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Numerical Analysis and Optimization Design of Hot Stamping Die Cooling System Based on FLUENT

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Abstract: Whether the design of die cooling system is reasonable is an important index to evaluate the performance of the whole mold system. Aiming at the problems existing in the cooling process of hot stamping die, the selection of cooling pipe parameters is taken as the main research content, and the main factors affecting the cooling system performance of the die are found out. Using the fluid analysis software FLUENT to simulate the U type work piece hot stamping process, analyzes the different pipe diameter, flow velocity, pipeline layout conditions and mould changes of work piece temperature field and heat balance, find out the optimization scheme.

Keywords: Cooling system; FLUENT; Hot stamping

INTRODUCTION

Hot stamping is a new forming method for manufacturing high strength steel stamping, and cooling is a very important link in the process of hot stamping process, which directly influences the service life of the mechanical properties and use of forming parts. The forming of rapid and uniform cooling is an important index to measure the mold cooling system is reasonable, the ideal cooling system can improve the production efficiency, is the key to improve the performance and accuracy of the part mechanics, so it is very important to research and optimization design of mould cooling system. The interference problem Wang Wei for the cooling of existence, put forward a design scheme of cooling pipe based on genetic algorithm, can automatically evaluate the interference checking and cooling performance, effectively improve the quality and efficiency of the design of the cooling system of injection mold. Song Ke to improve the cooling efficiency of injection mold, the distribution of the cooling water channel is analyzed and optimized design, the application of Mold flow software for runner balance analysis, so as to obtain the optimal arrangement of mold cooling channel. Li Xiaoping and so on uses the Abaqus to simulate the flow velocity in the pipeline, so as to obtain the relationship between the water storage capacity and the pipe diameter and the flow velocity, and provide the basis for the cooling system design. Ceng Jinghua analysis of the parameters affecting cooling area, cooling time and cooling water flow on cooling, and the cooling system of injection mold design, puts forward the design method of typical flow channel, complex flow cooling system template, provide theoretical basis for the establishment of the cooling system of library.

Based on this, the basic theory of fluid mechanics and heat transfer analysis of various factors to find out the influence of the cooling effect and measure, and pipeline of the cooling system of hot stamping die diameter, pipe layout and cooling water flow velocity at the same time for the design, analysis and optimization of the changes of temperature field under different structural parameters using numerical simulation FLUENT software, in order to obtain the simulation results and the most reasonable mould structure.

HOT STAMPING PROCESS

Hot stamping process is much more complex than cold stamping process, which needs to be carried out in a certain high temperature environment, mainly including pre forming, heating, stamping and pressure hardening process, such as figure 1.

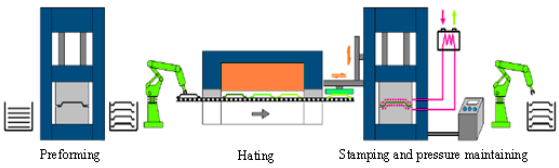


Fig. 1 Schematic diagram of hot stamping

The plate is heated in the heating device to the recrystallization temperature above, so that the microstructure is completely austenite, so as to obtain better plasticity. Subsequently, the sheet metal at high temperature is rapidly put into the hot stamping die

with cooling device, and the structure of the sheet is changed from austenite to homogeneous marten site. The forming parts obtained by hot stamping process have higher mechanical strength, mechanical properties and dimensional accuracy, and generally no springbuck occurs after forming.

PERFORMANCE INDEX ANALYSIS OF COOLING SYSTEM

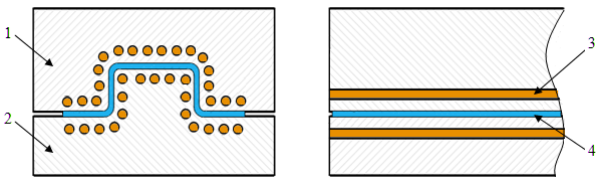
The purpose of cooling is to make the internal structure of the formed parts change from austenite to marten site, and the cooling effect directly restricts the mechanical properties and service life of the products. A measure of die cooling effect there are two indexes, namely the uniformity of cooling rate and cooling, the design of the cooling system, various factors should be considered in the theory of heat transfer of the cooling effect, focus on the following aspects:

1. The contact between the forming parts and the mould. The contact area and pressure between the forming parts and the mold affect the heat transfer coefficient between the two parts, and the larger the contact area and the greater the pressure between them, the better the cooling effect.

2. Meter and layout of pipeline. The larger the diameter of the pipe, the more dense the arrangement, the closer to the die surface, the better the cooling effect, but beyond the limit will affect the strength of the mold, so it is necessary to rationally design the diameter and layout of the pipeline. Figure 2 shows the layout of the cooling pipe for the U type stamping die.

3. The initial temperature, flow velocity and flow state of the fluid. The temperature of the forming parts and the mold is mainly taken away by the flowing cooling water, so the lower the initial temperature of the fluid, the faster the flow velocity, the faster the cooling rate and the better the cooling effect.

4. Initial temperature of tool and forming parts. The greater the initial temperature or temperature difference between the die and the die, the greater the cooling rate and the better the cooling effect.



1-concave die 2-punch 3-cooling tube 4-workpiece
Fig. 2 Schematic diagram of piping layout for hot stamping die of U shape work piece

SIMULATION ANALYSIS

The simulation process takes the U shape workpiece as the object, and uses the PRO/E software to establish the mold model, its composition mainly includes the work piece, the concave mold, the convex mold and the cooling pipe.

Mesh generation is an important part of finite element analysis, which has a great influence on the accuracy of numerical simulation. In this paper, the change of temperature field of U shaped parts and dies under the action of cooling system is mainly studied. In order to obtain more accurate temperature distribution and heat transfer, the tetrahedral mesh method is used to mesh the model in ANSYS software, and the results are shown in figure 3.

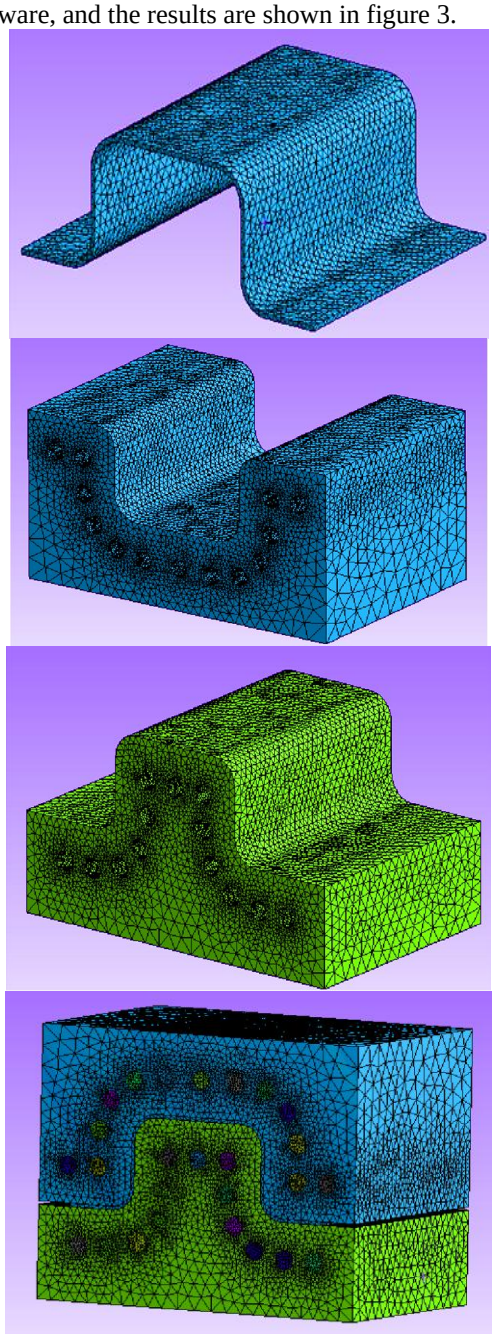


Fig.3 Grid division

According to the analysis of the parameters of the cooling system, in accordance with the actual situation of the cooling effect of the project,

respectively, diameter on the flow velocity, pipe spacing, A, B, C pipe selection of three different groups of numerical simulation analysis, the first group value (8 m/s, 6cm, 5cm), second groups of data (6m/s, 12 cm third, 5mm), group (6m/s, 8cm, numerical 10mm), and set the initial forming temperature of 950 DEG C, the simulation time is 2S, simulated by FLUENT fluid analysis software, the results are shown in figure 4-6.

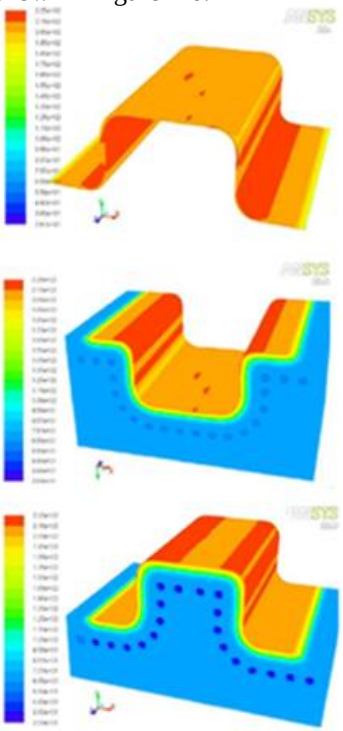


Fig.4 Analysis results of the first set of data

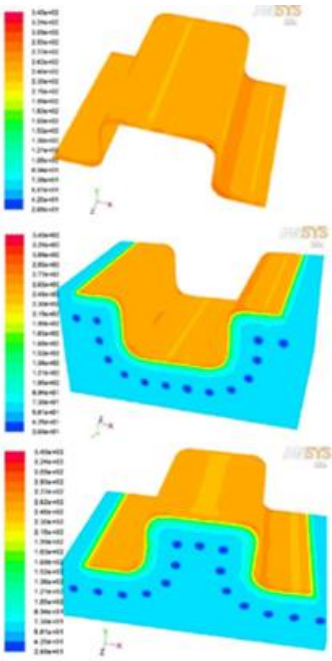


Fig.5 Analysis results of second sets of data

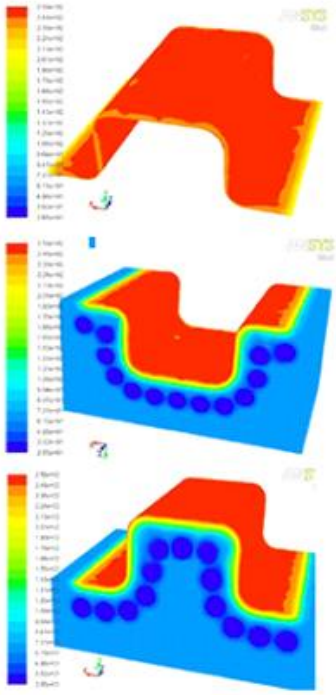


Fig.6 Analysis results of third sets of data

The results show that the cooling temperature of the formed parts has decreased greatly after cooling, and the cooling effect has been achieved. A group and B group although the data pipeline data of the same diameter, the flow speed is faster, but because the pipe spacing is larger and the number of pipeline is less, so the cooling effect is poor; group C data due to the pipe diameter is bigger, the corner plate distance is far, the temperature is very high, the cooling effect is not ideal. Therefore, the piping parameters should be rationally allocated in the design of cooling system.

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