



# Strategies and Techniques for Improving Production Efficiency of Hot Stamping

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**Abstract.** The use of high-performance sheet metal hot stamping and strengthening technology to produce body structures for passenger cars can reduce body weight, improve safety, and contribute to reducing carbon dioxide emissions, and is widely used. China's current hot stamping production capacity is close to 50% of the world's total production. With the increase in the amount of hot stamping parts per car body, if the concurrent increase in production and the demand for small parts are solved, in addition to increasing the production line to increase production capacity, how to improve cooling efficiency, shorten production takt time, and how to in the production cycle, producing more parts is an important means to improve production efficiency.

**Keywords:** Hot stamping · Conveying mechanism · Production efficiency · Die technology · Positioning datum

## 1 Introduction

With the increase in the amount of hot stamping parts for a single body, if the concurrent product increment in production and the increasing demand for small parts are solved, in addition to increasing production lines to increase production capacity, improve cooling efficiency, shorten production takt time, and how to in the rhythm, producing more parts is an important means to improve production efficiency [1]. In the existing production line equipment, the ways to improve the production efficiency include, in addition to improving the cooling efficiency of the mold, and improving the production cycle by shortening the pressure holding time [2], the use of a "one-mold multi-cavity" mold can improve the single-shot The number of parts to be stamped, thereby increasing the production efficiency of the production line. The matching of the manipulator end picker and the blank shape of the part used in the blank conveying [3] of the thermoforming production process requires a large number of custom end pickers. How to improve the versatility of the end pickers is to reduce costs and reduce installation during mold change work. The time to debug the end picker is an issue that needs attention to improve the efficiency of the production line. After multiple processes before and after, how to improve the positioning benchmark from blank blanking to product inspection is a technical means to improve the reliability of production quality. The comprehensive application of these technologies will help improve the productivity and efficiency of hot stamping production lines.

## 2 The Main Points of Technical Realization

### 2.1 Cavity Layout for Multi-piece Forming in One Mold

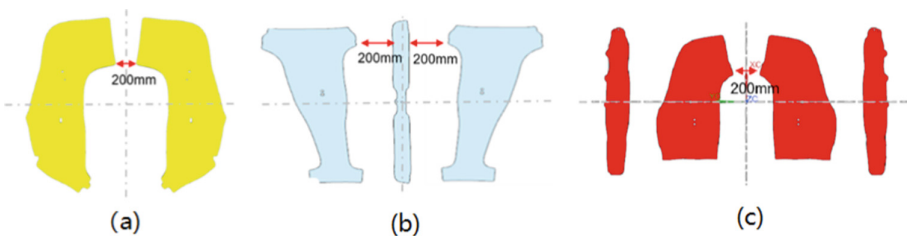
The layout of a mold with multiple cavities generally follows the principle of symmetrical layout of the cavities, which is the basic element to ensure that the pressure center of the mold is consistent with the slider load center of the press. If there is an asymmetric arrangement, or the forming conditions of the parts are inconsistent, the symmetrically arranged cavities will have asymmetric loads, which will also cause eccentric loads, which will affect the deviation and consistency of the mechanical properties of the formed parts.

According to the author's practical application cases and experience, the cavity arrangement should follow the following principles, as shown in Fig. 1. For the first time, it is necessary to consider the size of the working table of the press and the effective width of the heating furnace cavity, as well as the limitations of the mold structure, especially the interference of the outer pressing plate. According to the discharge tolerance of the heating furnace, the spacing of the blanks should generally be maintained at about 200 mm. Whether the center spacing of the blanks can be unified, in addition to the mold structure, the position adjustment of the pressure center also involves the layout of the mold cavity.

Eliminate the uneven force on the clamping plane of the mold caused by the mold load offset of one mold and multiple cavities, and also consider the accuracy of the sheet material and coating, as well as the overall rigidity of the mold.

### 2.2 Common Use of End Pickers for Billet Conveying

The blank before hot stamping needs to be picked up by a mechanical or pneumatic suction cup that matches its shape and conveyed to the loading platform of the heating furnace. For the picking and conveying of multiple pieces of one mold, one end picker and mechanical conveying mechanism can be matched for each solution. The method to reduce the cost and improve the quick replacement of the end effector is to design and manufacture the end effector mechanism that can be shared, as shown in Fig. 2. When changing molds to produce different products, there is no need to replace the conveying mechanism, and the replaced product blank can be picked up only by adjusting the position of the suction cup. The use of shared end-stop technology can speed up the time spent on end-stop replacement and improve the efficiency of the production line.



**Fig. 1.** Layout scheme of one mold and multiple cavities for thermoforming parts: (a) 2 molds; (b) 3 molds; (c) 4 molds.

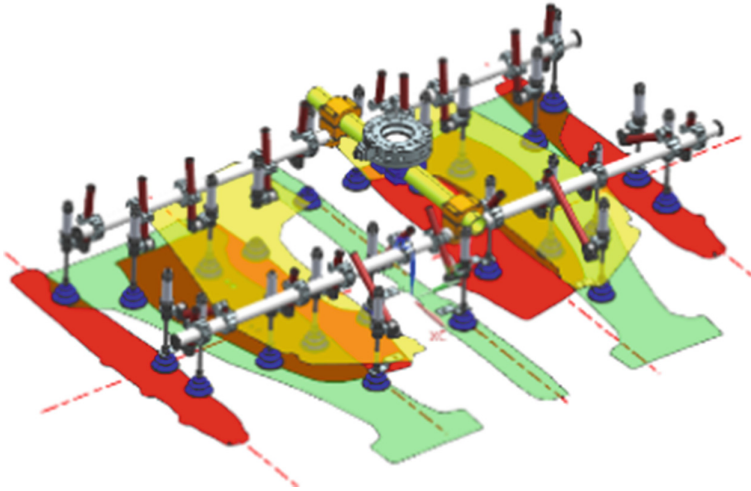
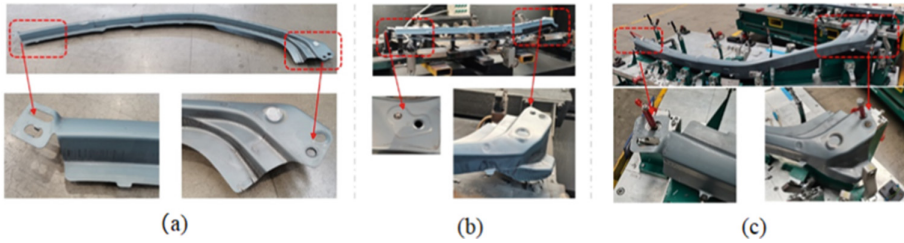


Fig. 2. Three sets of molds share a set of end pickers (1 out of 2, 1 out of 3 or 1 out of 4).

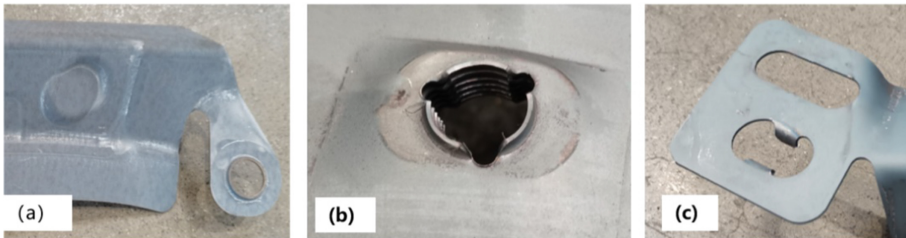
### 2.3 Multi-process Positioning Method Based on Datum Transfer

Considering the entire production process of hot stamping parts, the generation of the positioning marks of the stamping die and the transmission of the positioning datum can reduce the time consumption of subsequent laser cutting and repeated positioning of part size detection, and reduce the error of repeated positioning. As can be seen from Fig. 3, the first is the blank positioning hole or special turning hole structure obtained during blanking. After hot stamping, continue to use these positioning holes as the benchmark for laser processing to complete the cutting of parts. If the necessary positioning holes or local forming structures can be retained after cutting, it can be used for the positioning of the inspection tool for thermoforming parts. The unified positioning method of the whole process can avoid the cumulative error of repeated positioning, simplify the operation of the subsequent process, and better ensure the product quality. More importantly, it is of great significance to adopt a unified mark, which is more conducive to the tracking of product defects and the optimization of the process.

The key to the realization of multi-process positioning is the design of mold positioning pins and positioning holes. The matching clearance between the positioning pin and the positioning hole of the blank requires unique skills. In order to maintain the positioning accuracy of multiple blank or part transfers, "flanging holes" can be used as positioning holes. The design of the flanging hole can also consider the close contact in one direction, while the "loose coupling" in the other orthogonal direction maintains the degree of freedom of positioning in this direction, as shown in Fig. 4.



**Fig. 3.** Transfer of positioning datums in the whole production process: (a) hot stamping die blank positioning; (b) laser processing positioning; (c) part inspection tool positioning.



**Fig. 4.** Several flanging hole positioning structures with different positioning functions.

### 3 Conclusion

After years of research and practical production application by the author, under the existing production line equipment conditions, after adopting the optimal layout of the “one-mold-multiple-piece” mold cavity, the shared end picker, and the unified positioning reference control method, the replacement of the product is changed. The mold time was reduced from 27 min to 10 min. Improve product quality and reliability while increasing production efficiency and reducing production downtime.

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