

Research of Design and Optimization for Injection Mold Based on CAD/CAE Technology

Zhou Ye

(NanChang Institute of Science & Technology, Nanchang,330108; Jiangxi Engineering Laboratory of Digital Manufacturing for Automobile Parts)

Keywords: CAD technology; Mold flow analysis; Injection mold; Optimal Design

Abstract. Changing the previous mold design methods based on experience, intuition or repeated testing molds, the design method with combination of the computer-aided design software UG, the data transfer software CADDdoctor and the finite element analysis software MoldFlow is adopted for design and optimization for injection mold in the paper; the results showed that the mesh density may not be used as the standard basis for the accuracy analysis of plastic part by testing the indicators such as forming pressure, filling time and the maximum locked-mold force; through stimulation for filling analysis, cooling analysis and warpage analysis in the injecting procedure, the optimum design parameters for the feed system and cooling system of plastic part are obtained, and the distributing characteristics such as cavitation, weld lines and warpage are obtained to provide a significant reference for optimal design of mold structure; lastly, practice proved that the mold structure based on CAD technology can provide good flexibility, reliability and qualified products, and it can provide references for the colleagues.

Introduction

In an era of constant innovation for products and technologies, more and more plastic products, shorter and shorter development cycle. To improve the competitiveness of enterprises, the manufacturers constantly search for new methods of reducing the development cycle of products from the processes of conceptual design, product design, mold design, opening mold and testing mold. It is found that testing mold is a core part, and the traditional design method that the mold is corrected according to experience, intuition or repeated testing molds has not been able to satisfy the demands of modern productions and integrated technology. Now, it can not only check the production feasibility of various products but also predict the condition which may occur and correct it to minimize the problem in the design stage to replace the actual testing mold with the analysis and simulation for mold design on the computer based on mold CAD technology.

With injection molded pallet as an example, a new optimized mold design is proposed that the computer-aided design software UG, the data transfer software CADDdoctor and the finite element analysis software MoldFlow are fully used for mold development. The results showed that the mold design reduces the development time for mold, lowers the material consumption and cost and improves the production efficiency.

Overview of CAD Technology

CAD is refer to the computer-aided design. Computer-aided design system is made from a mix of hardware and software. The hardware part is refer to the computer system which includes master computer, work station, terminal, output devices, etc. The software part includes system program, professional application program and various aided programs.

The process of computer aided design mainly includes the two links 3D modeling with CAD software based on samples or draws and mold design with CAD software based on satisfactory evaluation on the realistic effect.

Application of CAD Technology in Injection Mold Design

The plastic injection mold based on CAD technology can intuitively reflect the design thought of

mold and adjust the mold structure conveniently and reasonably, and this is particularly important for comparison of many designs in the early stage of mold design. Through dynamic simulation for opening and closing mold, the design reasonableness of parting surface of mold and the mechanism for opening and closing mold and the possibility of mold unloading for injection products can be tested. The designs for gating system, cavity layout and cooling system of mold based on computer aided design technology provide structural material for flow analysis and computation of Moldflow.

1. Design of Plastic Products

3D modelling software based on features provides a convenient design platform for designers. It has powerful function of editing&modifying, the function of surface modeling and vivid display effect, and which make the designers to freely express their design intent and really carry out their designs then want. In addition, with the 3D modeling software, the different physical parameters such as the quality and volume of products can be calculated and saved together to lay a good foundation for the subsequent design and analysis. The general 3D CAD software includes Pro/E, UG, CATIA, So1, idedge, Solidwork, etc.

2. Design of Mold Structure

The design module for injection mold of 3D CAD software provides the functions such as definition of parting surface, automatic generation of molding part, design of gating system and construction&usage of standard mold base library. Computer technology is mainly used in the structure design of injection mold. The daily modules includes the mold design module of the software Pro/E, Mold/Wizard of the software UG and the injection mold design module of the software CATIA.

3. Dynamic Stimulation for Opening and Closing Mold

The injection mold has complex structure and independent parts, and it is required to strictly control the sequential operating of mold parts. CAD technology can be used to stimulate the processes of opening and closing mold and pushing products to find out the unreasonable aspects about design of mold structure and correct them in time to reduce the time for modifying mold structure. The dynamic stimulation for opening and closing mold can be realized with help of the movement stimulation module of 3D CAD software.

Mold Design Flow Based on CAD Technology

With the development of injection molding technology, the requirements of quality, speed and accuracy of products are continuously increasing. In the early stage of product development, from the perspective of molding conditions, integrating injection molding analysis technology, numerical simulation technology, computer aided design technology(CAD) and computer aided engineering(CAE), the design of production flow for core content is realized with numerical analysis, and the common engineering technicians can flexibly optimize and manage the project in the specific production operation to effectively improve the competitiveness of enterprises. After discussion, the design flow is shown in Figure 1.

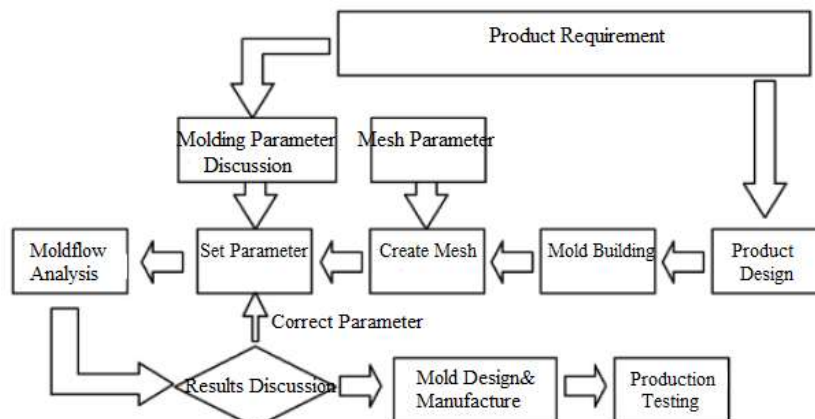


Figure 1. Mold Design Flow

In the flow, the product modeling is carried out with help of the computer aided design software UG4.0, and with the numerical simulation method, the simulation analysis for filling process in plastic parts injection molding, holding pressure process and cooling process are realized with help to the computer aided analysis software MoldFlow to understand the dynamics of plastic in the injection process such as temperature, pressure, density, the best gate location, cavitation distribution, weld line and warpage, and then the processing conditions are determined or corrected based on these “data flow”. In addition, these data flow can be used as the reference for mold design.

Mold Structure Design

Based on the above numerical simulation analysis, the mold structure design for pallet is carried out on CAD platform. The results are shown in Figure 2.

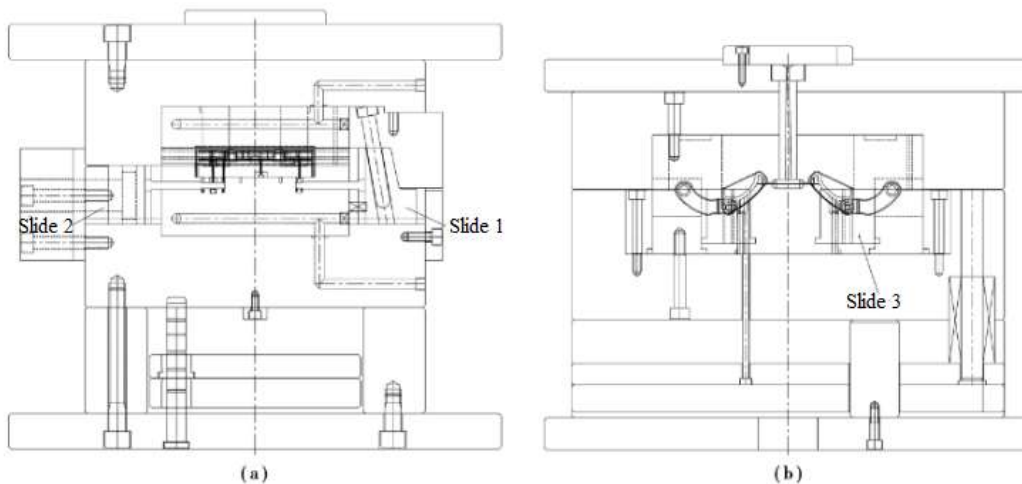


Figure 2. Mold Structure

The parting surface is constructed according to surface features, and the punch die and other mold parts are removed. Because the pallet is a plastic part similar to a cuboid, and its size is not big. Therefore, it used the configuration of two cavity in one plate and the centrosymmetric sprue. This configuration is conducive to pressure balance in cavity and coincidence between the center of pressure and the center of mold. The designs of runner and cooling system are shown in the diagram of numerical simulation system. The focus of injection mold design for pallet is the side pulling mechanism. From the product structure, we can see that there are a line of rotary shaft holes and an earhole on the back of the pallet which need to be molded with side core, and the core pulling mechanism is required. For the rotary shaft holes of two sides on the back of the pallet, two core pins are required for molding. The core pins are fixed to the side slide block, the hydraulic mechanism is used for core pulling at lug side, and the angle pin is used for core pulling at another side.

For the forming hole of lug, it also used the angle pin side slide block core pulling mechanism, the difference is that this hole uses the combination form of side core and slide block because of short core pulling distance. But its guiding direction is same with the former, and it used the same T-slot with the former. For the ejecting mechanism, it used the pin ejector to pull the plastic parts out easier to be processed and designed, and set a push back pin with spring. Other detailed structure is shown in Figure 2. lastly, the production practice shows that the mold has special structure, the side pulling movement of plastic part is flexible and reliable, the mold release is smooth, the product quality is well controlled, and various indicators can satisfy the requirements of customers.

Conclusion

In the mold design based on the continuous “data flow” of Moldflow, the optimal design parameters

of gating system and cooling system of product are obtained, which make the anticipation judgement for the emergence of injection defects such as cavitation, weld line and warpage, and lay a solid foundation for mold structure design. The mold structure is constructed based on CAD technology. The production practice shows that the mold design is reasonable and reliable, and the product fully satisfy the requirements of customers. The mold design effectively integrates the design of plastic injection molding product, design of mold structure, verification of molding conditions, structure verification and production operation. The optimization design method can effectively reduce the cost and improve the market competitiveness of enterprises.

Acknowledgement

Project funding: Project at Nanchang institute of science and technology (No.SZZX-17-19)

References

- [1] Zhao M, Zhao L. Design of Injection Mold for Door Board of Automobile Interiors Based on CAD/CAE[J]. *Plastics Science & Technology*, 2011.
- [2] Lin Q. CAD/CAE Technology-based Injection Mold Design Optimization[J]. *Journal of Chongqing Technology & Business University*, 2012.
- [3] Li S, Xu L, Wang Y Q. Design and NC Manufacturing of Plastic Injection Mold Based on UG Software[J]. *Science Technology & Engineering*, 2009, 630:163-166.
- [4] Ding S, Chu Z, Li X, et al. Injection Mold Running System Optimal Design of Lampshade Part Based on Moldflow[M]// *Advances in Mechanical and Electronic Engineering*. Springer Berlin Heidelberg, 2012:113-118.
- [5] Jin Z, Jiang W, Yu M. Design and Manufacturing of Air Conditioner Panel Hot Runner Injection Mold Based on CAD/CAE/CAM[J]. *Applied Mechanics & Materials*, 2011, 42:68-72.
- [6] Duan L J. Based on the Intelligent Injection Mold CADSystem Two Development Platform Design[J]. *Equipment Manufacturing Technology*, 2012.
- [7] Li F. Rapid Design and Processing Technology of Injection Mold Based on UG 6.0[J]. *Plastics Science & Technology*, 2011.
- [8] Xiaochang X U, Gao D. Application of CAD/CAE Technology in the Injection Mold Design of Telephones Panel[J]. *New Technology & New Process*, 2014.
- [9] Jing H E, Lin Q, Che J. Plastic Products Mold Optimization Design Based on CAD /CAE Technology Assistant[J]. *Journal of Yichun University*, 2014.
- [10] Matin I, Hadzistevic M, Hodolic J, et al. A CAD/CAE-integrated injection mold design system for plastic products[J]. *International Journal of Advanced Manufacturing Technology*, 2012, 63(5-8):595-607.
- [11] Liu F, Tao L H. Design of Injection Mold for Power Switch Component Based on NX and Moldflow[J]. *Journal of Zhejiang University of Water Resources & Electric Power*, 2016.
- [12] Ma C. Design of the Injection Mold for Laptop Battery Cover Based on CAD/CAE[J]. *Plastics Science & Technology*, 2015.