Improve the Efficiency of the Entire Line by Optimizing the Hot Stamping Production Control Process and Auxiliary Tools

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Abstract. With the increase of hot stamping parts of various varieties and small batches, especially before the development and large-scale production of new energy vehicles, the production line is required to be more suitable for small and medium batches and various materials, which intensifies the hot stamping production line. Die change and replacement of auxiliary tools workload. Adopting a series of optimized operation specifications and using simple and effective auxiliary tools can shorten the interruption time of die change of the entire production line, improve production efficiency and reduce production costs. In order to shorten the overall time for changing the mold, it is necessary to optimize the operation process of the whole process, and it also involves the improvement of auxiliary tools of the production line.

Keywords: Hot stamping · process Optimization · Auxiliary tool development

1 Introduction

With the development of high-strength steel materials and processes, the development of hot forming equipment, especially hot forming production lines, has been driven. The roller hearth furnace production line is suitable for large-scale production, and its high efficiency is mainly reflected in the production rhythm. One-mold multi-cavity forming mold technology has promoted the reduction of the cost of hot-formed products, so that hot-stamping strengthened parts are widely used in automotive lightweight [1, 2]. With the diversification of automotive products, the demand for multi-variety and small-batch products has gradually increased, especially before the development and large-scale production of new energy vehicles, the production line is required to be more adaptable to small and medium batches and various materials [3], as well as rapid replacement Mold and material requirements.

The hot stamping production line is composed of a dismantling and stamping feeding structure, and the material is transported to the feeding table of the roller hearth furnace. To send the stomped material to the feeding table, it is necessary to arrange the positioning column, and put the material of different shapes on the specific position on the feeding table. After the tablet is heated in the roller hearth furnace, when it is output from the

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discharge end, in order to improve the positional accuracy of the tablet, it needs to be repositioned by the material stopper mechanism. After the material heated by the roller hearth furnace moves to the discharge port, it needs to be repositioned with the stopper. After changing the mold and the blank, the baffle of the stopper needs to be readjusted. When the molds and blanks are replaced, the standby position of the press feeding manipulator and the height of the gripper need to be adjusted to a shorter pick-up position. In order to shorten the overall time of the mold changing operation, it is necessary to optimize the operation process of the whole process, and it also involves the improvement of auxiliary tools of the production line.

2 Optimization and Improvement of Production Line Tools

2.1 Optimization of the Discharge Blocker of the Thermoforming Heating Furnace

Using a conventional stopper, although it is highly versatile, it needs to be replaced frequently and the dimensions used need to be measured and installed during the replacement process. If the production line uses a multi-cavity mold, the adjustment time for measuring different shapes of blanks will be multiplied.

The original fixed blocking plate was separated from the beam, and the installation process was time-consuming, as shown in Fig. 1(a). Through design optimization, the one-piece structure is replaced, as shown in Fig. 1(b). The size of the improved one-piece blocking plate is more suitable for fixing the length of the sleeve, which is convenient for adjustment and installation, saving the time of repeated measurement and shortening the preparation time for mold change. The optimized new blocker reduces the overall weight by 20%, is easy to replace and simple to operate. After adopting the new improved structure, the process control process plan was re-formulated. The new general baffle developed and produced turns the blocking beam into a general mode, so only the blocking plate needs to be replaced to avoid the measurement and adjustment process. The original need to replace the work requires two It takes 7 min for an individual to complete, and the new program only takes 3 min to replace by one person.

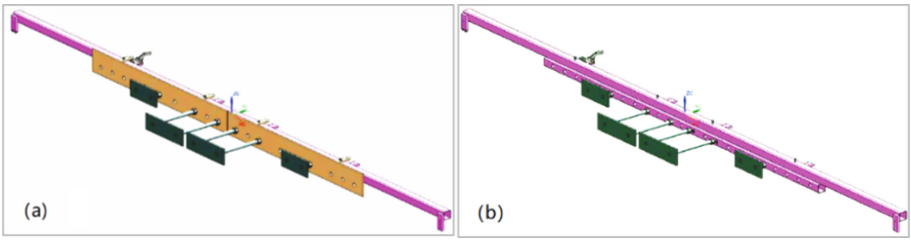


Fig. 1. Schematic diagram of the structure of the discharge blocker before (a) and after (b) optimization.

2.2 Thermoforming Discharge Time Optimization

In the original discharging process, the distance between the outlet of the material and the coincidence point needs to be adjusted, and the buffering and stabilization of the material requires a certain waiting time. Improve the optimal alignment of the fingers, reduce the redundant auxiliary positioning fingers, and shorten the buffer time of the fingers. The distance between the blank and the coincidence point is optimized, and the stable waiting time caused by the impact of the blank motion inertia is reduced. Further improve and shorten the distance between the centering finger and the blank, reduce the positioning time, and reduce the buffer time through fast positioning.

On the existing stopper adjustment equipment, after reducing the distance from the grating to the coincident point from 4500 mm to 3900 mm, the buffer time can be saved by 0.2 s to ensure that the material reaches the key position under the front desk without buffering. After changing the position of the positioning finger, 0.1 s is saved because the buffer time is reduced during the positioning process of the blank. This improvement reduces a total of 0.3 s of the discharge process time.

2.3 Path Optimization of Thermoforming Robot Arm

According to the proper adjustment of the operation situation and the mold space, the movement trajectory of the discharging manipulator can be gradually optimized to reduce the running time and improve the automation efficiency. Check that the current operating path of the robotic arm is micro-optimized under the condition of barrier-free and material feeding risks, and repeated inspection and confirmation to reduce the risk of collision. The use of lateral gripping and pre-moving the manipulator to the pre-reclaiming position for waiting reduces the travel time from the waiting position to the fixture. The method is to adjust the height position of the manipulator. The improvement effect is obvious. The original manipulator takes 0.3 s to increase to 410 mm, and the optimized standby position is 378 mm in advance, and it only takes 0.2 s to move up.

2.4 Removing the Auxiliary Positioning Frame of the Stamping Table

With the increase of hot stamping parts of various varieties and small batches, the workload of changing molds and replacing auxiliary tools in hot stamping production lines has been intensified. The conventional method is to position the blank by placing positioning posts on the dismantling table according to the layout drawing of the blank. The operator should consider how to place the supporting beam so that the beam does not interfere with the operation of the forklift, so that the bracket is completely positioned and does not shift. In order to simplify the installation and positioning process, a simple quick guide device is designed to solve the method of quickly installing the positioning post. Make a simple positioning frame for each set of molds, as shown in Fig. 2. Place the positioning frame on the material table before feeding, see Fig. 3. After inserting the positioning column in the hollow position given by the positioning clip, the positioning frame can be removed, and the material can be placed on the feeding table. This kind of fast navigation device can greatly simplify the operation process, prevent operation errors, and save the time of tool replacement for mold changing and product changing.

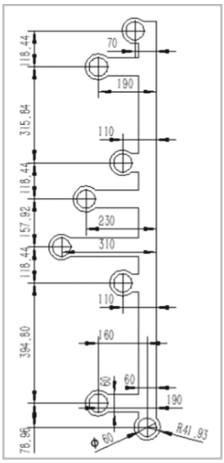


Fig. 2. Auxiliary positioning frame customized for blank.

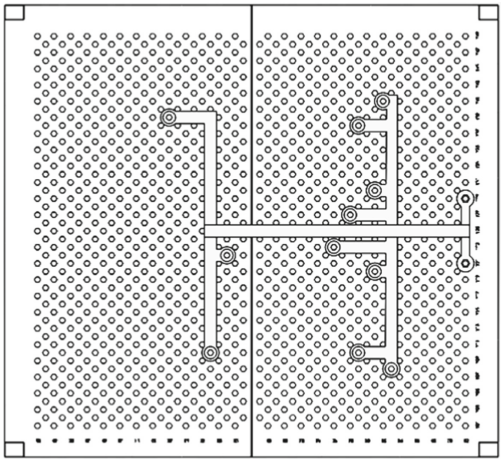
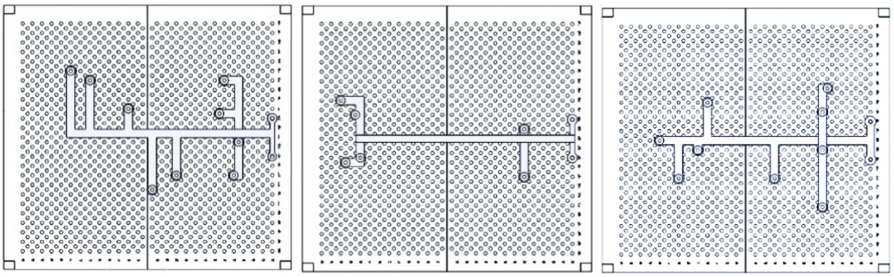


Fig. 3. The positioning frame placed on the material table guides the positioning of the positioning column.

The production of the positioning frame can be predicted by the corners, laser-cut to form, and then welded into the required positioning frame. When the spacer is not in use, it can be placed on a special rack. Each rack is managed by a label, so that everyone can be trained to perform blank positioning operations, improving efficiency.

Figure 4 is an example of a point stand that has been actually used. Figure 4(a) shows the channel blank spacer and its arrangement in a car body. Figure 4(b) is the positioning application of a body B-pillar, and Fig. 4(c) is the positioning application of a body A-pillar.



(a) Blank spacer for middle channel (b) Spacer for B-pillar blank (c) Blank spacer for A-pillar

Fig. 4. Application of spacers for common blanks that have been used in hot stamping production.

3 Summary

The domestic regular time mold change time is 20–30 min, and it takes 27 min of work for 4 people. To shorten the mold change interruption time of the production line, the first is to improve the entry and exit of the mold into and out of the press table, and the second is to improve the positioning column installation method of the material stamping table. Using the guide function of the positioning frame, the positioning rods can be inserted quickly, thus shortening the operation time of changing the loading table device. Using a series of optimized operating specifications and the use of simple and effective auxiliary tools, the mold change interruption time of the entire production line can be shortened to 4 people and 10 min. In the best case at present, the mold change can be completed in 5 min, and the production after the mold change can be started in 10 min.

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