **Fill Settings** or **Fill+Pack Settings** page of the Wizard, then click **Edit profile** next to the **Pack/holding control** option.

You can use shortcuts to edit the input data.

%Filling pressure vs time	Controls the packing phase of the molding cycle as a function of percentage filling pressure versus time.
Packing pressure vs time	Controls the packing phase of the molding cycle as a function of injection pressure versus time.
Hydraulic pressure vs time	Controls the packing phase of the molding cycle as a function of hydraulic pressure versus time.
%Maximum machine pressure vs time	Controls the packing phase of the molding cycle as a function of percentage maximum pressure versus time.

Temperature profiles

7

Temperature profiles enable you to specify the surface temperature of a specific zone of the mold during the molding cycle.

Temperature profiling has the following uses:

- Enables the input of measured temperatures into an analysis.
- Enables the temperature variation of different zones within a mold to be more closely represented.
- The Cool solver only represents the average temperature of the mold surface throughout the injection cycle. The mold surface temperature variation through the injection cycle can be represented by a temperature profile, but at the expense of additional computational time.
- Rapid heating and cooling techniques can be simulated.

You can select a zone on the mold surface where you want to apply a profile. It is possible to define up to 2500 different zones, each with its own profile.

NOTE:

- A profile can have temperatures that increase and decrease, but if the temperature drops below the transition temperature (T_{trans}) of the material it must remain below this value for the rest of the profile.
- If the cycle time is longer than the specified profile, the last temperature specified will apply for the balance of the cycle.

The following three mold temperatures can be used:

- Cool analysis temperature result
- Local temperature profile
- Global Mold surface temperature as set in the **Process Settings Wizard**

If you have run a Cool analysis, the resultant mold temperature will override any temperature profiles you have set, and it also will override the global Mold surface temperature.

A temperature profile will override the global Mold surface temperature in the zone to which the profile applies. Outside that zone, the global Mold surface temperature applies.

NOTE: Mold temperature profiles do not support hot runners.

Temperature profiles

The mold surface temperature can be represented by a temperature profile which defines how the temperature varies over time.

To correctly apply a temperature profile, the following points must be considered.

- If the injection cycle time is longer than the total profile time, the last temperature specified will apply to the balance of the cycle time.
- When defining a profile, the time component must be entered in ascending order.
- A profile can have temperatures that increase and decrease, but if the temperature drops below the transition temperature (T_{trans}) of a thermoplastic material, it must remain below this value for the rest of the profile.
- Ensure that a **Fill + Pack** analysis sequence has been selected.
- A **Cool** component in an analysis sequence will invalidate any temperature profiles specified.

CAUTION: If you modify an existing profile, all zones previously assigned with that profile will be modified as well.

Specifying a temperature profile (Midplane & Dual Domain)

- 1 Click and drag on the area where the temperature profile is to apply.
- 2 Right click on the highlighted area and select **Properties** from the menu that appears.
The **Part surface** dialog appears.
- 3 Select the **Mold Temperature Profile** tab.

For a Midplane model, the following steps may need to be repeated for both the top and bottom surface.
- 4 Click **Select**.
The **Select mold surface temperature profile** dialog appears.
- 5 Choose the profile to assign to the selected surface area. If you need to define a new profile, choose **Mold temperature profile**.
- 6 Click **Select**.
The **Part surface** dialog re-appears.
- 7 Select the required profile from the drop-down box.
If the profile does not require editing, click **OK** to exit the dialog.
- 8 Click **Edit**.
The **Mold surface temperature profile** dialog appears.
- 9 Enter the temperature profile information in the table.

NOTE: When defining a profile, the time component must be entered in ascending order.

NOTE: If the injection cycle time is longer than the total profile time, the last temperature specified will apply to the balance of the cycle time.

NOTE: A profile can have temperatures that increase and decrease, but if the temperature drops below the transition temperature (T_{trans}) of the material it must remain below this value for the rest of the profile.

CAUTION: If you modify an existing profile, all zones previously assigned with that profile will be modified as well.

- 10 Enter a suitable name for the temperature profile, if required, and click **OK** twice to exit the dialog.

Specifying a temperature profile (3D mesh)

- 1 Click and drag on the model to select the entities on which the temperature profile is to apply.
- 2 Right-click on the selected entities and select **Properties**. The **Part (3D)** dialog appears.
- 3 Select the **Part Surface Properties** tab.
- 4 From the **Mold surface temperature** list, select **Profile**.
- 5 Click **Select**. The **Select mold temperature controller** dialog appears.
- 6 Select a profile from the **Mold surface temperature** list.
If the required profile does not appear in the list:
 - a Click **Select** to browse for a predefined profile; for example, you can choose a profile that you saved in another study.
 - b Click **Select** to confirm the profile selection and return to the **Select mold temperature controller** dialog.
- 7 If necessary, click **Edit** to make changes to the selected profile or define a new profile. The **Mold surface temperature** dialog appears.
- 8 Edit the temperature profile information in the table; specify a suitable name if you are defining a new profile.

NOTE: When defining a profile, the time component must be entered in ascending order.

NOTE: If the injection cycle time is longer than the total profile time, the last temperature specified will apply to the balance of the cycle time.

NOTE: A profile can have temperatures that increase and decrease, but if the temperature drops below the transition temperature (T_{trans}) of a thermoplastic material, it must remain below this value for the rest of the profile.

CAUTION: If you modify an existing profile, all zones previously assigned with that profile will be modified as well.

- 9 Click **OK** to save the profile and return to the **Select mold temperature controller** dialog.
- 10 Ensure the required profile is selected from the **Mold surface temperature** list and click **OK** twice to exit the dialog.

Gas injection profiles

8

Gas injection profiles are used in gas injection molding to control the velocity of the gas, which in turn controls the velocity of the polymer flow front.

A filling profile is used to control the polymer injection. There is often a delay between the end of the polymer injection and the start of the gas injection to allow time for the material in the mold to cool a little. Gas is injected to complete the filling stage and to maintain pressure during the packing stage.

As the gas displaces the polymer, there is less polymer between the gas front and the polymer flow front; therefore the gas pressure required to push the polymer through the mold to finish filling reduces over time. The image below illustrates how the distance between the gas front and polymer flow front becomes less over time.



Using a constant gas pressure during the gas injection will increase the shear heating of the polymer as it is pushed by the gas to fill the mold. As the polymer injection is typically very fast, this is difficult to profile. Using profiles to taper the gas injection pressure in the remaining filling phase and in the packing phase helps prevent the following problems:

- Surface defects
- Inconsistent wall thickness
- Gas fingering into the walls
- Structural defects
- Flashing

You can specify gas injection profiles to start after a short delay by using a pressure that is less than the polymer injection pressure. The gas pressure is then reduced over the remaining filling and packing phases.

The following graph and table show a relative gas profile where the gas injection is specified by the gas volume controller. The graph shows the change from filling profile to gas injection profile. There is a 0.2 s delay between the end of the polymer injection and the start of the gas injection. The percentage duration of the gas injection is shown above the graph.

NOTE: Gas injection profiles do **not** include the polymer injection profile or the delay between polymer injection and gas injection.

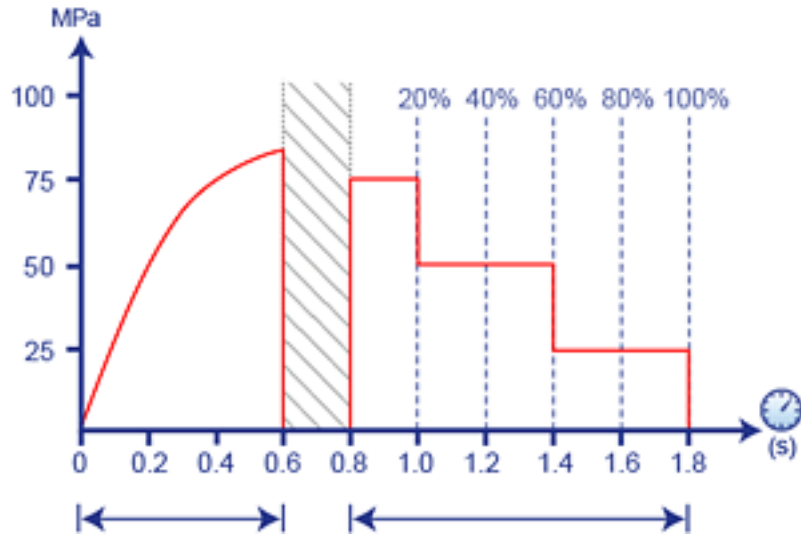


Figure 2: (0–0.6 s) Polymer injection profile, (0.8–1.8 s) Gas injection profile by gas volume control

The relative gas injection profile in the following table is shown in the above graph starting at 0.8 s and ending at 1.8 s.

Gas injection time (%)	Gas volume (%)
0	75
20	75
20	50
60	50
60	25
100	25
100	0

Examples of filling profiles

9

Ram movement during filling either can be automatically calculated, or you can define the movement profile. The variables you can select to define ram movement differ between different models and makes of injection molding machines, so a varied selection of input methods is available.

In absolute filling profiles, a ram position of 0mm corresponds to the position of the screw at the end of injection. Profiles that use ram position should be entered from the position of the screw after plastication when it is ready to start the shot. The screw must not move backwards, so ram position should not increase from one step to the next.

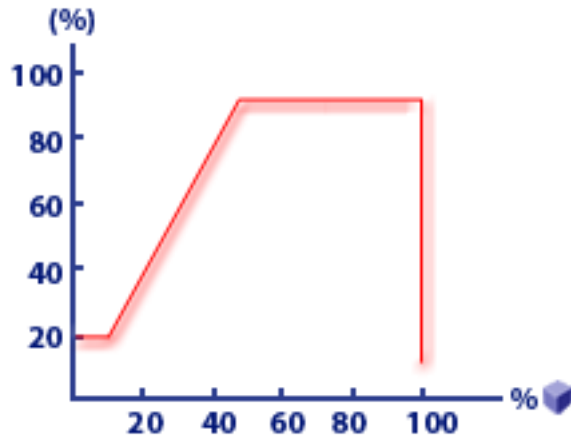
NOTE: Zero and negative velocity values in absolute profile steps are ignored.

The following tables and associated graphs are examples of the values that are required to achieve various filling profiles. These examples use both constant and linear profile steps. To enter a constant profile, you must enter steps with a duration of 0 seconds.

Relative filling profile: percentage flow rate vs percentage shot volume

A shot volume of 100 percent indicates the part is completely filled, and a zero percent shot volume indicates the injection has not started.

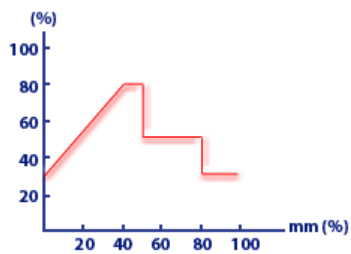
% Shot volume	% Flow rate
0	20
10	20
50	90
100	90
100	10



Relative filling profile: percentage ram speed vs percentage stroke

A stroke of 100 percent indicates the position of the screw after plastication when it is ready to start the shot, and zero percent stroke indicates the position of the screw at the end of injection. Percentage stroke values should be entered in descending order because backwards movement of the screw is not allowed.

% Stroke	% Ram speed
100	30
80	30
80	50
50	50
50	80
40	80
0	30

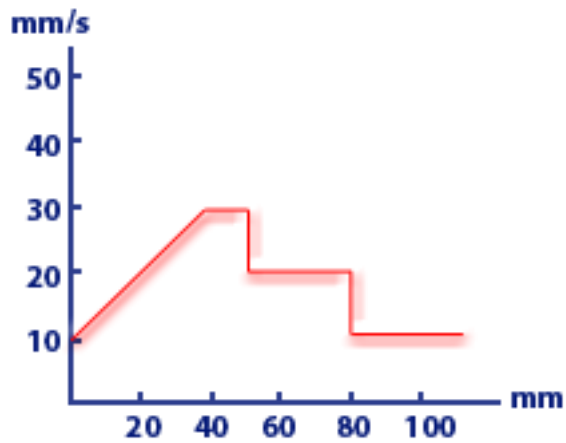


Absolute filling profile: ram speed vs ram position

An arbitrary ram starting position of 110 mm was used in the following example.

Ram position (mm)	Ram speed (mm/s)
110	10
80	10
80	20

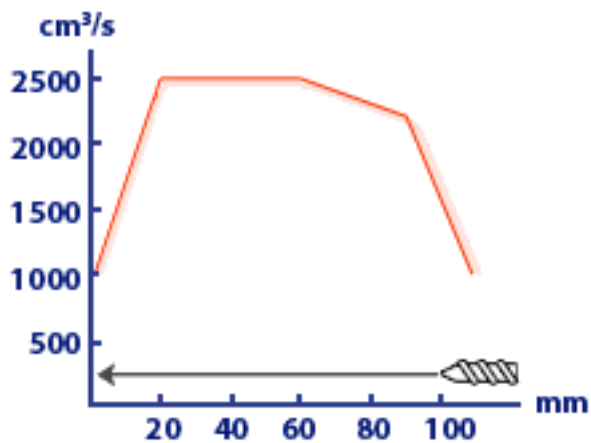
Ram position (mm)	Ram speed (mm/s)
50	20
50	30
40	30
0	10



Absolute filling profile: flow rate vs ram position

An arbitrary ram starting position of 110 mm was used in the following example.

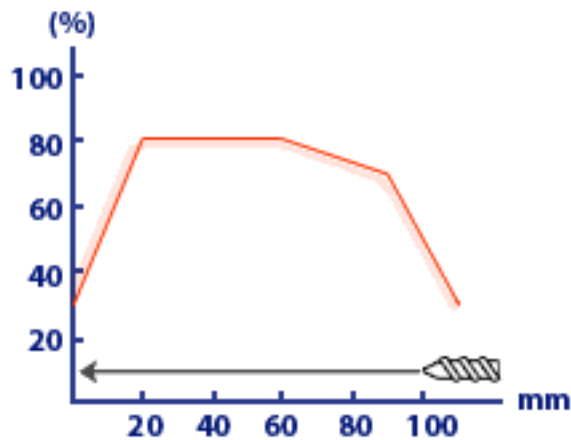
Ram position (mm)	Flow rate (cm ³ /s)
110	1000
90	2200
60	2500
20	2500
0	1000



Absolute filling profile: percentage maximum ram speed vs ram position

An arbitrary ram starting position of 110 mm was used in the following example.

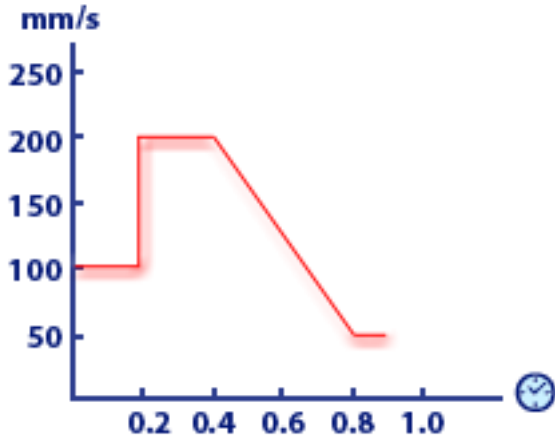
Ram position (mm)	% Max ram speed
110	30
90	70
60	80
20	80
0	30



Absolute filling profile: ram speed vs time

Enter times as absolute times from the start of injection.

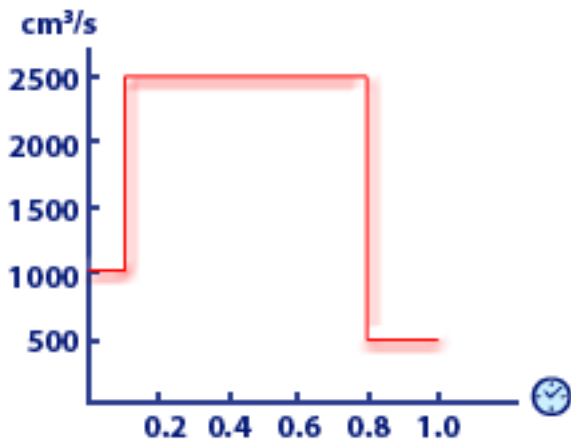
Elapsed time (s)	Ram speed (mm/s)
0	100
0.2	100
0.2	200
0.4	200
0.8	50



Absolute filling profile: flow rate vs time

Enter times as absolute times from the start of injection.

Elapsed time (s)	Flow rate (cm ³ /s)
0	1000
0.1	1000
0.1	2500
0.8	2500
0.8	500

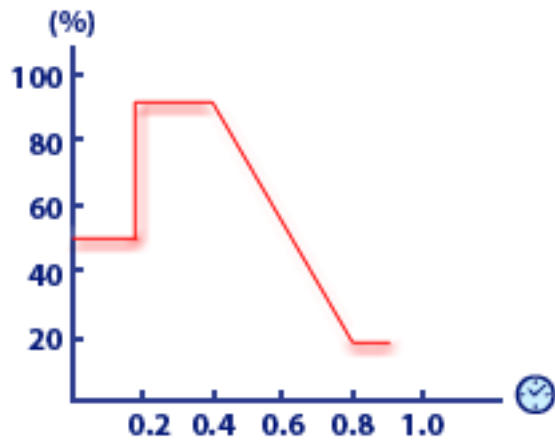


Absolute filling profile: percentage maximum ram speed vs time

Enter times as absolute times from the start of injection.

Elapsed time (s)	% Max. ram speed
0	50
0.2	50
0.2	90

Elapsed time (s)	% Max. ram speed
0.4	90
0.8	20



Examples of packing/holding profiles

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Packing/holding profiles are used during the packing and holding phases to reduce defects in the part due to uneven shrinkage, warpage, and overpacking.

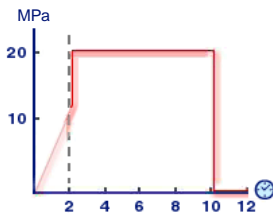
Filling profiles are used during the molding cycle until the velocity/pressure switchover point has been reached. Pressure profiles then begin.

You can use a constant profile or a linear profile.

Following are three examples packing profiles, the tables below each profile provides the values used to achieve them.

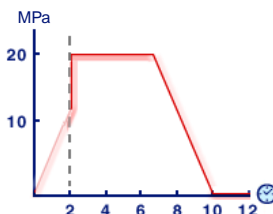
NOTE: The end of fill occurs at 2 sec in the following examples.

Example 1. Constant profile



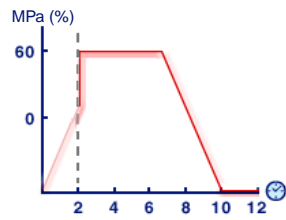
Duration (sec)	Pressure (MPa)
0	20
8	20
0	0

Example 2. Linear profile



Duration (sec)	Pressure (MPa)
0	20
5	20
3	0

Example 3. % Maximum machine pressure vs time (linear profile)



Duration (sec)	Pressure (%)
0	60
5	60
3	0



Examples of temperature profiles

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Combinations of temperature profiles can be applied to the mold surface of a part.

NOTE: If the molding cycle time is longer than the temperature profile time, the last specified temperature will be applied to the remaining time.

In these examples it is assumed that the global mold surface temperature is set at 100°C.

NOTE: The global **Mold surface temperature** is set using the  **Process Settings Wizard** in either the **Fill Settings** or **Fill + Pack Settings** page, or alternatively click  **Home tab** > **Molding Process Setup panel** > **Process Settings** .

A profile can have temperatures that increase and decrease, but if the temperature drops below the transition temperature (T_{trans}) of the material it must remain below this value for the rest of the profile.

Single temperature profile zone



The selected pink zone can be assigned the following temperature profile.

Table 3: First temperature profile

Time (s)	Temperature (C)
0	120
2	120
3	80
10	60

Over the cycle time, the mold surface temperature of this zone will vary as shown ([Figure 3: First temperature profile graph](#) on page 32).

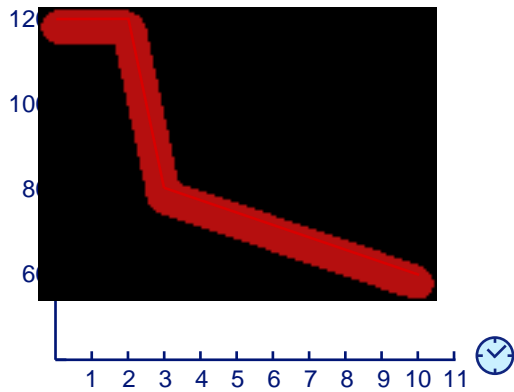
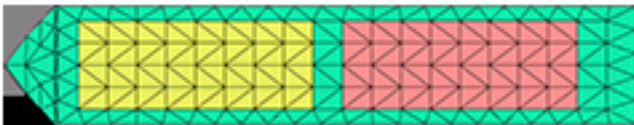


Figure 3: First temperature profile graph

The rest of the part will use the constant global mold temperature of 100°C.

Multiple temperature profile zones



The yellow section of the part has been assigned the same values as specified for the single zone example (*Table 3: First temperature profile* on page 31).

The second pink section of the part has then been selected and has had a different profile applied to it (*Table 4: Second temperature profile* on page 32).

Table 4: Second temperature profile

Time (s)	Temperature (C)
0	110
4	90
9	90
10	70

Over the cycle time, the mold surface temperature of the pink section will vary as illustrated (*Figure 4: Second temperature profile graph* on page 33).

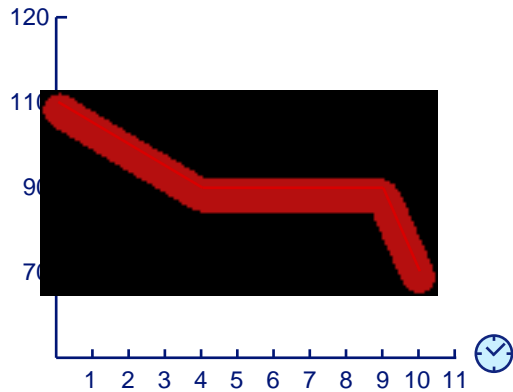


Figure 4: Second temperature profile graph

The yellow section will retain the original temperature profile (*Figure 3: First temperature profile graph* on page 32). The rest of the part will use the constant global mold temperature of 100°C.

It is possible to have up to 2500 different temperature zones on the part, with each zone having its own time/temperature data.

Constant temperature zone

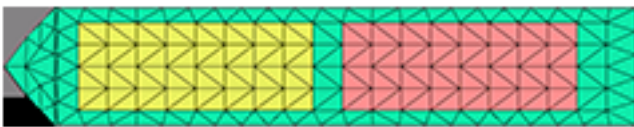
You can assign a constant mold surface temperature to a zone that is different to the global mold surface temperature.

Applying the following profile to the selected zone will result in that part of the mold surface using a constant temperature of 110°C

Time (s)	Temperature (C)
0	110
10000	110

The balance of the part will use the constant global mold surface temperature of 100°C.

Constant and profiled zones



The yellow section of the part can have a mold variable temperature profile specified while the pink section can have a constant mold temperature applied. The balance of the part will use the constant global mold temperature.

It is possible to have up to 2500 different temperature zones on the part, with each zone having its own time/temperature data.