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A study on an inlay type hollow extrusion die

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Abstract: A inlay type porthole extrusion die for the semi hollow profiles is presented. The structure parameters of the die are introduced. The selection of structure parameters is described in detail, it mainly includes the structure of male die and the layout of portholes, it also includes the determination of fitting clearance ,the size of cores, the structure of the chamber and the bearing etc. the new structure has the obvious advantages, it can greatly improve the life of the die, it is a good structure which is worth of popularizing.

1. Introduction
The use of semi hollow aluminum profiles is very common. The die is the key factor for extrusion production of semi hollow aluminum profiles. Because of the high complexity of the design on the semi hollow aluminum dies, it is the key and the emphasis to solve the strength of the cantilever in the die design. To this end, many scholars and engineers have carried out extensive and deep research, they achieved some successful experience and put forward some new and effective die structures. For example, the cutting type porthole die, the covered type porthole die, the protective type porthole die and the hanging porthole type die structure etc. However, because of the variety of shape and sections, it is very necessary to explore the die structure of the semi hollow aluminum profiles to make the die structure have wider adaptability and pertinence. Through an application case, a new porthole extrusion die named inlay type for the semi hollow profiles was presented. For reference.

2. The structure of inlay type porthole extrusion die
Figure 1 is shown as a semi hollow section.

Figure 1. The signal of section.

The area of the section is 234mm², and the minimum width of the opening of the dangerous cantilever is 16.2mm. By calculation. The ratio of the tongue to the profile is 5.6. According to the
characteristics of the profile and the factors such as the extrusion ratio and cost, the extrusion machine capacity of 8MN is selected and its inner diameter of the container is 125mm. The extrusion ratio is 52.4 and the size of the die is selected to be 200 mm by 130 mm.

The structure of inlay type porthole extrusion die is that the die is designed to has false cores in both male die and female die. The false core of the male die is not like the usual core of porthole, which should fit into the hole of the female die, but it maintains a certain gap with the bottom plane of chamber of the female die. The position of the cantilever of the chamber corresponding to the male die is raised to a false core of a female die, and the false core of the male die is dug in the corresponding position, and the false core of the female die is embedded into the cavity of the male die excavated. This cavity excavated is a blind hole. There is a certain gap between the top surface of the false core of the female die and the cavity part of the false core of the male die, so that it can eliminate the pressure of the cantilever of female die, when the force of the male die is flexed or pressed down. Similarly, there is a suitable gap between the side surface of the false core of the female die and the cavity excavated in the false core of the male die. When the false core or cantilever of the female die is subjected to the lateral force produced by the metal extrusion forward force or metal flow, Whether it is a downward deflection or a lateral deflection, it will be constrained and restricted by the false core of the male die. As long as the male die has enough strength, it ensures the stability of the cantilever during the extrusion process to protect the cantilever, so the strength of the die will be greatly improved. The die structure is shown in Figure 2.

![Figure 2. The signal of die structure.](image)

3. The key points of structure design

3.1. The size determination of the false core raised from the female die

The size of the cavity excavated in the false core of male die is determined by the size of the false core in the female die, while the cavity to the core of the male die should have a certain edge value. The experience value of the edge shows that it should not be less than 3mm, and the distance from outer contour of the false core of the male die to the boundary of the female die cantilever are 3 mm. The size of the false core of the female die can be calculated, as shown in Figure 3.
Figure 3. The signal of size of false core in the female die.

3.2. Design of portholes
The design of portholes for the new die structure mainly includes determining the layout of feeding holes and the area of feeding holes, that is, the ratio of feeding. In the layout of feeding holes, it is important that the feeding holes should not be set at the end of the cantilever that is the support side of the cantilever. When the feeding hole is set at the head of the cantilever, it is necessary to avoid that the head of the cantilever should be directly impacted when the metal flows. When the head is directly impacted by the metal, the bending moment to the cantilever root is the largest, which may cause the cantilever to produce the downward flexure to the maximum. Of course, if the features of the profile are allowed, the supply of metal at the central part of the head should be considered, it is the best a scheme that the head and root of the cantilever cannot set a shunt hole, but the adjustment of the metal flow velocity is not difficult. The larger feeding ratio should be selected and the metal forming and the strength of the die should be considered synthetically so as to reduce the extrusion pressure. The experience shows that the feeding ratio to the extrusion ratio is the most suitable from 30% to 40%. The arrangement of feeding holes and the structure the male die are shown in Figure 4.

The main parameters are as follows:
(1) the feeding ratio is 23.7.
(2) the width of the bridge is 24mm, and the height is 70mm.
(3) the inlet chamfer of bridge is 6 mm by an angle of 20 degrees.
(4) the safety factor of the die strength is 3.4.
(5) the largest circumcircle of the feeding hole is 114mm.

Figure 4. The signal of portholes and male die structure.
3.3. The chamber and the bearing of the female die

The structure of the female die chamber, one is the outer edge contour of the chamber, which is mainly based on the outer edge of feeding holes into the chamber. The other is the height upward that the false core of the female die is raised from the plane of the chamber, if it is too high, it will reduce the rigidity and stability of the cantilever, and the height is too small, and it will make the contact area of two false cores decreases, so that the false core of the male die reduces the binding force to the false core of the female die, and it is also not conducive to the strength improvement of the cantilever. Experience shows that the most suitable height of false core of the female die is equal to the height of chamber. The selection of the bearing for the die hole is based on the convention principle. The chamber structure and bearing are shown in figure 5.

![Figure 5. The chamber structure and the bearing belt.](image)

3.4. The gap between the two false cores

The matching gap between the two false cores consists of two directions, one is the gap between the top of the false core of the female die and the bottom of the cavity excavated in the false core of the male die in the direction parallel to the direction of the extrusion, and the other is the direction perpendicular to the direction of the extrusion, that is the side gap between the false core of the female die and the side of the cavity excavated in the false core of the male die. The gap is shown in Figure 6.

- The value of the experience gap is shown as follows:
  1. \(a=b= (1-2) \text{ mm}\).
  2. \(c= (0.08 - 0.12) \text{ mm}\), larger from 0.03 to 0.05 mm than the gap between the male die and the female die.

![Figure 6. The signal of clearance between two false cores.](image)
4. Conclusions
For the inlay type hollow extrusion die, the key is to determine the gap between two false cores and design the feeding holes. The practice shows that the new structure can improve the force condition of the cantilever, greatly reduce and overcome the force of the metal to the cantilever during the extrusion process. It can greatly improve the strength and life of the die. Accordingly, the new die structure is worth popularizing.

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