A Covering and protection Type Porthole Die For Semi-Hollow Al-Profiles

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Abstract—A new structure named covering type for the semi-hollow Al-profiles was present. Through a common actual case, the determination of structure parameters was introduced in detail. Mainly including the arrangement of portholes, the structure design of chamber and the selection of bearing. The method of checking the die strength was introduced. According to the extrusion results, the structure of the traditional solid die and the covering type structure were compared. The characteristics of the latter structure were simple and easy to process. The practical application shows that the new die structure can enhance the die life, improve the production efficiency and reduce the cost. The high precision and the surface brightness of the profiles were obtained. The structure is worth promoting. The aim is to provide reliable data and reference for the further research and development on the structure for semi-hollow Al-profiles.

1. Introduction
With the development of modern manufacturing technology, as well as the understanding and research of aluminum alloy, aluminum alloy profile has been widely used, and the market demand is huge. In the huge market demand, the proportion of the half hollow section is quite common \cite{1}. And semi hollow section of the production, the mold is the key element. This is because the mold design of the semi hollow profile is higher, and the strength of the mold is the key. Therefore, vigorously developing suitable for semi hollow profile extrusion die structure has a very important significance. In this paper, through the common actual examples, a covering type porthole die structure will be introduced specially for semi hollow aluminum profiles to offer reference.

2. The covering and protection type porthole die structure
The covering and protection structure is a kind of structure which is used with a porthole structure of covering and protection stead of the traditional solid structure for semi hollow profiles \cite{2}. At present, the porthole structure commonly used in the semi hollow section is the cutting type porthole die, but the structure is easy to produce the raised wire and convex flange on the surface of profiles. The covering and protection type porthole die structure is that the center part of the male die is used as a cover or shelter to protect the cantilever\cite{3}, so that the cantilever can not bear the positive pressure of the metal during the extrusion process, and the cantilever is completely protected. And in the female die, the cantilever must protrude or raise upward, but it has no contact with the male die, there is a gap named stress gap between the top of bulge and male die, as a result of the gap, even if the male die is bent...
downward by force in the extrusion process, the male die can not touch the cantilever, and the cantilever will be protected effectively, which improve stress state of the cantilever and reduce the force area of the cantilever, so as to greatly improve the strength of the cantilever and the die. And the porthole die structure is used to make full use of the bridge as the protection of the cantilever, avoid the cantilever and its end in particular bearing directly the positive pressure of the metal extrusion, so as to improve the strength of the die.

### 3. Determination of die structure parameters

#### 3.1 The design of portholes and the bridge

The design of the portholes includes the determination of the feeder ratio, the size of the porthole and the structure of the bridge. This is the key. The section shown in Figure 1 is a common section of civil building doors and windows, a typical semi hollow section.

![Fig1. The signal of typical semi hollow section](image)

The purpose of using the new structure is to protect the cantilever from the direct impact of the metal. Therefore, it is important to avoid the impact of the end part of the cantilever directly to withstand the impact of the metal, as far as possible the use of the bridge for shelter [4]. According to the characteristics of the profile shown in Figure 1, it is more suitable to use two portholes and a bridge. As shown in Figure 2, you can do what the cantilever is arranged under the protection of the porthole bridge, and the use of the structure, the area of portholes can be taken larger to increase the feeder ratio, which can reduce extrusion pressure, lighten the cantilever force, improve the cantilever strength.

![Fig.2 The signal of the portholes arrangement](image)

Because the cantilever must protrude or raise upward, the structure of the bridge should be designed according to the protruding boundary dimension of the corresponding cantilever. The structure of the bridge is shown in figure 3.
3.2 The welding chamber and the bearing

The shape of welding chamber is determined in terms of the outer contour of the portholes [5]. The key is to determine the size of raised boundary of cantilever, which is the key to the structure of the covering and protection type. The size relation between the raised part and the die hole of cantilever is shown in Figure 4.

The principle is that the distance from the edge of the protruding part to the edge of die hole of the cantilever can be determined in the range from 2mm to 3 mm. At the same time, with a stress gap between the top of raised part of cantilever and the bottom of the bridge, for a ease of processing, the gap is built by cutting the top of the cantilever, the experience value show that the gap is a range from 0.5mm to 1.2 mm, the bridge does not produce a force to a cantilever, so the value of gap is taken 1.0 mm. The welding chamber structure and bearing are shown in Figure 5.
3.3 The die Structure composition
The die is composed of the male die and the female die, as shown in Figure 6.

From taking cost of die, extrusion coefficient and die strength into account, we choose 10MN extrusion machine, its inner diameter of container is 135mm. After a calculation, the extrusion coefficient is 61.2, the feeder ratio is 20.1, the die size of selection is that the diameter is 200mm, and its thickness 130 mm.

Fig.6 The signal of die Structure composition

4 The extrusion results comparison
According to the extrusion tracking for the profile shown in figure 1, using the traditional solid and the covering and protection type of the porthole die structure, the results of the comparison as shown in table 1. The results show that the new structure has the obvious advantage.

| Die structure                              | Die life (tons) | Wall thickness deviation | Extrusion Marks and brightness | Dimension Precision level | Change of Opening size | Processing difficulty | Die material |
|--------------------------------------------|----------------|--------------------------|--------------------------------|--------------------------|------------------------|-----------------------|--------------|
| Traditional solid                         | Less than 1.2  | obvious                  | deep, rough                    | general                  | big                    | big                   | 62Kg         |
| Covering and protection type               | 26.7           | Not obvious              | low, shining                   | high                     | medium                 | simple                | 35Kg         |

5. Conclusions
Through the test of extrusion and use tracking. The results show that the die is successful in one time. And by the repeated use after nitrided, die extrusion production life reached 26.2 tons. Thus it can be shown that the new structure named covering and protection type is effective, it can improve production efficiency and reduce cost; it is a kind of worth promoting structure. At the same time, we can see that the design of portholes, the bridge structure and die welding chamber structure and selection of bearing are key and important to the new structure.
References

[1] LIU Jingan. Die design manufacture application and maintains for aluminum profiles extrusion [M]. Beijing:Metallurgical Press, 1999:181-183.
[2] XIE Jianxie, LIU Jingan. Die design manufacture application and maintains for aluminum profiles extrusion [M]. Beijing: Metallurgical Press, 2012: 133-138
[3] WANG Liwei. Optimization design of extrusion die for the bigger slenderness ratio half hollow aluminum profile [J]. Die and Mould Manufacture, 2011(4): 61-64.
[4] YU Mingtao, LI Fuguo. Simulation extrusion process of the sketch hollow aluminum profile based on infinite volume method [J]. Die and Technology, 2008(4):40-43.
[5] SUN Xuemei, ZHAO Guoqun. Fake porthole extrusion die structure design and strength analysis for cantilever aluminum alloy profiles [J].Journal of Mechanical Engineering,2013, 49 (24): 39-44.
[6] KUANG Weihua, CHEN Biaobao. Research on design and structure of extrusion die for cantilever aluminum profile [J].Hot Working Technology, 2013, 42(21): 136-138.
[7] DENG Rurong, Huang Xuemei. Design of the extrusion die of semi-hollow aluminum profile [J].Light Alloy Fabrication Technology,2015,43(4):51-54.