Influence of Welding Tooling and Technology on Welding Performance of Aluminum Alloy

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Abstract: Aluminum alloys are widely used in various structural constructions due to their excellent metal properties, and there are characteristics of difficulty in assembly. Based on this, the paper analyzes the influence of welding tooling and process on the welding performance of aluminum alloy, selects the surface positioning method, designs various types of splint, and completes the design of box welding tooling. On this basis, vacuum electron beam welding is used to complete the tailor welding of the chassis through strict process measures, and the weld seam with the aspect ratio meets the requirements is obtained, which ensures the integrity of the chassis structure.

1. Introduction

The aluminum alloy not only continues the aluminum light and elastic characteristics, but also has more properties according to different metal additives, such as better thermal conductivity, high strength, high electrical conductivity and the like [1]. The research and application of aluminum alloy is one of the hotspots at present, and its proportion in the application of trains and related equipment is increasing [2]. Especially, it can heat treat 6000 series aluminum alloy sheets, which can well meet the body and related equipment. Frame structure requirements. While the power pan is reducing its own weight, it also ensures the strength and rigidity of each component in a high-speed service environment [3]. The 6000 series aluminum alloy has low density, high specific strength, good elasticity, good impact resistance, corrosion resistance and high. The advantages of electrical conductivity, easy surface treatment, easy processing and high recycling are gradually applied to the traditional steel materials in the pantograph welded structure. Aluminum alloy rectangular tailor welded chassis is widely used in the electronics industry. The aluminum alloy rectangular chassis has various structural forms [4]. In the development process of the aluminum alloy rectangular chassis, the manufacturing process is first to process the panel, and then the four panels are welded into the chassis. The assembly accuracy of the chassis is mainly guaranteed by the welding process. In the process of tailor welding of aluminum alloy chassis, there are problems such as difficulty in assembly and difficulty in ensuring assembly accuracy [5]. If the welding method and process parameters are improperly selected, it will not only cause serious deformation after welding of the chassis, but also may seriously affect the quality and performance of the chassis due to defects such as weld porosity, slag inclusion and incomplete penetration. In order to ensure the quality of the welding, the process measures must be strictly controlled to obtain the products that meet the quality requirements.

2. Aluminum Alloy Welding Process

From the overall structure of the commonly used aluminum alloy rectangular chassis, it is usually composed of a left side plate and a right side plate [6]. The thickness of the front and back panels and the bottom plate is generally about 10 m, and is welded by using the material of the alloy aluminum plate. In the long-term situation, because the form of welding and related process parameters are not well selected, it has a certain impact on the quality of the chassis after welding [7]. Or it is due to the certain defects of the weld pores that affect the cracking of the metal of the weld. This not only has a certain impact on the mechanical function of the chassis, but also reduces the corrosion prevention function, resulting in the quality of the chassis and the overall quality of the welding is not well protected [8]. According to the needs of the cabinet, after the completion of the welding of the chassis, there are certain requirements: First, to ensure the robustness during welding, slag inclusions and cracks must not occur after welding, and the strength should meet the relevant quality standards. In addition, take appropriate measures to deal with parts cleaning and tailoring work. Finally, the welding form and the selection of the welding value, the proper selection of the welding place, the reasonable design of the shape of the weld wave mouth, the way to avoid the deformation of the workpiece during welding, and the related process plan to improve the product quality.

Aluminum exhibits oxidation due to physical properties, and alumina has a higher melting point [9]. Not only is it difficult to remove, but it also affects the smooth progress of welding. In the welded joint, there are disadvantages in different aspects such as pores and incomplete penetration. Therefore, the relevant personnel should use the AC tungsten argon arc welding method for the welding of the chassis. In the welding process, because the polarity of the alternating current is changed by the period, the half wave in each cycle is different, or the direct current is connected, or the direct current is reversed. [10] In the DC positive connection process, the tungsten level can better control the emitted electrons and improve the arc stability. In the process of DC reverse connection, the oxide film is removed, which makes the surface smooth and forms a better weld. Such tungsten-grade argon arc welding can better clean the effect, and also reduce the loss of tungsten level and improve the efficiency of arc stabilization. Especially suitable for aluminum alloy chassis welding. Choose a better quality tungsten argon Syn-croW ave250. The advantages of this type of soldering are lighter and smaller, and the switch can be used to select the appropriate welding current for easy operation. Welding parameters are selected with reference to years of experience and combined with relevant welding information.

3. Aluminum Alloy Welding Structure Characteristics and Quality Requirements

3.1. Welding structure characteristics and quality requirements

The aluminum alloy chassis is welded by four panels of different structural forms, which are uncovered cube structures with a panel height (ie weld length) of 400 mm. According to the drawings and technical conditions, after the overall forming of the chassis, the acceptance criteria are: weld quality requirements, penetration depth greater than 10 mm, weld bead, no slag inclusions and cracks after welding; overall size requirements, before and after The verticality and flatness of the panel and the side panel are less than 0. 03 mm; the inner cavity size is required. The inside of the chassis is used for placing electronic components. After welding, it cannot be processed, and the deformation is strictly controlled to ensure the space size before and after.

This structural form preferably retains the angular structure of the box structure, but the welding is difficult. Mainly include: aluminum alloy is easily oxidized in air; large specific heat capacity and thermal conductivity of aluminum alloy, hot cracking tendency of welding, large heat input required to achieve the required penetration; panel The groove and the boss structure on the upper part are close to the weld seam. If the process parameters are improperly selected, the groove and the boss will be collapsed. The assembly of the chassis is difficult, and the position and assembly accuracy of the panel can only be ensured by visual inspection; Tailor-welding consists of four welds and the welding sequence needs to be properly set. The long weld seam and large heat input will inevitably lead to deformation and stress.

3.2. Welding deformation analysis and welding method

The weld seam of the chassis is a long weld of thick plate, the transverse shrinkage of the weld is large, and the angular deformation caused by the lateral contraction will cause saddle deformation of the chassis. Figure 1 shows the welding deformation of common aluminum alloys.

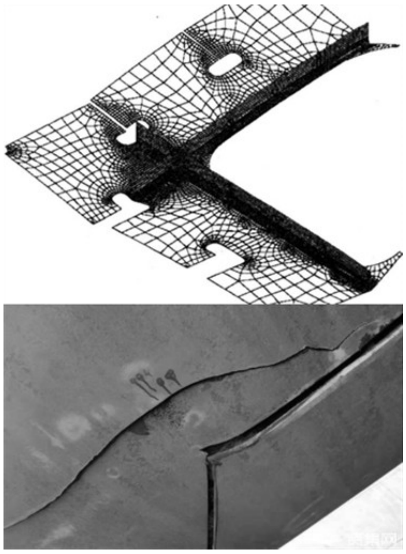

Fig.1. The welding deformation of common aluminum alloys

For box-type components, the heat conduction and rigidity of the joints are very different. There is a big difference in the longitudinal shrinkage between the front and rear panels and the left and right side panels after welding. For long welds, improper welding sequence or process measures will cause the weld to be misaligned. Will cause spiral deformation. The size of the inner cavity of the chassis is small, and only one-side welding can be used for double-sided molding, and the structure has a large requirement for the aspect ratio of the weld. Therefore, it is proposed to use vacuum electron beam welding, one-time welding to reach the requirements of penetration: on the one hand, welding in vacuum, avoiding the oxidation of aluminum in the air, effectively preventing defects such as pores, slag inclusions and incomplete penetration in the welded joint; In terms of small heating area and small deformation, it can form a welded joint with a large aspect ratio. The shrinkage and angular deformation of the joint are one order of magnitude smaller than that of TIG welding, and have little effect on the structure near the weld of the casing.

3.3. Tooling design

The actual experience shows that the most important controllable factor affecting the dimensional accuracy and shape tolerance of the weldment after welding is the clamping state of the workpiece. Design tooling to ensure the assembly quality of the chassis has become a key task in the successful development of the chassis. Due to the complexity of the chassis structure, in order to ensure the integrity of the corresponding functional structure on the chassis panel, the design of the aluminum alloy chassis tooling has its own unique principles and requirements on the basis of the principles and requirements of the common fixture design: (1) Welding tooling There should be sufficient assembly and welding space, which does not affect the welding operation and visual observation range, does not hinder the loading and unloading of the welding parts, and must leave the beam space of the electron beam beam; (2) The clamping device cannot damage the positioning device of the welding piece. And the geometry to ensure that the weldment does not loosen and slip after clamping; (3) The force-bearing member should have sufficient strength and rigidity to withstand the restraining forces in various directions caused by the limitation of welding deformation; (4) different The panel and side panels of the chassis contain different structural forms, and the fixtures need to have certain flexibility to meet the needs of different structural forms of the cabinet; (5) for the deformation form of the chassis tailor welding, reasonably arrange the clamping force application position and manner And size to control welding deformation.

According to the softer characteristics of the aluminum alloy, the tooling is positioned by the surface or profile of the workpiece. The fixture includes a positioning device and a clamping device, which cooperate to shape the part and reduce the welding deformation during the welding process. The assembly welding fixture of the chassis is composed of four parts: front and rear panel clamping plates, left and right panel clamping plates, inner supporting blocks and plugs.

Front and rear panel splints: front and rear panels The y-direction clamping force can be transmitted by the left and right side panels, while the x-direction has no positioning plane and positioning features, so the “sandwich” positioning and pressing design is adopted. The workpiece is pre-positioned by pre-fixing the internal splint position, and the two splints ensure positioning and clamping of the workpiece. Due to the large size of the front and rear panels of the chassis, if the whole plate is clamped, material is wasted and assembly is not easy, so the appropriate width of the splint is designed for the four welds. For the plane with the boss and the groove, the rigidity of the boss is small. It is easy to deform and avoids the collapse of the boss when the clamping force is applied. According to the structure of the boss and the groove, the corresponding structure is processed on the splint to match the panel structure of the chassis, and the clamping force is ensured to be evenly distributed on the plane of the splint, and the structural features can be utilized for the assembly and positioning of the splint. When designing the splint structure, due to the difference in the positional structure of the bosses and grooves of the different chassis panels, the flexibility of the clamps needs to be considered, so that one splint can be applied to various types of chassis.

Left and right side panel clamps: The vertical and horizontal orientations of the left and right side panels and the front and rear panels can be ensured by the front and rear panels. Only the y-direction clamping force is applied to the left and right side panels to ensure the assembly accuracy of the left and right side panels. Under the premise of ensuring the assembly quality, in order to reduce the assembly difficulty and the difficulty of the fixture processing, the shape of the left and right side panel clamps is designed as an H-shaped surface. The width of the H-shaped surface is the same as that of the left and right side panels. When assembling, the H-shaped surface is attached to the edge of the chassis. Qi.

Inner support block and plug: For the saddle-shaped deformation of the workpiece after welding, the inner cavity forming and positioning method is adopted, and the inner lining tool is installed to prevent the front and rear splint from being deformed, and the steel tire strip having a linear expansion coefficient smaller than the aluminum alloy is used as the positioning support. The size of the tire directly affects the size of the cavity and the tolerance of each shape. If it is too small, it will not be able to act as a pole. If the assembly is too small, the chassis will be inconvenient to assemble or even reversely deform.

Connection mechanism: The clamping plate is fastened by the nut, and the adjustment of the nut is achieved in all directions to ensure that the clamp is attached to the workpiece. The thread length of the stud is to ensure ample adjustment range. The x-direction and y-direction connection studs intersect perpendicularly in space, and the position needs to be reserved, staggered in the z direction and leave enough space to avoid interference. If the front and rear direction connecting studs are placed under the left and right direction connecting studs, and the left and right direction connecting studs are placed inside the box body, the operation space of some fixing nuts of the front and rear splints is narrow, and it is difficult to apply torque. Passing the studs in the left and right direction from the inside of the front and rear jigs will well avoid this problem.

The height of the splint determines the installation space of the stud. The height of the design splint should be based on the economic basis and the implementation of the clamping force. Consider the position of the stud hole and the installation position of the arc chute. The stud hole position is located as close as possible to the center line of the splint.

The thickness of the splint must ensure that the splint has a certain rigidity, so that the deformation of the weldment is always limited by the clamp. The position of the splint is as close as possible to the weld without affecting the welding operation. At the same time, the position of the workpiece comparison rule is selected to reduce the processing difficulty of the positioning profile.

3.4. Post-weld quality

According to the process plan, the assembly and welding of the rectangular chassis were completed, and satisfactory quality was obtained, as shown in Figure 2.

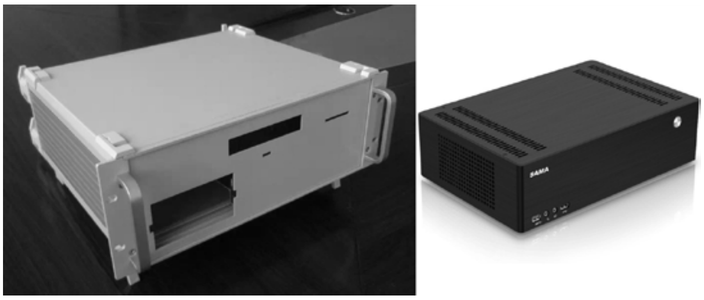

Fig.2. Welding finished product

The surface of the weld is bright and visually inspected. The deformation of the chassis after welding is small, and the inner block is easy to remove. After testing, the dimensions of the inner cavity of the chassis and the tolerances of each shape and position meet the requirements of the drawing size. The technical specifications of the dimensional tolerance of the chassis meet the design requirements. Achieved the intended goal of the development of rectangular chassis.

4. Conclusion

Based on the analysis of the weldability of the aluminum alloy chassis, the saddle-type and spiral-type deformation of the chassis structure were designed. The tooling of the one-time assembly of the chassis was designed. The process of welding to both ends was used, and the chassis was completed by vacuum electron beam welding. Developed. The invention solves the problem that the welding of the aluminum alloy chassis is easy to deform and the dimensional accuracy is difficult to ensure. Practice has proved that the chassis developed according to this process scheme has small deformation of the chassis, beautiful overall structure and excellent appearance of the weld.

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