Design of blanking and drawing stamping die based on the perspective of human capital and job characteristics

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Abstract. From the perspective of matching people and posts, this paper intends to improve the work efficiency of first-line workers in the manufacturing industry through the transformation of existing molds, and improve the performance of enterprises. The main content of this paper is to produce blanks for muffler end caps with molds, to develop relevant process routes, and to design molds for production. The process route mainly includes two processes of blanking and deep drawing, and is designed as a blanking and deep drawing composite die. The selection of the stamping process was based on the review of the relevant materials and the careful analysis of the dimensions formed outside the product; the design of the stamping die comprehensively considered the economics, the stamping processability and complexity of the parts, etc.; The unfolding size calculation is performed by converting to a familiar model without any influence on the shape of the part. Finally, the total assembly drawing is generated according to the requirements of the part structure design and the production parts.

Keywords: human-gang matching composite mold blanking drawing deep drawing

1. Introduction
With the continuous development of economic aggregates and light industrial product technologies, the demand for molds in various industries is increasing, and the technical requirements are getting higher and higher. Experts in the industry believe that although there are many types of molds, the current development focus should be to meet both large-scale demand and high technical content, especially the molds that are not self-sufficient in China, need to be imported in large quantities, and large and precise that can represent the development direction, complex, long life mold. Therefore, some important mold standard parts must also be developed, and its development speed should be faster than the development speed of the mold, so as to continuously improve the standardization of molds in China, thereby improving mold quality, shortening mold production cycle and reducing costs.

Due to various reasons, the current status of China's mold industry is still not suitable for current industrial development. Whether in designing manufacturing technology and production capacity, or in terms of management level, it is far from meeting the demand, seriously affecting the variety, quality and production cycle of industrial product production, weakening the competitiveness in the international market and hindering the introduction. The continued use and diffusion of technology and production lines has also cost a lot of foreign exchange. To this end, it is imperative for China to ensure
the speed of national economic development, achieve the grand goal of four modernizations, become an industrialized country, and revitalize and vigorously develop the mold industry.

The deformation process of the stamping part is very complicated, although it cannot be described very accurately here, but the practice and research of the predecessors show that if the gap between the convex and concave molds remains normal, the deformation process of the stamping can be roughly divided. It is the three stages of elastic deformation, plastic deformation and fracture separation.

2. Analysis of stamping materials

![Figure 1. Parts figure](image)

The parts are as shown; its material: carbon structural steel Q235, mass production.

| Material | Shear Strength | Tensile Strength | Elongation | Yield Strength |
|----------|----------------|------------------|------------|---------------|
| Q235     | 310-380MPa     | 380-470MPa       | 21-25      | 240MPa        |

The requirements for stamping on the sheet material must first meet the technical requirements of the product, such as strength, stiffness and other mechanical properties. Secondly, it must meet the requirements of the stamping process, that is, it should have good stamping and forming properties. With the minimum material consumption, the minimum number of processes and working hours, the stable quality products can be obtained stably, and the mold structure is simple and the mold life is high, so labor and punching costs can be reduced.

The factors affecting the processability of the drawn parts are mainly the structure and size, precision and materials of the drawn parts. The requirements for the structure and size of the deep drawing process are that the deep drawing piece is as simple and symmetrical as possible, and can be deep drawn at one time; the wall thickness tolerance or thinning amount of the deep drawing part should generally not exceed the variation law of the wall thickness of the drawing process; When the degree of deformation of the part is too deep, in order to avoid cracking, multiple deep drawing is required. At this time, under the premise of ensuring the necessary surface quality, the inner and outer surfaces should be allowed to have traces that may occur during the drawing process. Under the guarantee of assembly requirements, the side wall of the deep drawing piece should be allowed to have a certain inclination. The radial dimension of the deep drawing member should only be marked with the outer dimension or the inner dimension, and the inner and outer dimensions cannot be marked at the same time.

The process requires that the material has good plasticity, and the smaller the yield ratio \( R_m / R_{el} \), the greater the degree of ultimate deformation allowed by one draw, and the better the draw performance: the plate thickness directivity coefficient \( r \) and the plate plane direction coefficient \( \Delta r \) reflect the materials. The anisotropic property, when \( r \) is large or \( \Delta r \) is small, the deformation of the material thickness is easier than the deformation in the thickness direction, the difference in the performance of the plane direction of the plate is small, and the material is not easily thinned or cracked during the drawing, thereby facilitating the drawing.
The part is simple in structure and symmetrical in shape, and is composed entirely of arcs and straight lines without long cantilevers and slots. In addition to the distance between the center hole and the two center holes, the dimensions of the parts are close to the IT11 level, and the other dimensions are free size and no other special requirements. The parting requirements can be achieved by ordinary blanking method. The material of the parts is ordinary carbon steel Q235, the annealing tensile strength is 380~470MPa, and the yield strength is 240MPa. This material has good structural strength and plasticity, and its punching workability is good. The part has good punching property and can be punched and processed, and is suitable for mass processing.

The part dimensions are unfilled and can be considered as IT14, all within the economic accuracy of the stampings. Due to the small size of the part, the positional tolerance (symmetry, concentricity) is determined by 1/2 of the maximum dimensional tolerance in the width direction. It is 0.15mm.

3. Stamping process calculation
When drawing, the metal material flows according to a certain rule, and the shape of the blank must be adapted to the requirements of metal flow. Since the volume of the material before and after drawing is constant, the surface area of the blank before drawing and the surface area of the workpiece after drawing are considered to be approximately equal for the constant thin drawing due to the assumption that the material thickness in the deformation is constant.

Determining the trimming margin: Due to the anisotropy of the material and the difference in metal flow conditions during drawing, the mouth of the workpiece is not flat after drawing, and usually needs to be trimmed after drawing. Therefore, the blank size should be calculated in the height direction of the workpiece ( Add a trim δ to the flangeless member or flange.

The flanged deep drawing member can be regarded as a semi-finished product when the general circular through-shaped member is not drawn at the end, that is, the drawing process is finished only when the outer diameter of the blank is drawn to be equal to the diameter \( d_f \) of the flange edge (ie, the flange). The stress state and deformation characteristics of the deformation zone should be the same as those of the cylinder.

\[
d_f/d = 142/90 = 1.5778 > 1.4
\]

That is, the flange member is a wide flanged tubular member. It can be seen from Table 3-1 that the flange trimming margin is \( \Delta R = 3.6 \). Therefore the diameter of the flange of the cylindrical member is:

\[
d_f = (142 + 2 \times 3.6) = 149.2 \text{mm}
\]

| Flange diameter \( d_f \) | Relative flange diameter \( d_f/d \) |
|--------------------------|-------------------------------|
|                           | 1.5  | 1.5-2 | 2-2.5 | 2.5-3 |
| <25                      | 1.8  | 1.6   | 1.4   | 1.2   |
| >25-50                   | 2.5  | 2.0   | 1.8   | 1.6   |
| >50-100                  | 3.5  | 3.0   | 2.5   | 2.2   |
| >100-150                 | 4.3  | 3.6   | 3.0   | 2.5   |
| >150-200                 | 5.0  | 4.2   | 3.5   | 2.7   |
| >200-250                 | 5.5  | 4.6   | 3.8   | 2.8   |
| >250                     | 6.0  | 5.0   | 4.0   | 3.0   |

The material area drawn into the die is 5% more than the area actually required by the part, that is, the actual area of the material that is first drawn into the die is:

\[
A = \frac{\pi}{4} \left[ 12731.2 + (110^2 - 68^2) \right] \times 105\% \text{mm}^2
\]

\[
= 20759.76 \times \frac{\pi}{4} \text{mm}^2
\]
After pulling in more than 5% of the die, the corrected blank diameter is

\[ D = \sqrt{20759.76 + (142^2 - 110^2)} \text{ mm} \]

= 169.57 mm

4. Calculation of main process parameters

The punching force is the pressure of the punch on the material during the blanking process. It varies with the stroke of the punch. Generally speaking, the punching force refers to the maximum value of the punching force. Punching force is an important basis for the selection of presses, mold design and strength check. The punching can theoretically be considered as shear fracture, so the maximum punching force can be calculated according to the anti-dropping force of the sheet. Similarly, the unloading force, pushing force and top piece force can be calculated.

Table 3. Discharge force, pushing force, top piece force coefficient

| Material thickness / mm | \( K_u \) | \( K_p \) | \( K_t \) |
|-------------------------|-----------|-----------|-----------|
| Steel \( \leq 0.1 \)    | 0.065–0.075 | 0.1       | 0.14      |
| >0.1–0.5                | 0.045–0.055 | 0.063     | 0.08      |
| >0.5–2.5                | 0.04–0.05   | 0.055     | 0.06      |
| >2.5–6.5                | 0.03–0.04   | 0.045     | 0.05      |
| >6.5                    | 0.02–0.03   | 0.025     | 0.03      |
| Aluminum, aluminum alloy| 0.025–0.08  | 0.03–0.07 |           |
| Pure copper, brass      | 0.02–0.06   | 0.03–0.09 |           |

5. Assembly of the mold handle

The mold adopts a B-type press-in mold shank in the flange mold shank, the mold shank and the upper mold base are matched with H7/h6, the mold shank is mounted on the mold base, and the mold shank and the upper mold base are inspected by the square ruler. The verticality of the upper plane, the error is not more than 0.05 mm, and then fixed to the upper mold base with screws. The push plate should be loaded before the mold shank.

(1) Assembly of guide post and guide sleeve

The guide bush guide sleeve and the upper and lower die holders are respectively connected by press-in connection, and the cooperation between the guide bushing and the guide post and the die base is respectively required to correct the verticality of the guide post to the bottom surface of the die seat when pressing the H7/h6 and H7/m6 respectively. The distance between the fixed end surface of the guide post and the bottom surface of the lower mold base is not less than 1–2 mm.

(2) Assembly of punch and concave mold

The cooperation between the punch and the punch fixing plate of the mold is H7/m6, and after the punch is installed into the fixing plate, the fixed end surface should be in the same plane as the supporting surface of the fixed plate, and the punch and the fixed on the press are adjusted. The verticality of the plate presses the punch into the fixing plate. After the perpendicularity of the punch to the fixed bearing surface is checked, the upper end of the punch is riveted. Before assembling, the upper end surface of the punch is ground together with the fixing plate on the surface grinder. Flat and flatten the working face of the punch with the positioning of the fixed plate support surface. The fit between the concave-convex mold and the fixed plate is H7/m6. Before the final assembly, the concave-convex mold should be pressed into the fixed plate, and pressed on the surface grinder to flatten the upper and lower surfaces.

6. Mold assembly

(1) Place the fixing plate assembled with the punch on the lower die holder, press the center line to fix the position of the fixed plate, clamp with the parallel collet, drill the taper hole on the lower die holder through the screw hole, and remove the convex. The mold fixing plate is drilled on the lower mold base by tapping the threaded bottom hole and tapping, and the punch fixing plate is placed on the lower mold base and aligned, screwed, drilled, and pinned.
(2) When the drill hole is unloaded, the unloading plate is placed on the concave-convex mold that has been loaded into the fixed plate, and a contour horn of appropriate height is placed between the fixed plate and the unloading plate, and the parallel chuck is used. The clamping is performed, and the taper hole is drilled on the mold base according to the position of the screw hole on the unloading plate, and then the hole is taken apart, and the hole is drilled according to the taper hole.

(3) Inserting a discharge spring into the spring hole of the concave-convex mold fixing plate, and inserting the discharge plate into the concave-convex mold; using the same method as in (1), the screw hole on the drill plate and the upper mold base, the push rod Holes, and then the combination parts of the gasket and the discharge plate, the concave-convex mold, and the concave-convex mold fixing plate are sequentially loaded into the upper mold base, fixed by fastening screws, and the pin is positioned.

(4) Inserting the stopper pin on the blanking die, loading the pusher block into the blanking die, and loading the pusher into the pusher hole of the fixed plate, and using the fastening screw to form the blanking die The punch fixing plate is fixed, drilled, and pinned.

7. Conclusion
This paper analyzes the material and type of stamping die. The article calculated the parameters of the abrasive tool and put forward every flow of its operation. On the basis of design and calculation, this paper gives the related design chart. The research of mould reformation is helpful to improve the economy and practicability of production. In addition, the design of the mold also helps to improve the work efficiency of workers. The research in this field is an important research direction of future ergonomics and industrial machinery.

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