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Application of MoldFlow Technology in the Warp Analysis

***Abstract**. Warp analysis is always the key to the mold design. In practical process, it is always controlled by technicians through practical experience accumulation, which will lead to high waste. Through MoldFlow powerful analysis ability, a practical warp analysis is conducted, and then several plans are compared and adjusted, finally the best design is chosen. It simplifies the design process, improves design efficiency and decreases molding waste greatly, with strong practical application.*

Streszczenie:** Kluczem projektowania form wtryskowych jest zwykle analiza wypaczeń. W praktyce często oznacza to gromadzenie doświadczeń przez techników i jest bardzo kosztowne. Możliwość wykorzystania systemu MoldFlow do symulacji procesu wtryskiwania pozwoliła na praktyczne wprowadzenie analizy wypaczeń i porównania ich w różnych płaszczyznach oraz uzyskania najlepszego projektu formy. Zastosowanie MoldFlow upraszcza proces projektowania, poprawia jego wydajność i znacznie zmniejsza wypaczenia formy; ma bardzo duże praktyczne zastosowanie.* ***Zastosowanie technologii MoldFlow w analizach wypaczeń form wtryskowych

Keywords: MoldFlow; injection molding; warp; optimize
Słowa kluczowe: System komputerowy MoldFlow, Odlewanie wtryskowe, Wypaczenia, Optymalizacja

Introduction

MoldFlow software is a product of U.S. MoldFlow Company. MoldFlow Company issued the world's first set of plastic injection molding flow analysis software in 1978. The global market share of Moldflow CAE software in the modeling analysis area has exceeded 75%. Moldflow technology provides a technical reference for the traditional injection mold design.Users can take advantage of Moldflow technology to analyze the entire injection molding process by the computer simulation and accurately predict the melt filling, packing, cooling and the stress, molecular, fiber orientation distribution of the product, etc. It can improve product quality and reduce cost.

Experimental researches

The best gate location and the number and the workpiece flatness of this example should be analyzed. The analysis of the flatness is also called the workpiece warp analysis. The workpiece material is nylon PA66 by adding 30% glass fiber. Although the flow property of the nylon is better, it is easily to warp because of the glass fiber material. Therefore, in the calculation process the fiber trend analysis must be considered. We can determine its impact on product strength to judge the correct location of the gate is set or not by analyzing the fiber orientation in the flow process. So it is difficult to analyze the entire injection molding process.

The main reason of work piece warp is the uneven shrinkage of the workpiece. It manifests in the following aspects. 1) The shrinkage rates of different areas are different; 2) The shrinkage rates along the thickness direction are different; 3) The shrinkage rates along the parallel and perpendicular direction are different.

MF / WARP Warp attributed shrinkage reasons to the following three points: 1) uniform cooling; 2) uneven shrinkage; 3) the molecular orientation is inconsistent.

Therefore, the main purpose of MPI /WARP module is to determine whether the warp result meets the design requirements. If it can not meet the design requirements, the main reason of warp. Before the warp analysis, the cooling flow analysis has been completed. There are two analytical processes: Cool-Flow - Warp (hereinafter referred to CFW) and Flow -Cool- Flow - Warp (FCFW).Assume that the cutting-edge temperature of the melt is constant when CFW do the cooling analysis. Assume that the mold wall temperature is constant when FCFW do the cooling analysis. When we assume that the cutting-edge temperature of the melt is constant, the calculation result is more accurate, so the best choice is Cool - Flow - Warp analysis process.

1. Analysis process

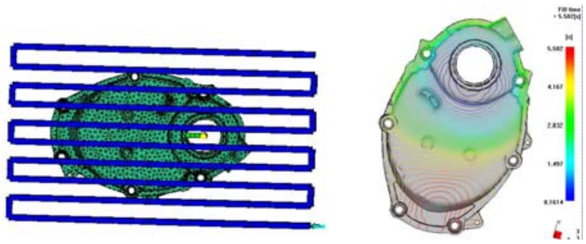
(a) Finite element model establishment:

Import CAD models provided by the company to the MF of STL format, because the part thickness is relatively thick, so Fusion (double-sided mode) mode is adopted to import. Finite element model is obtained by meshing.

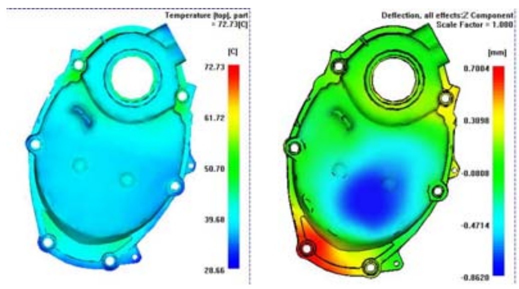
(b) Parameter settings

The material provided by the company is PA66 +30% glass fiber, injection molding machine is HTF360XB. The maximum clamping force is 360 t. screw diameter is Φ70mm, injection speed is 368mm3 / s, injection pressure is 180 tons, injection stroke is 322mm.

(c) single-point pouring:



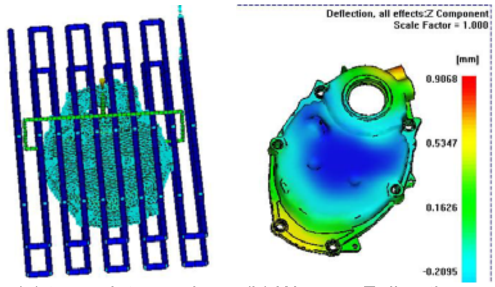
(a) gate location and cooling pipe layout (b) Filled material flow



(c) Cooling temperature distribution (d) 4 Warp on Z direction

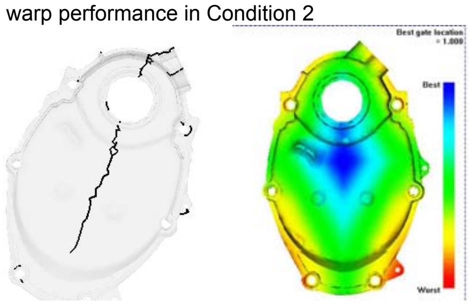
Fig. 1. The warp performance in Condition 1

As can be known from the result of the single point pouring, the filling flow trend is not ideal, Figure.1 shows that the warp on Z direction is 0.7004mm, and the warp occurs mainly in the connection parts. Therefore it is unable to meet the requirements of flatness, so the filling process should be adjusted, and adjusted parameters are shown in Table 1.The effects are poor.

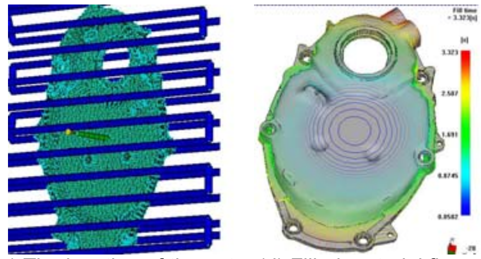


(a) two points pouring (b) Warp on Z direction

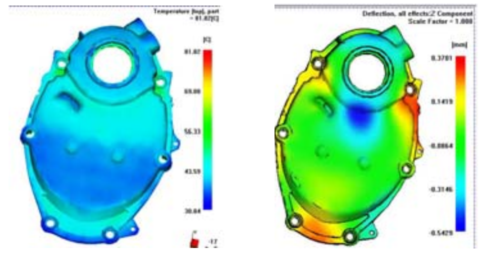
Fig..2 The warp performance in Condition 2



(a) Weld traces (b) the best gate area



(c) The location of the gate (d) Filled material flow



(a) temperature distribution (b) Warp on Z direction

Fig..3 The warp performance in Condition 3

Table 1.

plan	Process parameters										resulting data		
single-point pouri-ng	Mo-ld te-mp-er-at-ure (^{0}C)	Mat-eri-al tem-per-atu-re (^{0}C)	Mold Time (s)	Cyc-le time(s)	The filling process (% of volume and speed %)			Dwell time (% of maximum injection pressure And time of s)			Warp component （mm）		
					Par-agr-aph.1	paragraph.2	Paragra-ph.3	Par-agr-aph.1	Par-agr-aph.2	Par-agr-aph.3	X	Y	Z
Plan.1	85	295	10	35	20	80	100	80	80	0	0.64	0.83	0.75
					20	40	25	0	10s	3s			
Plan.2	85	295	10	35	20	80	100	80	80	0	0.64	0.84	0.69
					30	50	25	0	10s	3s			
Plan.3	85	295	10	45	20	80	100	80	80	0	0.61	0.82	0.83
					10	35	15	0	10s	3s			
two points pouring	Mo-ld te-mp-er-at-ure (^{0}C)	Mat-eri-al tem-per-atu-re (^{0}C)	Mold Time (s)	Cyc-le time(s)	The filling process (% of volume and speed %)			Dwell time (% of maximum injection pressure and time of s)			Warp component （mm）		
					Par-agr-aph.1	Paragr-aph.2	paragraph.3	Par-agr-aph.1	Par-agr-aph.2	Par-agr-aph.3	X	Y	Z
Plan.4	80	295	10	35	20	80	100	80	80	0	0.72	0.88	0.49
					15	30	25	0	10s	3s			
Plan.5	85	295	10	50	15	75	15	0	12	3	0.74	0.75	0.69
					20	45	25						
Plan.6	85	295	10	60	15	75	15	0	15	5	0.73	0.77	0.71
					20	45	25	60	60	0			

Table 2.

plan	Process parameters										resulting data		
The improve d gate	Mold tem-per-atu-re (0C)	Mat-eri-al tem-per-atu-re (0C)	Mold Time (s)	Cyc-le time (s)	The filling process (% of volume and speed %)			Dwell time (% of maximum injection pressure and time of s)			Warp component （mm）		
					Parag-raph.1	Parag-raph.2	Parag-raph.3	Par-agr-aph.1	Par-agr-aph.2	Par-agr-aph.3	X	Y	Z
Plan.7	90	295	8	50	20	80	100	80	80	0	0.66	0.60	0.37
					50	70	30	0	12s	3s			
Plan.8	90	295	8	50	20	80	100	80	80	0	0.66	0.59	0.36
					45	60	30	0	12	3			

（d）The improved plan adopting two points pouring:

As can be known from the result of the two points pouring, Figure.2 shows that the warp on Z direction is 0.9068mm. The warp value is bigger than single point pouring. The weld trace is too obvious to affect the quality of the workpiece surface. Therefore, it is unable to meet the requirements of flatness, so the filling process should be adjusted, and adjustment parameters are shown in Table 1.

(e) Automatic analysis

Through the optimization of the Mold/Flow gate, choose the best gate location.

The choice of the location of the gate needs to consider the impact of the gate on the appearance of parts.

In this case, the desired location of the gate is obtained. Put away the location of the gate, arrange the cooling pipes. Cooling pipe should close to the workpiece surface to make a good cooling effect and avoid the warp due to poor cooling effect.

The analysis result should provide these reference parameters: Injection time, injection pressure, injection speed, packing pressure, packing time, cooling time, the maximum clamping force, cycle time, and so on. And the filling flow process can be viewed by the figure. After cooling, the temperature distribution, the tendency of the fibers, predicting the place of weld trace, cavitations, warp can be observed. The technology by the above parameters and image was arranged, and the location of the gate was re-changed.

（f）The location of the gate optimized by Mold/flow:

As can be known from the results of inside surface pouring of the workpiece, the liquidity flow gradient is quite satisfactory, And Figure.3 shows that the warp on Z direction is 0.3701mm.The warp value can meet the requirement of the company and can achieve the effect by the analysis.

The adjustment of process parameters can be seen in Table 2.

Comparison of the plans

Warp components on Z-direction in plan.8 can achieve the requirement of the company, and the quality of the workpiece surface is better. Plan.8 is adopted as the final plan.

Conclusions

MoldFlow is excellent software for the mold industry. With the application of MoldFlow technology in molding injection process, the flow behavior of the melt in the mold can be simulated. The forefront of melt flow, the changes of pressure and temperature in the filling process, the location of the weld trace and cavitation can be predicted and shown to help craft workers to predict possible defects before the tryout and identify the causes of defects and the success rate of a test mode. This method can reduce the product development cycles, faster time to market and greatly enhance the competitiveness of enterprises.

REFERENCES

[1] Shan Yan, Wang Bei, Wang Gang. Moldflow mold analysis technical basis. Beijing: Tsinghua University Press, 2004.9

[2] Zhang Xiaolu.Flow Analysis and Application of MoldFlow Software.Die&Mould Manufacture,2002.7

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