Autodesk® Moldflow Insight 2026

Validation of Solver Changes

Executive Summary

The Autodesk Moldflow 2026 release introduces accuracy, speed and functionality improvements compared to the previous software version.

The accuracy of the Moldflow Insight 3D Warp deflection predictions is improved by improvements to the STAMP shrinkage model and the adoption of STAMP as the default 3D shrinkage model for polymers which have shrinkage characterization data.

The Moldflow Insight 2026 and Moldflow Adviser 2026 software release includes speed improvements in the 3D Flow and 3D Warp solvers, resulting in reduced computational times without compromising solution accuracy. The degree of these speed improvements depends on the complexity of the model and the type of analysis. This report includes a comparative analysis of computational times between Autodesk Moldflow Insight 2025 and Autodesk Moldflow Insight 2026 across various analysis types.

A new capability to perform a mold thermal analysis for the Resin Transfer Molding (RTM) process has been introduced for 3D studies. This includes a new capability to specify different coolant temperatures and coolant flow rates at different stages of the RTM process.

Contents

Executive Summary **1**

Contents **2**

3D Shrinkage Correction by Measured Shrinkage Data **3**

Introduction.. 3

Theory.. 3

Comparison with shrinkage molding data 4

Improvements to STAMP 6

Warp Validation Suite 9

3D Solver Speed Improvements **10**

Introduction.. 10

Methodology.. 10

Speed Comparison Results.. 11

Transient Cool (FEM) analysis for 3D Resin Transfer Molding simulation **13**

Background 13

Temperature control for RTM 13

Moldflow Cool (FEM) analysis for 3D RTM 13

Solver settings.. 13

Cooling stages.. 14

Transitioning between cooling stages.. 14

Examples of predicting the temperatures inside the mold in an RTM process 15

Simulation of a multi-cycle RTM process using *Conduction Solver* 15

Simulation of a single-cycle RTM process using *Flow analysis on every iteration*.. 17

Other Solver Improvements.. **21**

References.. **21**

3D Shrinkage Correction by Measured Shrinkage Data

Introduction

The STAMP (Shrinkage Test Adjusted Mechanical Properties) [1] shrinkage model has been improved in the Moldflow 2026 release and is now the default 3D Shrinkage Model for shrinkage characterized polymers.

The choice of 3D Shrinkage Model is available in the “Shrinkage Properties” tab of the “Thermoplastic material” dialog. (Right-mouse click on the material name in the “Study Tasks” list and select “Edit”)

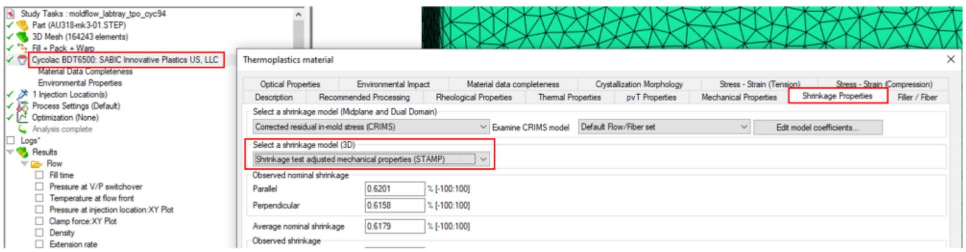


Figure 1: 3D Shrinkage model selection

In the Moldflow 2026 release, thermoplastic polymers which have measured shrinkage data will automatically have STAMP selected as their default 3D shrinkage model. You can change to shrinkage model selection back to the “Uncorrected Residual Stress” shrinkage model if you wish to compare the effect of the STAMP shrinkage calibration. The STAMP shrinkage model provides higher accuracy of shrinkage and warp deflection predictions for 3D parts. This is similar to the benefit of using the CRIMS [2] shrinkage model for Midplane and Dual Domain studies.

The STAMP shrinkage model calibrates mechanical properties by using measured shrinkage data obtained from rectangular plaque moldings. This is the same shrinkage molding data which is also used to calibrate the CRIMS and Residual Strain Shrinkage models for use in Midplane and Dual Domain analyses.

During shrinkage characterization of each polymer, moldings are made at three different plaque thicknesses, with variations in packing pressure, injection speed and melt temperature at each thickness. Due to the unidirectional flow which occurs during the filling of this end-gated cavity, the paired set of directional shrinkage measurements for each sample are described as being in the flow direction and the direction “transverse” to flow. Fiber inclusions are strongly aligned in the flow direction.

This measured shrinkage data is available for over 6000 polymer materials in the Moldflow public material database, as well as many confidential polymers, representing many years of shrinkage characterization tests. The STAMP model makes use of this data to improve the warp prediction accuracy of 3D analyses without requiring the retesting of polymers for which shrinkage characterization for CRIMS had previously been performed.

Theory

The first step in the STAMP method is the calibration of so-called compressibility values, which express the sensitivity of measured shrinkage outcomes to the packing pressure. Calibrated compressibilities are determined in both the flow and transverse directions based on the respective shrinkage measurements in those directions as follows:

$$C_i = \frac{\sum_{j=1}^{N_i} (S_{i,j} - \bar{S}_i) * (P_{i,j} - \bar{P}_i)}{\sum_{j=1}^{N_i} (P_{i,j} - \bar{P}_i)^2} \qquad (1)$$

Where for either the flow or transverse direction, C_i is the compressibility for a series of moldings *i* which vary only by packing pressure; N_i is the number of moldings in that series; $S_{i,j}$ and $P_{i,j}$ are respectively the measured shrinkage and cavity packing pressure of each molding in that series and $\bar{S}_i$ and $\bar{P}_i$ are the average shrinkage and cavity packing pressure of the series *i*.

Once the calibrated compressibilities have been determined for each measurement direction, the calibrated CTE for each direction can be calculated according to:

$$\alpha_j = \frac{S_j + C_i P_j}{T_{sol} - T_{room}} \qquad (2)$$

Where for either the flow or transverse direction, α_j is the calibrated CTE from the *j*th molding, P_j is the cavity packing pressure of that molding condition, T_{sol} is the solidification temperature and T_{room} is the room temperature at which the shrinkage samples were measured.

For polymer composites which contain fiber reinforcements, the goal is calibration of the polymer matrix properties of modulus, Poisson's Ratios and CTE. Anisotropic, locally varying properties of the polymer compound are then calculated by micro-mechanics using these calibrated polymer matrix properties, plus the known properties of the fiber and the local fiber orientation prediction [3, 4].

Calibrated properties of the polymer matrix are obtained through an automatic iterative process of optimization in which the objective function to be minimized is the error in matching the calibrated compressibilities and CTE values of the compound (from Equations 1 & 2). Details of the calibration process are available in US patent 12,214,534 B2.

Comparison with shrinkage molding data

The shrinkage prediction accuracy of the new STAMP shrinkage calibration model for 3D analyses has been validated using the same molded shrinkage data which is used to calibrate the mechanical properties during the STAMP procedure. These validations have also been compared to the validations of the Uncorrected Residual Stress model to demonstrate the superior prediction accuracy of the STAMP model.

Figure 2 and Figure 3 show respectively the flow direction and transverse direction shrinkage comparisons between measured shrinkage from actual moldings and the predicted shrinkage for 171 polymers which do not contain fiber fillers. Of the 171 materials, 61 are amorphous, 70 are polypropylenes (PP) and 40 are other semi-crystalline materials. 90 of these polymer grades had no filler, while 61 had talc filler, 19 had some other spherical mineral filler and one had glass bead filler. 25 molding conditions including variations in thickness, packing pressure, injection speed and melt temperature are included for each polymer. Predicted shrinkage values from the Moldflow Insight 2026 release are shown for both the Uncorrected Residual Stress model and the STAMP calibration model. The solid diagonal line is a reference line showing the target equivalence between the measured and predicted shrinkage values. The data points for the STAMP model are more closely clustered around the diagonal line, indicating that the property calibration process of the STAMP model achieves superior accuracy than the Uncorrected Residual Stress model for the tested non-fiber filled polymers.

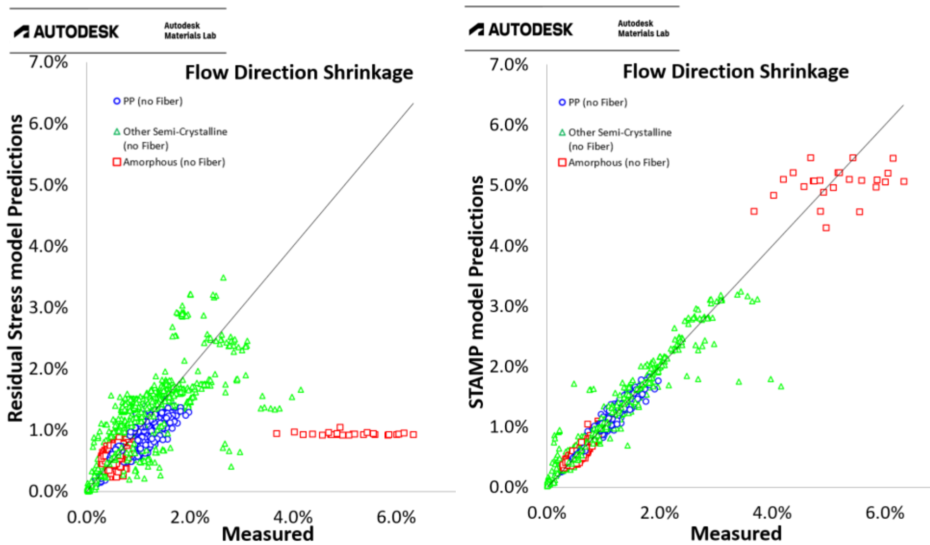


Figure 2: Flow Direction Shrinkage, comparison for 171 non-fiber filled polymers of measurement vs prediction of the Uncorrected Residual Stress (left) and STAMP (right) models

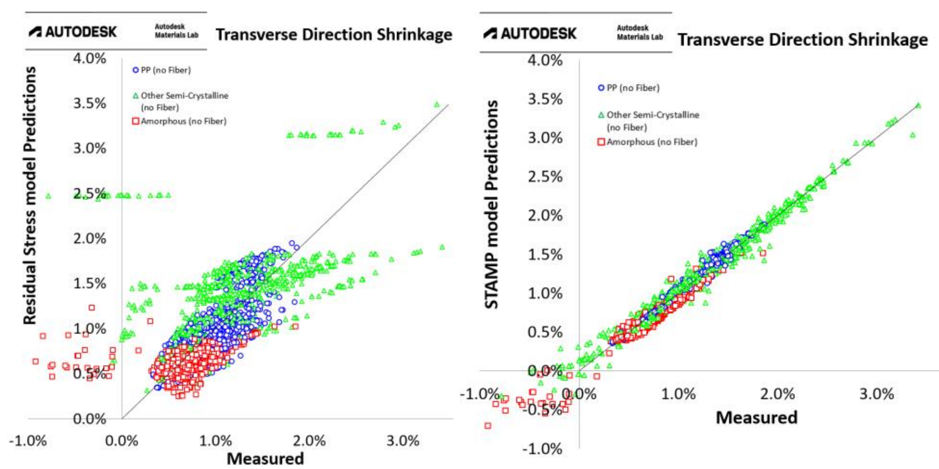


Figure 3: Transverse Direction Shrinkage, comparison for 171 non-fiber filled polymers of measurement vs prediction of the Uncorrected Residual Stress (left) and STAMP (right) models

Figure 4 and Figure 5 show respectively the flow direction and transverse direction comparisons of measured and predicted shrinkage for 106 fiber-filled polymer compounds molded in the Autodesk Material Laboratory. Of the 106 compounds, 5 contain amorphous polymers, 30 contain polypropylenes (PP) and 71 contain other semi-crystalline polymers. 11 of the compounds contain glass fiber reinforcements longer than 1mm. The predicted shrinkage values are all from 3D analyses in the Moldflow Insight 2026 release, which used either the default Uncorrected Residual Stress shrinkage model or the STAMP (calibrated) shrinkage model. Again, the diagonal reference lines show the position of the target 1:1 correspondence between measured and predicted values. Each data point represents one of the 25 molding conditions used for each polymer. When the STAMP model is used, the data points are closely clustered around the diagonal line, demonstrating the improved accuracy of the STAMP model over the Uncorrected Residual Stress model for fiber-filled polymers.

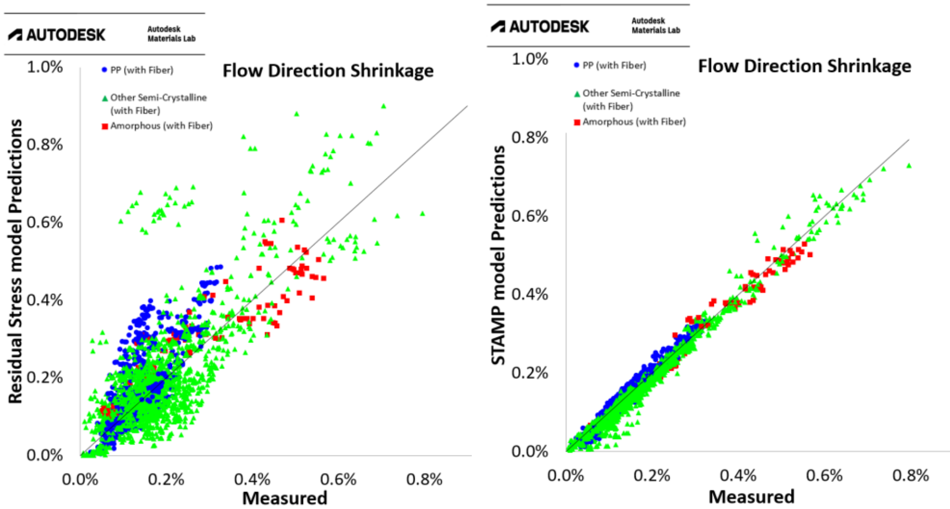


Figure 4: Flow Direction Shrinkage, comparison for 106 fiber filled polymers of measurement vs prediction of the Uncorrected Residual Stress (left) and STAMP (right) models

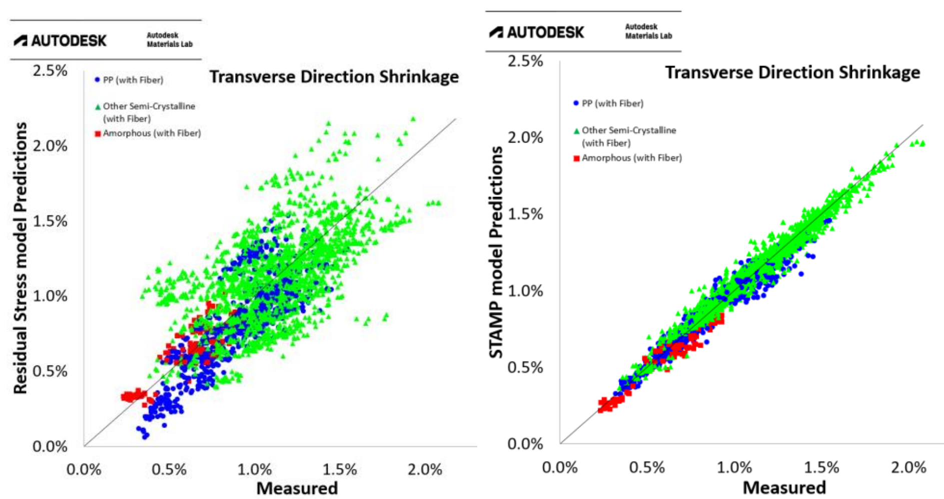


Figure 5: Transverse Direction Shrinkage, comparison for 106 fiber filled polymers of measurement vs prediction of the Uncorrected Residual Stress (left) and STAMP (right) models

Improvements to STAMP

The STAMP shrinkage model was available as an option for 3D analyses in the Moldflow Insight 2024 and Moldflow Insight 2025 releases. The Moldflow Insight 2026 release improves the STAMP method in two main ways:

1. The residual stresses which remain in the molded part after deformation (after ejection) are now more realistic. In the earlier releases, these residual stresses were calculated using the calibrated mechanical properties, which sometimes resulted in unrealistic values. In the Moldflow 2026 release, the residual stresses are calculated using the standard laboratory measured mechanical properties. This means that the residual stresses after deformation from the STAMP method are similar to those calculated for the "Uncorrected Residual Stress" shrinkage model. This change does not have any significant effect on the deformation prediction accuracy of STAMP for standard injection molding processes. However,

the previous method of using the calibrated mechanical properties during the post-deformation residual stress calculation did cause inaccuracies in the calculation of birefringence, which depends on these residual stresses. The previous STAMP method also caused inaccuracies in the deformation calculation of over-molding cases. These problems are now fixed in the Moldflow 2026 version of STAMP.

2. The calibration of the Coefficient of Thermal Expansion is improved by considering the potential for some shrinkage to occur before the polymer has solidified during the shrinkage molding experiments. This occurs when the packing pressure in the cavity falls to zero before the polymer has fully solidified. This improvement is most significant for amorphous materials which are more likely to experience this condition.

Figure 6 shows an example of the improved prediction of residual stress after deformation when using the STAMP shrinkage model in Moldflow 2026 in comparison to the Moldflow 2025 version. For comparison, the residual stress predictions from the Uncorrected Residual Stress model are also shown. While the maximum residual stress predicted by STAMP in the Moldflow 2025 version is too high, STAMP in Moldflow 2026 shows a similar residual stress magnitude as that predicted by the Uncorrected Residual Stress shrinkage model. In contrast the predicted deformation magnitude and shape from STAMP in Moldflow 2026 is very similar to the deformation prediction from STAMP in Moldflow 2025, as shown in Figure 7.

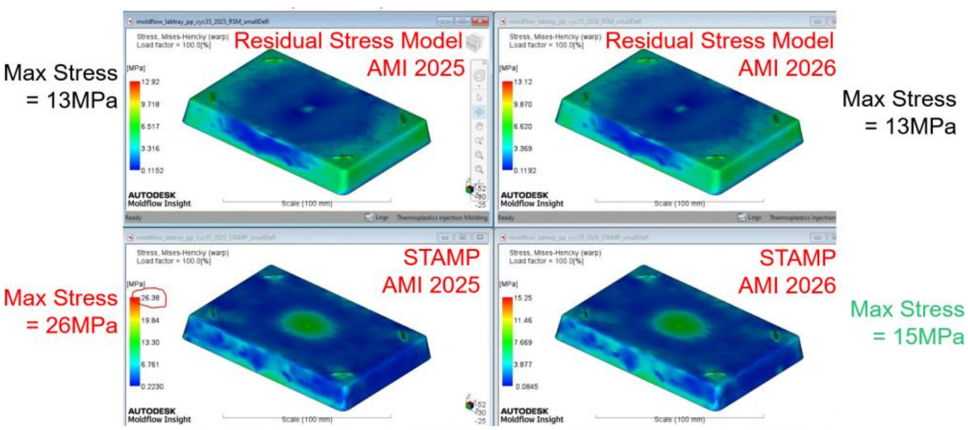


Figure 6: Residual Stress after deformation comparison for the STAMP and Uncorrected Residual Stress shrinkage models.

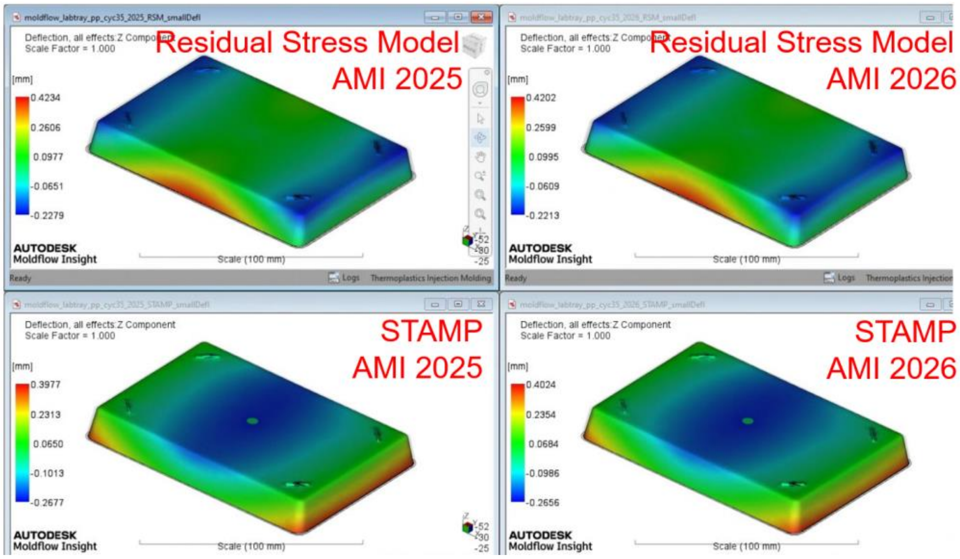


Figure 7: Deformation comparison for the STAMP and Uncorrected Residual Stress shrinkage models.

The effect of the changed coefficient of thermal expansion calibration is shown in Figure 8 & 9, which show the change in average relative shrinkage prediction error for 171 unfilled and 106 fiber-filled polymers respectively. The average relative shrinkage prediction error for a material is a measure of how closely the shrinkage prediction matches the measured shrinkage values. The error for each molding condition is expressed relative to the measured shrinkage magnitude and those errors are averaged over the 25 processing conditions for each material to calculate an overall measure of prediction accuracy for each direction. Figure 8 & 9 compare the average relative shrinkage prediction errors for the STAMP shrinkage model in the Moldflow 2025 and Moldflow 2026 versions. Data points on the diagonal line are polymer grades for which the STAMP prediction in the Moldflow 2026 version is very similar to the prediction from the Moldflow 2025 version. Data points below the diagonal line are those for which the Moldflow 2026 STAMP version has a lower (improved) prediction error. For semi-crystalline polymers, the comparison points are almost all very close to the diagonal line, indicating that the STAMP predictions in Moldflow 2026 are largely the same as those from Moldflow 2025 for semi-crystalline polymers. For amorphous polymers, many of the comparison points are below the diagonal line. This demonstrates that the STAMP predictions in Moldflow 2026 are more closely matching the measure shrinkage values. Note that only five amorphous polymers have fiber fillers.

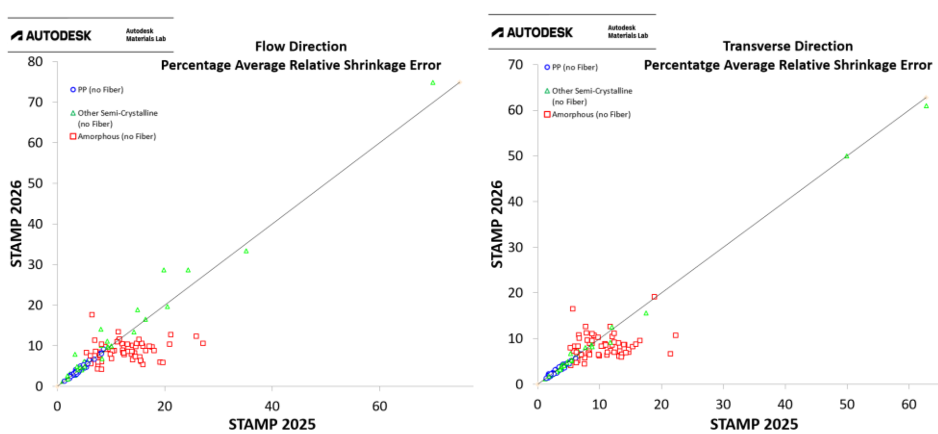


Figure 8: Average Relative Shrinkage Error Comparison for 171 Unfilled Polymers

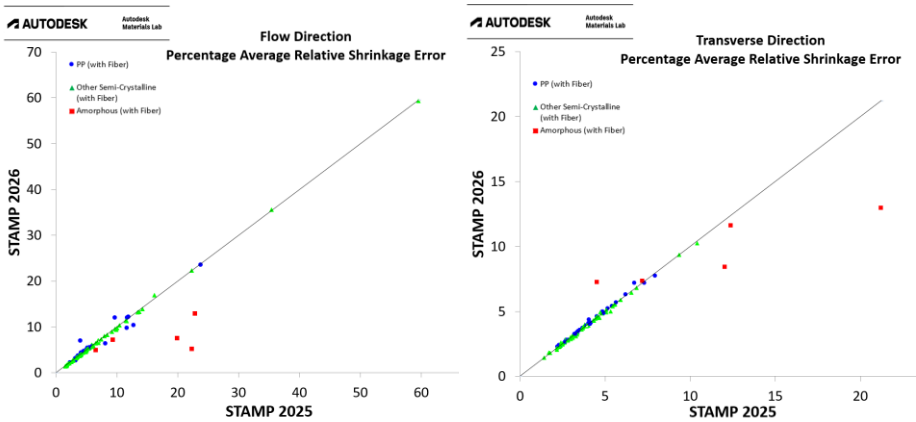


Figure 9: Average Relative Shrinkage Error Comparison for 106 Fiber-filled Polymers

Warp Validation Suite

Autodesk maintains internally a suite of 22 customer molding case-studies which have measured warpage data of actual moldings, and the material is shrinkage tested. Among those 22 moldings, 17 are molded with fiber-filled thermoplastics and five are unfilled.

The measured data may be of: deflection at specific locations; shrinkage between two points; difference in deflection between some locations; deviations from the round shape; etc. Some measured data are inexact, being only qualitative, e.g., “positive” or “negative”.

The warpage predictions are compared with the baseline predictions. We define the results as “better” if the average relative error of predictions decreases by more than a tolerance value, as “worse” if the average relative error of predictions increases by more than the tolerance value and as “similar” if the change is less than the tolerance value.

Warp validation tests was performed using Moldflow Insight 2026 to compare the STAMP and Uncorrected Residual Stress shrinkage models. Comparison results are shown in Table 1 in which the Moldflow Insight 2026 predictions using the Uncorrected Residual Stress model are used as the baseline.

Table 1: Results of Warp Validation Test suite. The baseline for comparison is the 2026 Uncorrected Residual Stress results.

	Compared to base line		
Build and shrinkage model	Better	Similar	Worse
Moldflow 2026			
Uncorrected Residual Stress (baseline)	0	22	0
STAMP	7	10	5

Seven cases show better accuracy when using STAMP compared to the Uncorrected Residual Stress model. Five cases are worse when using STAMP. Two of the test cases which showed improvements with STAMP now predict warpage magnitudes closely matching the measured deflections.

3D Solver Speed Improvements

Introduction

The Moldflow 2026 release includes several improvements to the software coding of the 3D Flow and 3D Warp calculation algorithms, aimed at reducing the computation time required for each analysis. These improvements do not introduce any loss of solution accuracy.

The speed gains in the 3D Flow solver are achieved by reducing the amount of result data transferred via the Simulation Compute Manager (SCM) during the analysis, when the option to *Dynamically update results display during analysis* is enabled, as illustrated in Figure 10. This option is on by default. When this option is enabled, the Moldflow 2026 3D Flow solver generates multiple smaller result files as the analysis progresses, rather than appending new results to a single file. The SCM then transfers only the new incremental files to Autodesk Moldflow Synergy. These speed improvements are most significant for large models with numerous intermediate results and for analyses conducted on the cloud or across a local network. There is no change to the way that intermediate results are transferred or stored for Midplane and Dual Domain analysis.

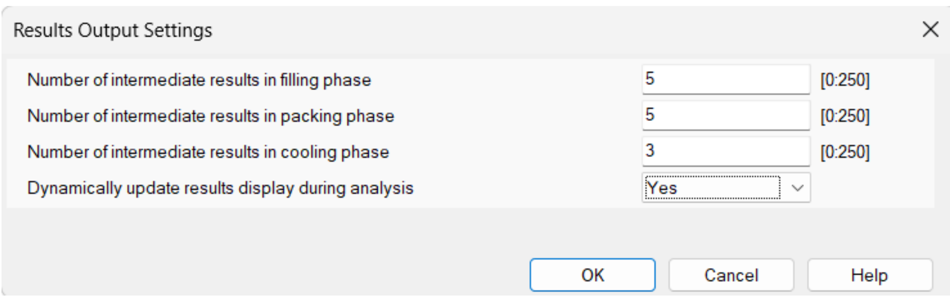


Figure 10. The option to Dynamically update results display during analysis *(*Process Settings -> Advanced options -> Solver parameters -> Fill + Pack Analysis *tab* -> Edit intervals*).*

The speed gains in the 3D Warp solver are achieved through more efficient access to the input data within the structural analysis code by using computer memory rather than disk storage. These gains are most notable when the option to *Isolate cause of warpage* is enabled. These improvements may result in increased memory usage during 3D Warp analyses.

Methodology

A comprehensive suite of studies was analyzed using both Autodesk Moldflow Insight 2025 and Autodesk Moldflow Insight 2026 on the same computer. The suite includes various molding processes and options such as injection molding, compression molding, injection-compression molding, gas-assisted injection molding, overmolding, Microcellular injection molding, reactive molding, resin transfer molding, and core shift analysis, utilizing both unfilled and fiber-filled materials. To ensure consistent computational times, a fixed number of threads were employed on a single processor. The analyses were submitted via the SCM to the local computer, with only one analysis running at a time.

Two sets of intermediate result numbers were specified for each study. The first set, denoted as 5/5/3, included 5 intermediate results in the filling phase, 5 in the packing phase, and 3 in the cooling phase, which are also the default settings in Moldflow Synergy. The second set, denoted as 50/50/30, included 50 intermediate results in the filling phase, 50 in the packing phase, and 30 in the cooling phase.

Each analysis was run twice, and the average wall clock time for each software version was used to calculate the speedup comparison between software versions. The speedup is determined by the ratio of the elapsed wall clock time in Moldflow 2025 to that in Moldflow 2026 for each analysis step in each study. A speedup value greater than 1 indicates the speed gain in Moldflow 2026.

An additional set of speed comparisons on different studies was done running the analyses as cloud solves. For these cloud solves, the Moldflow 2025 and Moldflow 2026 analyses were run one time each, with only the condition of 50 intermediate results in the filling phase, 50 in the packing phase, and 30 in the cooling phase.

Speed Comparison Results

The speed results for local solves of the 3D Flow solver are illustrated in Figure 11. The blue line represents the 5/5/3 (default) setting for intermediate results, while the orange line corresponds to the 50/50/30 setting. When using the 5/5/3 intermediate results, the analysis times in Moldflow 2025 and Moldflow 2026 are very similar, indicating that result file transfer does not significantly impact solver efficiency. For study2, the analysis time in Moldflow 2026 is longer than in Moldflow 2025, due to the increased number of time steps resulting from other solver improvements in Moldflow 2026. When using the 50/50/30 intermediate results, all cases demonstrate speed gains in Moldflow 2026. The speedup ranges from 1.002 to 1.518, with an average speedup of 1.147 (14.7%).

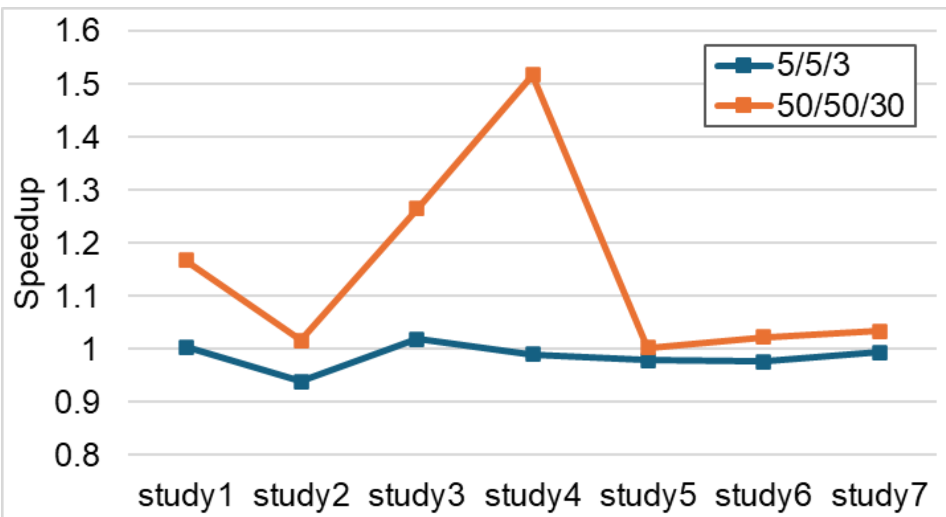


Figure 11. The Speedup of the 3D Flow local solves in Moldflow 2026, compared to Moldflow 2025.

The speedup of cloud solves for the 3D Flow solver are show in Figure 12. The largest speedup observed from these five analyses was 213%. All tests were set to produce many intermediate results.

A large speedup were also observed when running 3D Flow analyses on SCM local area network (LAN) workers. For this SCM configuration, a large 3D Flow analysis exhibited a speedup factor of 1.56 compared to Moldflow 2025 when using the default number of intermediates results. The speedup factor increased to 2.49 when the intermediate results setting was increased to 50 during filling, 50 during packing and 30 during cooling.

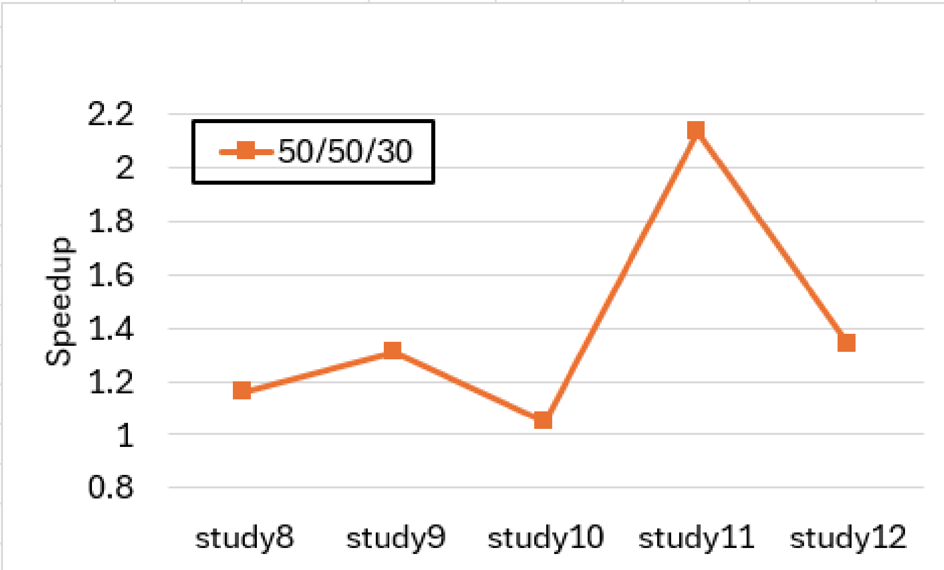


Figure 12. The Speedup of the 3D Flow cloud solves in Moldflow 2026, compared to Moldflow 2025.

The speedup results for the 3D Warp solver are shown in Figure 13. The setting of intermediate results does not affect the 3D Warp solver's performance, and the speedup results from local solves using the 5/5/3 setting are presented here. All cases exhibit speed gains in Moldflow 2026, with speedup values ranging from 1.005 to 1.313, and an average speedup of 1.125 (12.5%).

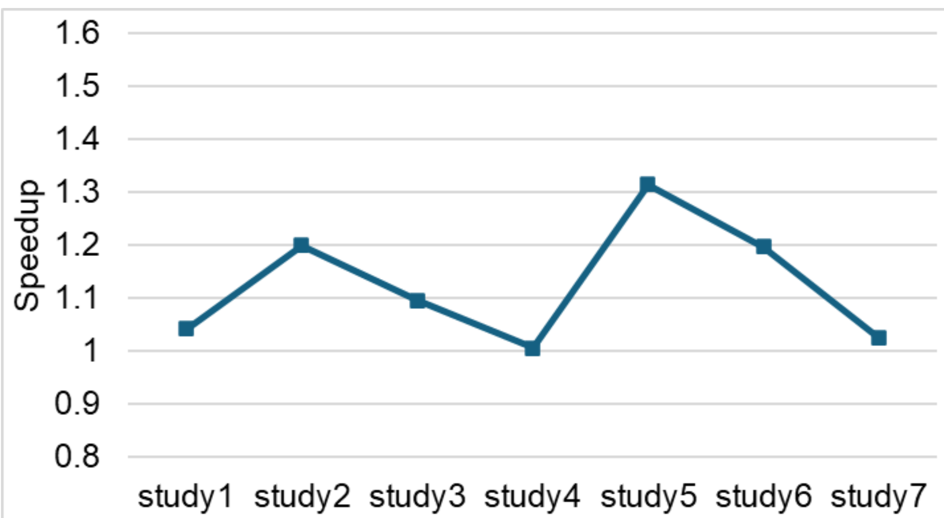


Figure 13. The Speedup of the 3D Warp solver in Moldflow 2026, compared to Moldflow 2025.

Transient Cool (FEM) analysis for 3D Resin Transfer Molding simulation

Background

Resin Transfer Molding (RTM) is a sophisticated manufacturing technique employed to produce fiber-reinforced polymer composite materials using thermoset resins. This process results in components that are both lightweight and possess high strength, making them highly desirable for applications in the automotive and aerospace sectors. RTM is advantageous over traditional manufacturing methods due to its potential for cost reduction and enhanced performance.

In the RTM process, dry fiber reinforcement, referred to as a fiber preform, is positioned within a mold cavity shaped according to the desired part. Upon sealing the mold, the thermoset resin is slowly injected, allowing it to thoroughly permeate the fiber preform. Subsequent to the resin injection, the curing cycle is initiated. During this phase, heat from the mold induces curing and hardening of the resin into a rigid plastic.

Temperature control for RTM

The RTM process may have specific mold temperature levels throughout its various stages. These stages generally encompass:

1. **Pre-Heating Stage:** The mold may be heated at the commencement of production. This can be regulated either by a predetermined time period or by achieving a target temperature using a thermocouple.
2. **Filling Stage:** Lower temperatures may be desired during this stage to delay the onset of curing.
3. **Packing and Curing Stages:** Elevated temperature levels may be used during these stages to facilitate the curing and transformation of the resin into a solid plastic.
4. **Cool Down Stage:** Following the curing stage, the mold and part may be allowed to cool before the mold is opened and the part is removed.
5. **Typical Cycle:** The cycle comprises Filling, Packing, Curing, Cooling Down, Mold Opening, and Mold Closing (with preheating for the subsequent cycle).

Moldflow Cool (FEM) analysis for 3D RTM

Solver settings

The Cool (FEM) analysis for 3D RTM constitutes a transient analysis designed to compute time-dependent outcomes, such as mold temperature and cooling circuit pressure, from the commencement of production. To calculate the evolution of temperature in the polymer resin, two solver options are provided: the *Conduction solver* and the *Flow analysis on every iteration*. The *Conduction solver* option assumes that mold cavity is instantly filled with liquid polymer initially at the melt temperature, whereas the *Flow analysis on every iteration* option integrates the part's flow analysis (encompassing filling and packing) with the heat transfer computations of the mold and cooling circuits.

Despite the capability of the 3D RTM process simulation to accommodate multiple production cycles, the default configuration for a Cool (FEM) analysis for 3D RTM is set to a single cycle. This is due to the typically prolonged process duration, which inherently restricts the likelihood of continuous cyclic production.

Cooling stages

Within the Moldflow Cool (FEM) analysis for 3D RTM, the process is organized into three principal thermal control stages, each delineated by control parameters accessible to the user:

- **Preheating and Filling**
- **Packing and Curing**
- **Cool down**

These stages are succeeded by the conventional mold opening and closing stages, which can be adjusted analogously to other processes.

Each stage is characterized by specified inlet conditions for the cooling circuits. Users can define the coolant flow's temperature at the inlets to modulate the mold temperature. Furthermore, users can enhance the heat transfer efficiency of the cooling circuits by adjusting the flow rate, Reynolds number, or pressure of the coolant inlets. Optionally, the cooling circuit flow rates can be set to zero in selected stages (e.g. during the cool down stage).

Transitioning between cooling stages

The Cool (FEM) analysis transitions from one stage to the subsequent stage as time advances. The control parameters governing the transition between stages can be specified within the Process Settings Wizard – Cool (FEM) Settings page, as shown in Figure 14.

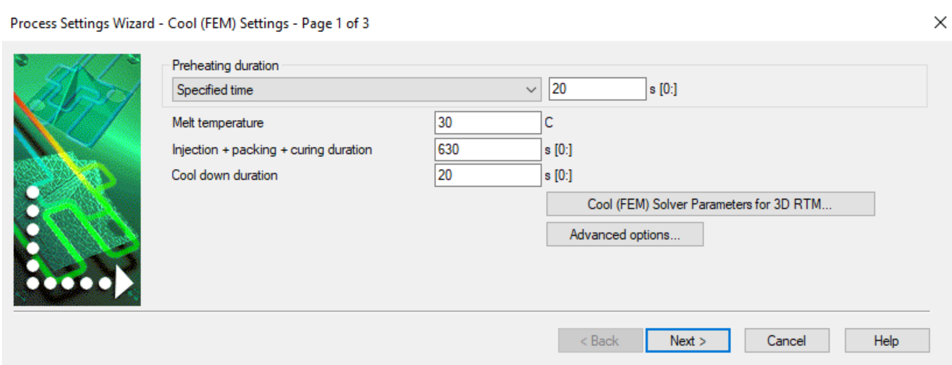


Figure 14: Process Settings Wizard – Cool (FEM) Settings page.

The duration of the preheating stage can be regulated by specifying a time period or by setting a target temperature on a thermocouple node; in the latter case, the preheating continues until the thermocouple node attains the specified target temperature. The Filling duration is also specified on the same page, and together with the Preheating duration, these settings determine the length of the first cooling stage of Preheating and Filling.

All remaining stages are time-controlled based on duration inputs for Injection + Packing + Curing and Cool Down. The duration of the Packing and Curing is calculated by subtracting the Filling duration from the total Injection + Packing + Curing duration.

It is pertinent to note that the durations of the Filling, Packing and Curing, and Cool Down stages are not strictly enforced in the simulation when utilizing the *Flow analysis on every iteration* solver option, wherein the actual durations are dictated by the polymer melt flow analysis.

Examples of predicting the temperatures inside the mold in an RTM process

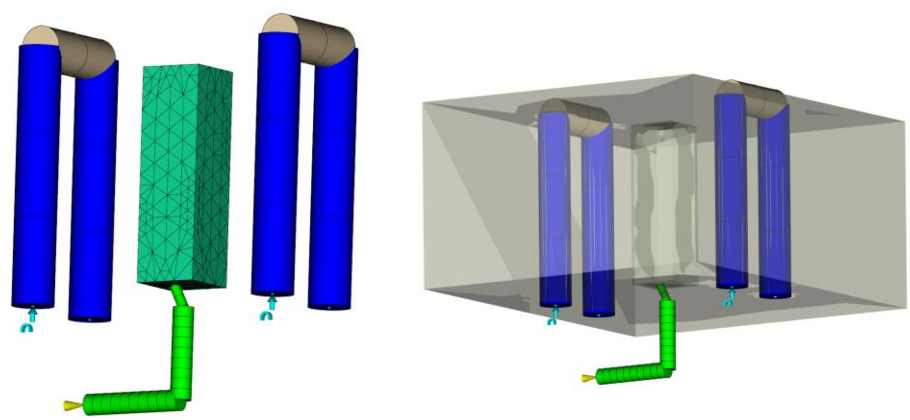
Simulation of a multi-cycle RTM process using *Conduction Solver*

This example demonstrates the simulation of a multi-cycle Resin Transfer Molding (RTM) process. The Cool (FEM) analysis employs the Conduction solver option and starts with the production start-up, where the mold is preheated to an optimal condition. The process then continues through production cycles until a steady state is reached, characterized by consistent temperature changes within each cycle. Each cycle encompasses polymer filling, packing, curing, cooling down, and designated mold-open and mold-close periods. During the mold-close period, the mold is reheated in preparation for the next cycle.

The Conduction solver option is particularly efficient for large models or lengthy processes, which are generally time-consuming to simulate. However, it assumes a uniform initial cavity temperature, which may slightly impact the accuracy of the results.

Figure 15 presents the model used in this example, featuring a 3D meshed cavity with the polymer injection location, a cooling system that includes cooling circuits, coolant inlets and outlets, and a 3D meshed mold.

The material and processing conditions for this model are provided in Table 2. The analysis sequence is Cool (FEM) only and is conducted using Autodesk Moldflow Insight 2026.



(a) Cavity and cooling circuits (b) Mold

Figure 15: Demonstration Model 1: (a) Cavity and cooling circuits; (b) Mold.

Table 2: Material and processing conditions of example 1.

Molding material	AROTRAN Q6055
Mold initial temperature	40 °C
Melt temperature	30 °C
Coolant material	Oil
Preheating duration	10 s
Filling duration	5 s
Injection + packing + curing duration	35 s
Cool down duration	5 s
Mold-open time	5 s
Mold-close time before injection	10 s

Table 3: Control parameters for each cooling stage of example 1.

Coolant control / Cooling stage	Reynolds number	Coolant inlet temperature
Preheating + Filling Stage	10000	150 °C
Packing + Curing Stage	10000	200 °C
Cool Down Stage	10000	100 °C

The simulation indicates that the process achieves a steady state after three cycles, after which the analysis is concluded. Figure 16 illustrates the coolant temperature history at a selected location within the cooling circuit. Note that the chosen location is not at the coolant inlet, resulting in a different temperature from that of at the inlet, due to heat transfer between the coolant and the mold after the coolant leaves the inlet. The coolant temperature history clearly depicts three cooling stages with specific timings, matching well with the specified inlet temperature.

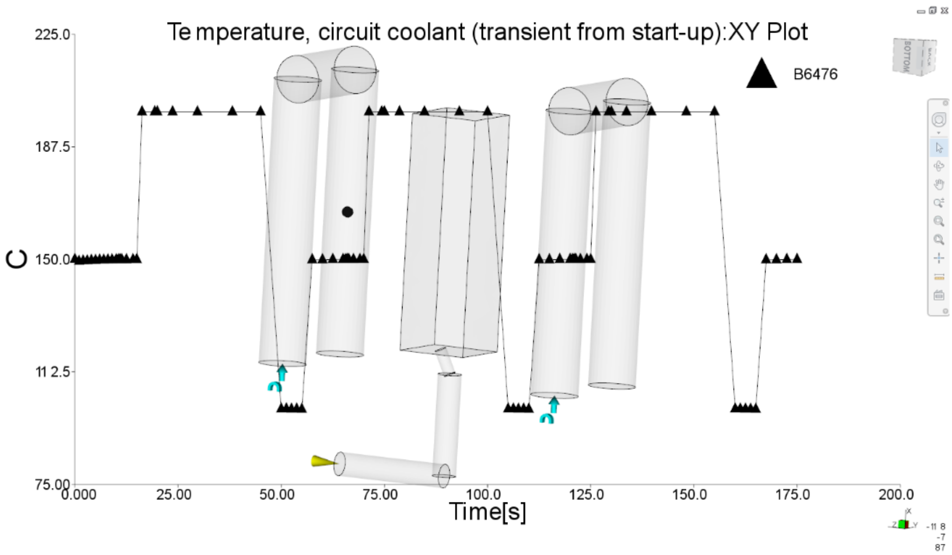


Figure 16: XY plot of the circuit coolant temperature at a selected location from production start-up.

To understand the impact of temperature changes in the cooling circuit, Figure 17 displays the XY plot of the mold temperature at a selected location. This time-dependent result shows the transient temperature history from the production start-up. The temperature history highlights all the distinct stages: the temperature rises from an initial value of 40°C during the set preheating period, remains around 150°C during filling, then jumps to approximately 190°C for packing and curing. Subsequently, it drops to around 100°C during the cool down period. As a preparation for the next cycle, the temperature increases again to around 150°C due to preheating during the mold-close period. The subsequent three cycles follow a similar temperature variation pattern, from filling to mold-close.

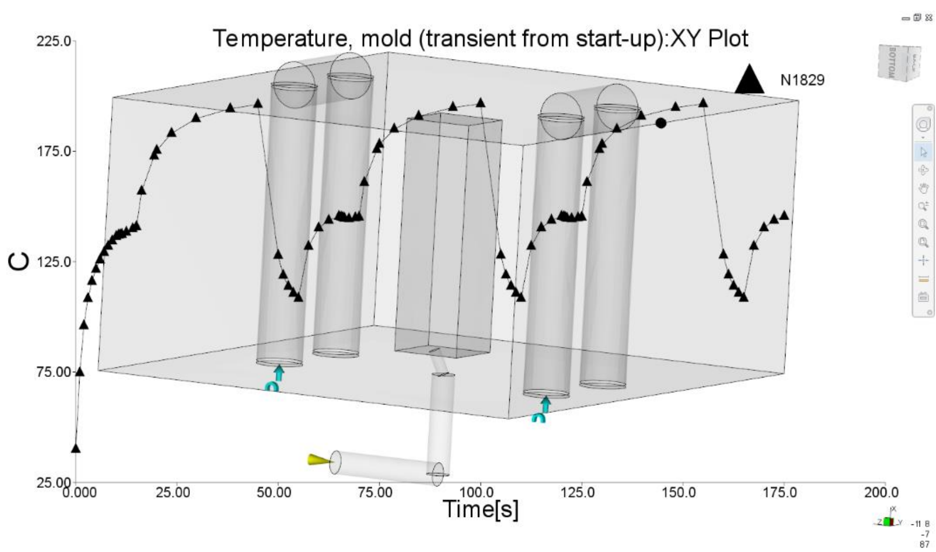
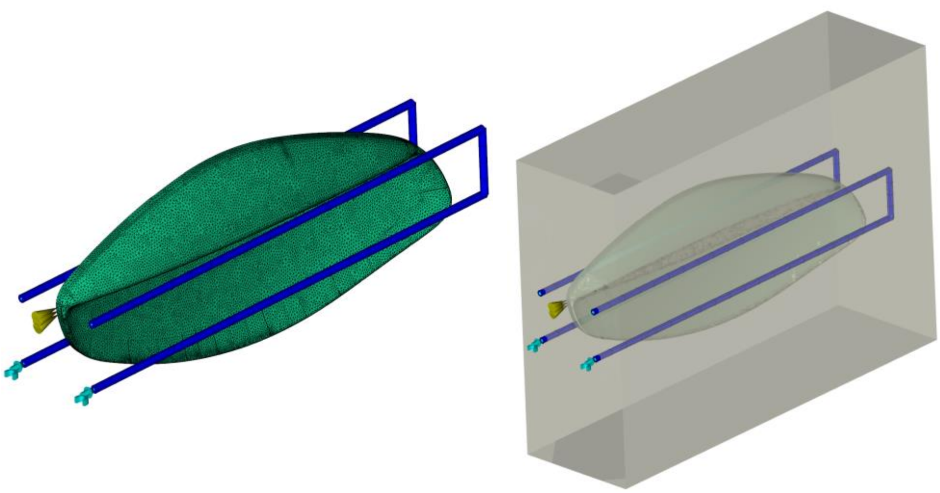


Figure 17: XY plot of the mold temperature at a selected location from production start-up.

Simulation of a single-cycle RTM process using *Flow analysis on every iteration*

In this example, the Flow analysis on every iteration option is utilized to simulate the RTM process. This approach couples the Cool (FEM) and Flow analyses, providing enhanced accuracy compared to the Conduction solver option, albeit with increased computational time. The RTM process simulated here is a single-cycle process, encompassing the entire history from preheating, filling, packing, curing, cooling down, to mold-open and mold-close stages.

Figure 18 depicts the model used in this example, which includes a 3D meshed cavity with the polymer injection location, a cooling system with cooling circuits, coolant inlets and outlets, and a 3D meshed mold. The material and processing conditions for this model are detailed in Table 4. The simulation is performed using Autodesk Moldflow Insight 2026, following the analysis sequence of Cool (FEM) + Fill + Pack + Warp. The preheating duration is controlled by a thermocouple node's target temperature; preheating continues until the thermocouple node's temperature reaches or exceeds the set target value. As an experiment, three different preheat target temperatures are set to observe their impact on the final part quality.



(a) Cavity and cooling circuits (b) Mold

Figure 18: Demonstration Model 2: (a) Cavity and cooling circuits; (b) Mold.

Table 4: Material and processing conditions of example 2.

Molding material	AROTRAN Q6055
Mold initial temperature	40 °C
Melt temperature	30 °C
Coolant material	Oil
Preheating target temperatures	45 °C, 60 °C, 80 °C
Cool down duration	20 s
Mold-open time	10 s
Mold-close time before injection	20 s
Injection time	30 s
Packing time	600 s
Packing pressure (% filling pressure)	100

Table 5: Control parameters for each cooling stage of example 2.

Coolant control / Cooling stage	Reynolds number	Coolant inlet temperature
Preheating + Filling Stage	10000	100 °C
Packing + Curing Stage	10000	200 °C
Cool Down Stage	10000	60 °C

Figure 19 presents the XY plot of the mold temperature at the thermocouple location (blue), and at two additional locations: one near (red) the coolant inlet, and the other far (black) from the coolant inlet. The results of the three different preheat target temperature cases are displayed from left to right: 45°C, 60°C and 80°C. Understandably, the amount of time required to preheat the mold increases as the target preheat temperature increases. This is reflected in the temperature rise curve throughout the early stage of the process starting from the production start-up. As this is a single-cycle process, there is only one temperature peak during the transient temperature history.

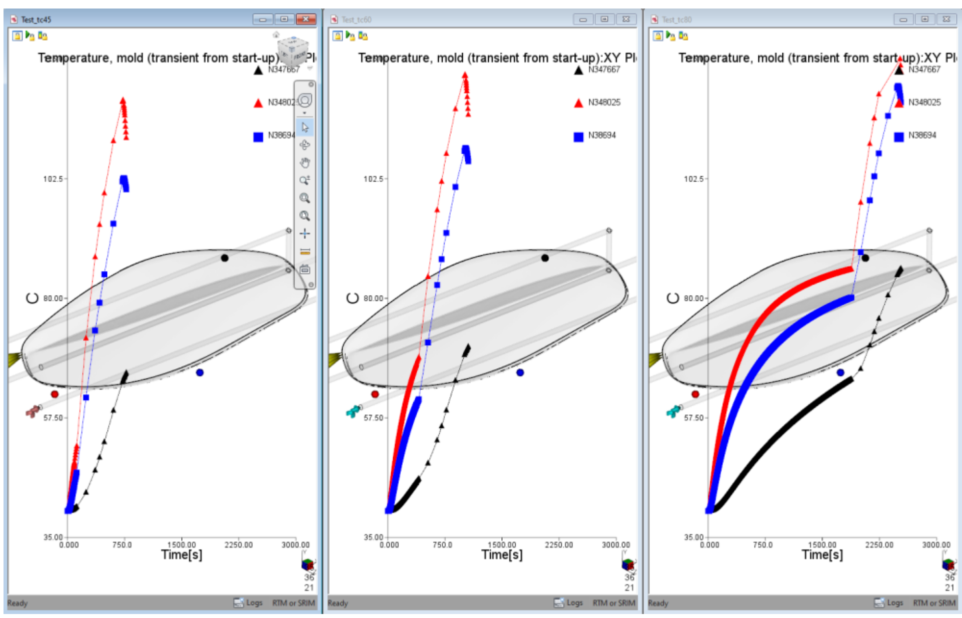


Figure 19: XY plot of the mold temperature at selected locations for the three different preheat target temperature cases: 45°C (left), 60°C (middle) and 80°C (right).

Figure 20 shows the **Conversion at node** results at ejection for the three different preheat target temperature cases. For the lowest preheat target temperature case, a portion of the part, specifically on the top and bottom, has a degree of cure less than the commonly recommended level of 0.8. The regions with degree of cure below 0.8 are shown as transparent regions in the result image because the result scale is restricted to values above 0.8. This indicates that the part is not fully cured at the end of the process. In contrast, for the other two cases, a higher preheat target temperature results in a generally higher mold temperature; consequently, the conversion rate exceeds the recommended level of 0.8, yielding a properly cured product.

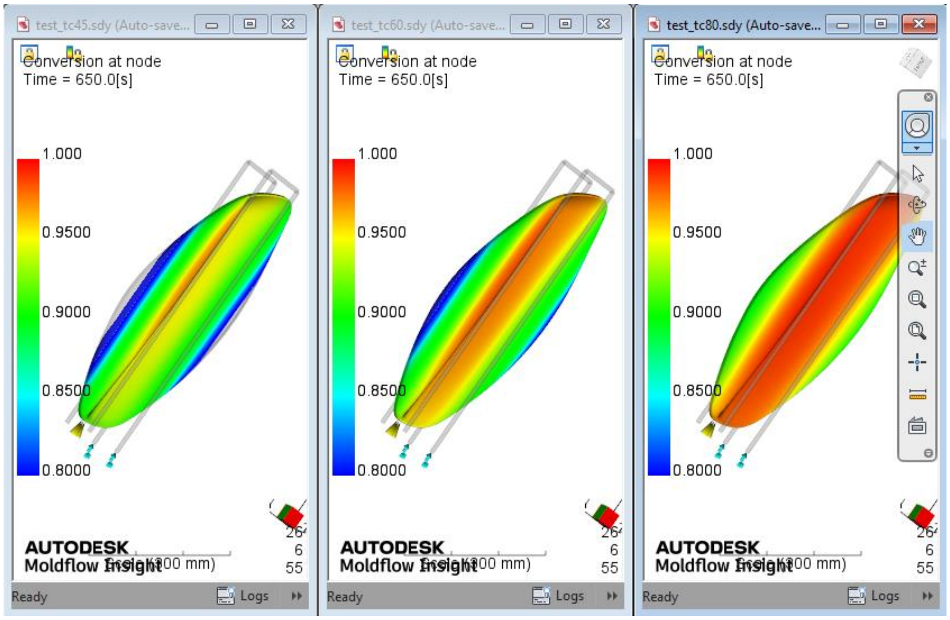


*Figure 20: **Conversion at node** results for the three different preheat target temperature cases: 45°C (left), 60°C (middle) and 80°C (right).*

Figure 21 illustrates the final warpage of the part, particularly measured as the deflection component that is normal to the local surfaces. Although the warpage pattern is similar among all the three cases, it is observed that the deflection magnitudes increase with the preheat target temperature. The maximum and minimum values for the 45°C preheat target case are 1.501 mm and -1.520 mm, respectively. However, this deflection value may increase after molding if the part continues to cure when exposed to elevated temperatures when in service. The other two cases, which have cured more, exhibit increased deflection values, 1.691 mm and -1.724 mm for the 60°C case, and 2.155 and -2.197mm for the 80°C case. Combined with the conversion results in Figure 21, it is logical to draw a conclusion that the result with the 60°C preheat target temperature is preferrable to the other two cases, as the end product has mild warpage while being properly cured.

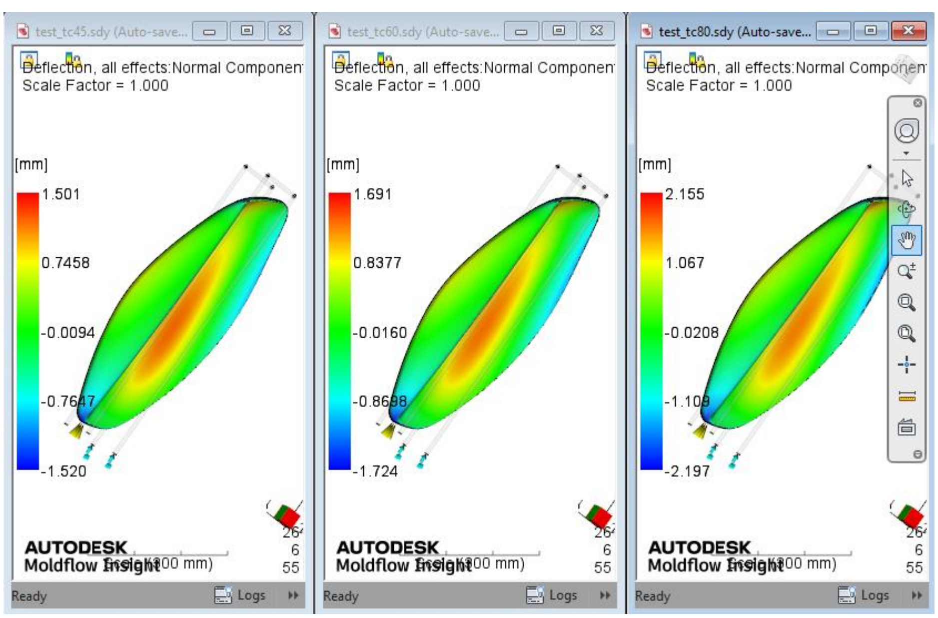


Figure 21: Normal component of warpage deflection results for the three different preheat target temperature cases: 45°C (left), 60°C (middle) and 80°C (right).

Other Solver Improvements

In addition to the above improved accuracy, speed and functionality, other solver improvements are also included in the Moldflow 2026 release. These include:

- Dual Domain surface meshing speed has been improved by up to 30% for large CAD models
- The 3D meshing algorithm has been updated, yielding faster meshing and better quality meshes. 3D meshing speed is up to 50% faster than previous releases. Mesh quality has improved with fewer very flat tetrahedral elements.
- The accounting of compressibility in the injection molding machine barrel and hot runners has been improved in two ways:
    - For 3D models, the calculation of automatic switchover from Velocity to Pressure control phases is improved for models with large hot runner volumes
    - For Midplane and Dual Domain models which use *Absolute ram speed profiles*, the calculation of ram position during the velocity control phase is now more accurate than in prior software versions.
- The accuracy of calculation of the Coefficient of Thermal Expansion (CTE) has been improved for some composite polymers in Midplane and Dual Domain studies, matching the composite CTE values already calculated in 3D studies.
- The calculation of part weight during 3D Compression and Injection-Compression molding has improved, being now more stable.

These improvements are explained in greater detail in the What's New section of the Moldflow Insight 2026 online help:

https://help.autodesk.com/view/MFIA/2026/ENU/?guid=MFLO-WHATS-NEW-2026-0

References

1. F.S. Costa, A. Bakharev, Z. Yuan and J. Wang, "Improved Injection Molding Warp Predictions by Characterization of Material Properties Using Measured Shrinkage Molding Data", *SPE-ANTEC Tech. Papers* (2023).
2. P. Kennedy and R. Zheng, "High Accuracy Shrinkage and Warpage Prediction for Injection Molding", SPE-ANTEC Tech. Papers, 60 (2002).
3. Zhao, Z., and X. Jin. Property Separation Based on Inversion of Micro-Mechanics, SPE-ANTEC Tech. Papers (2001), Dallas: 560-562.
4. X. Jin, J. Wang and S. Han, "Property Calculation System for Injection Molding and Compression Molding of Fiber-Filled Polymer Composites", The 19th International Conference on Composite Materials (ICCM19), Montreal, Canada (2013)

AUTODESK