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Design of Blanking Die for Bush

Lingqi Zeng

Qingdao University of Science and Technology, Qingdao 266061, China

q15610492017q@163.com

Abstract

Through the process analysis of the bushing parts, a single-process bushing blanking die was designed. The punching process force was analyzed and calculated. To ensure the dimensional accuracy of the punched parts, the dimensions of the main parts of the punching die were calculated. The positioning of the guide plate and the stopper pin was used to make the positioning of the strip more accurate. The process of using the mold. This mold can meet accuracy requirements and reduce costs.

Keywords

Bushing; blanking die; mold structure; design.

1. Introduction

The stamping die is indispensable process equipment for stamping production and is a technology-intensive product. The quality, production efficiency, and production cost of stamping parts are directly related to mold design and manufacturing. The level of mold design and manufacturing technology determines to a large extent the quality, efficiency, and development capabilities of new products. For bushing parts, it is necessary to ensure machining accuracy and reduce the cost of mold manufacturing. Therefore, the design of the bush parts mold is very important.

2. Process Analysis of Parts

The bushing parts are shown in Figure 1. The material of this part is 10F, and the production batch is small batch production. The part is a typical cylindrical part, which requires an internal size, a material thickness of 1mm, a simple and symmetrical part shape, good structural manufacturability, an accuracy level of IT12, and the remaining dimensions are free tolerances, dimensional accuracy requirements are not high, To meet the requirements of the process for the accuracy level; the material used for the parts is 10F steel plate, which is not strong, but has high plasticity and toughness, has good stamping, stretching and bending properties, and is easy to deep-draw. In summary, the drawing process of this part is better and can be formed by drawing.

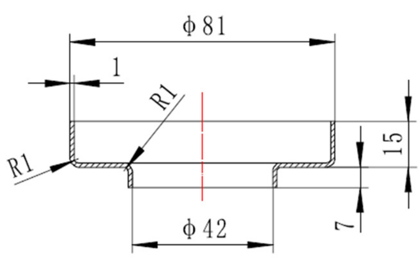

Fig. 1 bushing

3. Determination of Process Plan

3.1. Process Calculation

Calculation of geometric neutral layer according to thickness of workpiece: $\mathrm{d} = 80\mathrm{mm}, \mathrm{h} = 14.5\mathrm{mm}, \mathrm{r} = 1.5\mathrm{mm}$.

(1) According to the relative height of the drawing parts $\frac{h}{d} = 0.18 < 0.5$.Relatively small height, no need to trim.

(2) Billet diameter

$$D=\sqrt{(d^2+4d(H-1.5/2)-1.72rd-0.56r^2}=104mm \quad (1)$$

(3) Look up the table [1]to determine the edge value and blanking gap. Take 1.5mm on both sides, 1.5mm on both sides, and 0.08mm on the blanking gap.

3.2. Drawing up the Process Plan

This part is a cylindrical part with turning holes at the bottom, which needs to go through four processes: blanking, deep drawing, punching, and turning. The shape of the part is simple, the drawing height is small, the precision requirement is not high, and the stamping process is good. The design of the bushing blanking die can give the following three schemes:

Process one: Use four single-step die for blanking, deep drawing, punching, and turning, which can meet the accuracy requirements of parts, simple die manufacturing, low die cost, many shortcomings, many occupied punches, low productivity, suitable for small batches produce.

Technological scheme two: the use of blanking and drawing composite die and two pairs of single-process die punching and turning can meet the precision requirements of parts. The manufacturing of blanking and drawing die is slightly more complicated than single-process die, the cost of the die is slightly higher, and the productivity ratio The scheme is high, suitable for medium batch production.

Process three: use blanking deep drawing composite die and punching and turning composite die to produce two sets of molds, which can meet the accuracy requirements of parts. The production of composite molds is more complicated than the production of single process molds, the cost of molds is higher, and the minimum wall thickness of the convex and concave molds is affected at the same time. Restricted, high productivity, suitable for mass production.

According to these characteristics, consider small batch production, to reduce the cost of the mold, determine the adoption of program one.

4. The Layout of Blanking Parts

According to the shape characteristics of the workpiece, it can be divided into a straight row, diagonal row, straight row, diagonal row, mixed row, multi-row row, and cutting edge.

According to the thickness of the sheet material t=1mm, consult the literature, and choose the reasonable edge value when the sheet material is blanked a=1.5mm, a_1=1.5mm, the feeding step.

$$\mathrm{A} = \mathrm{D} + a_1 = 105.5mm \quad (2)$$

In the formula: D—the maximum dimension of the blanking piece perpendicular to the feeding direction; a_1 —The overlap between the blanking parts.

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According to sheet thicknesst = 1mm, Δ= 0.35mm, C = 0.35mm, When the strip is guided by the guide plate and there is no side pressure device between the guide plates, the width of the strip is:

$$B^{0}_{-\Delta} = (D_{m}ax + 2a + C)^{0}_{-\Delta} = 107.5^{0}_{-\Delta} \tag{3}$$

$$B^{0}_{1-\Delta} = B + C = 108^{0}_{(-0.35)}mm \tag{4}$$

In the formula: a—the overlap between the blanking part and the side of the strip;

a_1—The edge value between a punching piece and a punching piece;

5. Calculation of Punching Process Force and Pressure Center

The punching process force includes punching force, unloading force, pushing piece force, and top piece force. The purpose of calculating the punching process force is to select the punching equipment and design the die. The nominal pressure of the press must be greater than the punching process force[1].

5.1. Calculation of Punching Process Force

The punching force is the force required to separate the workpiece and the sheet when the punch and the die move relatively. The calculation method of the theoretical punching force of a general flat-edge die during punching is:

$$F_0 = Lt\tau \tag{5}$$

Where F_0—the theoretical blanking force, N;

L—the peripheral length of the punched piece, mm;

t—the thickness of the material, mm;

τ—Shear strength of the material, Mpa;

Considering factors such as blade wear, fluctuations in die gaps, changes in material mechanical properties, and material thickness deviations, the actual punching force needs to be increased by 30% [2], so the following should be taken:

$$\mathrm{F} = 1.3F_0 = 1.3Lt\tau = Lt \tag{6}$$

$$\mathrm{F} = \pi \mathrm{Dt}\sigma_b = 113\mathrm{KN} \tag{7}$$

5.2. Calculation of Discharge Force, Pushing Force and Top Force

Due to the elastic deformation and friction of the material during punching, the material with holes after punching will be tightly clamped on the punch, and the punched material will be tightly clamped in the cavity of the concave die. To continue punching, the material hooped on the punch must be removed, and the material stuck in the die must be pushed out or ejected. The force required to remove the material clamped on the die is called the discharge force; the force that pushes the material stuck in the die along the punching direction is called the pusher force; the force that is stuck in the die The force that the material is pushed against the punching direction is called the top piece force [3].

$$F_X = K_X F \tag{8}$$

$$F_T = nK_T F \tag{9}$$

$$F_D = K_D F \tag{10}$$

5.3. Determination of Press Tonnage

The nominal pressure of the press must be greater than or equal to the sum of various stamping process forces, and adopt the method of elastic discharge and discharge.

$$F_{\text{total}} = F_X + F + F_t \tag{11}$$

According to $P \geq (1.1\sim1.3)F$, get P=187.8KN. According to the literature, a press with a nominal pressure of 250KN is used.

6. Dimensions of the Working Part of the Male and Female Die

The dimensional accuracy of the blanking parts mainly depends on the dimensional accuracy of the cutting edge, and the gap value of the mold also depends on the size and tolerance of the cutting edge of the mold. Therefore, the reasonable determination of the size and tolerance of the cutting edge of the mold is the key link in the design of the blanking die.

6.1. Principles for Calculating the Cutting Edge Dimensions of Male and Female Dies

The blanking part is based on the large end size, and the large end size of the blanking part is equal to the size of the concave die, so when designing the blanking die, the concave die should be used as the reference, and the size of the punch should be reduced to ensure the gap; punching parts The size of the small end is equal to the size of the punch, so when designing the punching die, the punch should be used as the reference, and the size of the die should be increased to ensure the gap. The gap is generally taken as the smallest reasonable gap.

6.2. Calculation Method of Cutting Edge Size of Convex and Concave Die

To ensure that the die gap value is less than the maximum gap, the manufacturing tolerances of the punch and die must meet the following conditions:

$$\delta_{\text{Convex}} + \delta_{\text{concave}} \leq Z_{max} - Z_{min} \tag{12}$$

According to the literature [3], the initial double-sided gap of the punching die of the material and material thickness can be obtained:

$$Z_{max} = 0.14mm; Z_{min} = 0.1mm; \\ Z_{max} - Z_{min} = 0.04\text{mm} \tag{13}$$

The manufacturing tolerances of the convex and concave molds can be selected according to IT6~IT7 level, and the look-up table [4] gives:

$$\delta_T = 0.022mm; \delta_A = 0.035mm$$

$$\delta_{\text{concave}} = 0.6(Z_{max} - Z_{min}) = 0.024\text{mm} \tag{14}$$

$$\delta_{Convex} = 0.4(Z_{max} - Z_{min}) = 0.016mm \tag{15}$$

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Consult the literature, the wear factor X = 0.75, the tolerance of the blanking parts, the size, and tolerance of the blanking concave and punch edge parts can be obtained:Δ= 0.35mm;

$$D_A = (D_{max} - x\Delta)_0^{+\delta_A} = 103.7375_0^{+0.024}mm \tag{16}$$

$$D_T = (D_A - Z_{min})_{-\delta_T}^{0} = 103.6375_{-\delta_T}^{0}mm \tag{17}$$

7. Selection of Stamping Equipment

The nominal pressure of the press must be greater than or equal to the sum of the various stamping process forces F_Z, and adopt the method of elastic discharge and discharge.

$$F_z = F_X + F + F_t = 156.48KN \tag{18}$$

$$\mathrm{P} \geq (1.1\sim1.3)F_Z \tag{19}$$

Get P=187.8KN. According to the literature, a press with a nominal pressure of 250KN is used.

8. Design of the Main Parts of Punching Dies

8.1. Punching Punch

(1) Structure form of punch: adopt round punch. To improve the strength, stiffness, and stress concentration of the punch, the circular punch is designed as a step and smooth transitions with a larger radius.

(2) Fixing method of punch: adopt the press-fit fixing method. When punching small and medium-sized parts, a transition fit (H7/m6) can be used to fasten it on the fixed plate of the die, and a through shoulder is formed at the top to facilitate fixing and ensure that it is not pulled out during work.

(3) Calculation of the length of the punch: The length of the punch should be determined according to the structure of the punching die body, and the needs of grinding, the safety distance between the fixed plate and the discharge plate, and assembly should also be considered.

When the elastic pressure discharge plate is used, the length of the punch is calculated by the following formula (20):

$$\mathrm{L} = h_1 + h_2 + t + h \tag{20}$$

According to the design, h_1=13.1mm; h_2=15mm; h=24mm; t=1mm; the grinding amount of the punch is 5mm, the depth of the punch into the concave is 1mm, the fixed plate of the punch and the discharge plate The safety distance between them is 18mm, which is calculated as L=53.1mm when taken into the above formula.

8.2. Design of the Die

The shape of the concave mold is round and rectangular, and the structure is integral and mosaic. The material of the concave mold is the same as that of the convex mold, and the hardness of the heat treatment is slightly higher than that of the convex mold. The mold uses an integral concave mold [5].

(1) The external dimensions of the die:

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The external dimensions of the die should ensure sufficient strength, stiffness, and grinding capacity. The external dimensions of the die are generally determined according to the thickness of the material being punched and the maximum external dimensions of the blank. Die thickness:

$$H = Kb \tag{21}$$

And greater than 15mm; wall thickness of the die:

$$c = (1.5\sim2)H \tag{22}$$

And more than 30mm. Among them, b is the maximum external dimension of the blanking part; K is the coefficient of influence considering the thickness of the sheet, which can be obtained by looking up the table, K=0.18, $b = \emptyset 104mm$, calculated, H=18.72mm; c=32.76mm.

Die length:

$$L = b + 2c \approx 170mm \tag{23}$$

Die width:

$$B = b + (2.5\sim4.0)H = 150.8mm\sim178.88mm \tag{24}$$

Take B=160mm. Therefore, the external dimensions of the concave mold are 170 mm × 160 mm × 18.72 mm.

(2) The structure of the cavity opening of the die: the straight cylindrical cutting edge is adopted. The structure has high strength and the size of the cutting edge remains unchanged after grinding. The waste or blanking parts are easy to accumulate in the die, especially when the gap is small. The straight-wall part of the mouth wears faster and is used for punching parts with complex shapes or high precision requirements.

(3) Fixation of female mold: mechanical fixing. When the die and the fixing plate are positioned by screws and pins, the number and specifications of the pins and screws and their positions can be found in the standard typical combination according to the size of the die. The position can be adjusted according to the needs of the structure. The distance between screw holes, pinholes, and their edges to the template can not be too close, otherwise, it will affect the life of the mold.

9. Working Principle of Bushing Blanking Die

The structure of the bushing blanking mold is shown in Figure 2 below,

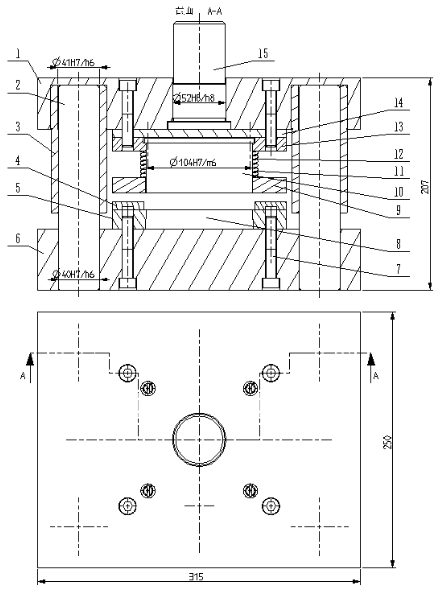

Fig. 2 Liner blanking die structure

1—Upper die base plate 2—Guidepost 3—Guide sleeve 4—Material guide plate 5—Female mold 6—Lower mold base plate 7—Hexagon socket screw 8—Stopper pin 9—Stripper plate 10—Punch 11—Spring 12—Discharge screw 13—Punch fixing plate 14—Pad plate 15—Mold handle.

Place the sheet material in the direction of the material guide plate, and use the material blocking pin to a position. The hydraulic press drives the mold handle to close the upper and lower molds. When punching, the die handle drives the punch, and the punch and die are matched to achieve blanking. When the upper die returns, it uses an elastic pressure discharge plate to discharge. After the discharge is completed, the entire stamping process is completed, and then the blank is removed.

10. Summary

Using this stamping process to produce bushes in small batches improves production efficiency. At the same time, the mold structure is simple, reducing manufacturing costs and meeting production needs.

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